IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: JR Spidell

Submitter Name: JR Spidell **Email:** seashoredreamer@gmail.com

Project Contact: JR Spidell **Email:** seashoredreamer@gmail.com

Project Title:

Machine Learning: Semantic Segmentation Optimization

Project Abstract:

Semantic Segmentation is an important type of machine learning algorithm that is used in many different algorithms today including generative AI, autonomous driving, and drone vision systems. Embedding SemSeg algorithms poses a challenge due to the large size of the models.

This project will break up an existing U-Net model into code segments that can then be pipelined. The result will be slightly higher latency but also higher throughput of the algorithm.

This project will implement the pipeline on an existing multicore (6-core) ARM embedded system.

Expected Deliverables:

C code running on an ARM based evaluation board

Specialized Resources Provided by Client:

All resources including starter code base, embedded system hardware, solid state drives will be provided. Client also provides tutoring and helps students overcome technical issues.

Anticipated Cost: _____ **Financial Resources Provided by Client:** All resources including starter code base, embedded system hardware, solid state drives will be provided.

Preferred Students for the Project:

- ☐ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Linux environment experience. Some python code experience is helpful. No machine learning knowledge is required.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☑ Web / video conferencing

☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj001
☐ Project Assigned: _____
☐ Advisor(s) Assigned: _____
_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: JR Spidell

Submitter Name: JR Spidell **Email:** SeaShoreDreamer@gmail.com

Project Contact: JR Spidell **Email:** SeaShoreDreamer@gmail.com

Project Title:

Machine Learning Based Camera Autofocus

Project Abstract:

In Machine Vision systems, it is common to periodically change a camera's focal point using some sort of autofocus algorithm. The use of machine learning techniques has the potential to significantly reduce the time required to achieve an ideal camera focus.

This project will attempt to implement and characterize a machine learning model to perform autofocus.

Expected Deliverables:

Code written in C and / or Python that implements and characterizes an ML based autofocus model.

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** All financial resources required for the project will be provided by JR Spidell.

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Linux environment experience required. Some python coding desired.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj002

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Matt Post/ECpE Department

Submitter Name: Matt Post **Email:** mpost7@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:

Interactive Poster Displays for ECpE Commencement

Project Abstract:

The goal of this project is to redesign the ECpE electronic poster displays used during commencement ceremonies. These displays showcase the SR Design teams posters to students families and friends. The current version uses a Raspberry Pi running an Android application to view the posters and the users interface with an encoder that is read by an Arduino. Your teams job is to completely redesign the system, backend, and user interface. The final product should be intuitive to use, easy to maintain and manage, and showcase the technical prowess of our department. The bare minimum solution (passing grade) is a embedded system that can take posters of any generic file type (png, jpeg, pdf), load them into a slideshow with a single application/executable, and have a professional way to interface with them. If a hardware solution is chosen a well designed enclosure and PCB are a must. Ideally the team will find a "touchless" solution that will allow for gesture navigation. This will require skills in image processing, embedded systems (Xilinx toolchain preferred), machine learning, etc... The team is encouraged to and has the support for going above and beyond with this project. Show you family and friends what you've learned here in Coover and give the Department something to be proud of with this project!

Expected Deliverables:

The team will start by researching various solutions to the project and with in a month have a final option chosen. A working proof of concept should be demonstrated for the 4910 presentation. This is flexible depending on the complexity of the chosen solution. Second semester should be spent reiterating the design, user testing, thoroughly documenting the project. The final project displays will be used for Fall 2025 commencement ceremonies.

Specialized Resources Provided by Client:

Team will be supported by ETG and the ECpE department

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☐ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering

Other: Any Electrical Engineers on the project must be comfortable and able to contribute to

- ☑ embedded system designs

Other Special Skills: Embedded System and UI design experience is a plus. Great project for any CPRE 488 students

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
  ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☑ 2	☐ 3	☐ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj003

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Matt Post/ETG

Submitter Name: Matt Post **Email:** mpost7@iastate.edu

Project Contact: **Email:**

Project Title:

ECpE Checkout Locker Final SR Design Team

Project Abstract:

This team will be responsible for the last remaining portion of the ECpE Checkout Locker project. Since 2008 this project has been attempted by SR Design team after team without success. The hardware portion of this project is complete and has been running without issues since late August. We now need you to help get this across the finish line - finally!

The checkout locker is a PO box style locker enclosure with 35 units that are controlled via CAN bus communication coming from a custom Raspberry Pi hat and individual locker control units (LCU's). Each locker is outfitted with a solenoid, LED, and hall effect sensor to handle the needed functionality for processing a student's checkout request. The locker will hold commonly used items from ETG for prototyping various ECpE designs. Students will have 24/7 access to the lockers allowing them to continue working even when ETG is closed.

An existing backend database was developed by a SR design team a few semesters ago. It uses Flask in Python to host the web application, and stores the user, locker, and item information in a MySQL database. The Flask server adds the data to be displayed in each HTML page using Flask's templating system. The team would be expected to complete any features needed in the back end, and develop an appealing and functional web interface, particularly focusing on easily navigating the locker's touch screen. To check items out, the team's design will need to read student ISU Cards using a Wave ID card scanner and connect to a university web API to get the user's information. The database has some security in place but needs further testing and development along with security for the front end. The web interface needs to be designed to ISU standards and written so that ETG's web team can easily take over the project.

Once the database and frontend are separately tested and vetted the team will be responsible for integrating them into the existing system using a prebuilt firmware API for the LCU's. If any revisions are needed for the firmware/hardware they will be provided by ETG. The group will have access to all previous attempts at this project along with support from the hardware and firmware engineers. They will also be mentored by ETG's IT staff to ensure standards and expectations for the design are met. The locker system will be installed in the TLA so the team can get actual user testing/feedback to iterate on their design.

Expected Deliverables:

First semester should be spent selecting a front end solution and implementing a working proof of concept. This will be done alongside finishing any needed backend work. Both of these designs should be working and in testing stages by 4910 presentations. Integration work should be started before leaving for Summer break. Second semester should be spent testing the system design, iterating the software as bugs are discovered, and gathering user feedback. Detailed documentation and proper GIT use are required throughout the project. The team should be able to demo a fully functioning locker system at the end of this project.

Specialized Resources Provided by Client:

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☐ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Previous UI and or web design experience is useful.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☑ 2	☐ 3	☐ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj004

Senior Design Project Proposal Form

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: ECpE Department

Submitter Name: Matt Post **Email:** mpost7@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:

CyDAQ Digital Signal Processing Platform Firmware Update

Project Abstract:

ECpE Department needs a group of talented Engineers to update and upgrade the CyDAQ firmware and software. The CyDAQ is a custom Digital Signal Processing (DSP) platform currently being used in EE 224 and 324 labs for hands-on Signals and Systems experiments. However, the long term goal is to make this an open source platform for Universities across the country to utilize in their DSP labs. The CyDAQ has programmable filters, a high speed Analog to Digital Converter (ADC), and a Digital to Analog Converter (DAC) all being run by a Xilinx's Zybo Z7 FPGA. The team's responsibility is to update the firmware on the CyDAQ to increase its functionality and bring it closer to being used by other Universities.

The CyDAQ is currently running an Asymmetric Multiprocessing (AMP) application across both ARM Cortex-A9 CPUs in the FPGA processing system. The first core is running PetaLinux to handle communication with Windows and the second core, which is running bare metal C code to handle the high speed sampling, PID controller, and other data processing. The senior design team will have to refactor the Remote Procedure Call framework to allow for live data streaming to finish implementing the balance beam. Once completed the team is free to implement the many additional features (DAC mode, Linux Sandbox, etc…).

This project cultivates great experience with the Xilinx toolchain which is used in CprE 488 and many companies in industry (i.e. AMD and ARM). This project will be managed by ETG and supported by Dr. Jones along with past students who worked on the project.

Expected Deliverables:

By the end of this project the team is expected to have implemented a RPC framework to properly communicate across the two CPU cores of the FPGA, finish the implementation of the balance beam, and implement any additional project features for the CyDAQ as time permits.

Specialized Resources Provided by Client:

Full access to all the necessary hardware and software for the project. Access to ETG engineering support and previous firmware design engineers.

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☐ Software Engineering

Other Special Skills: In depth understanding of the C Programming Language (preferably C11) and previous embedded systems programming experience is mandatory. You

☐ Cyber Security Engineering
Other: SE students are more than welcome but will not be able to Google your way through this project.
☑ must have embedded system experience

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☑ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj005
☐ Project Assigned: _____
☐ Advisor(s) Assigned: _____
_____

Senior Design Project Proposal Form

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Reiman Gardens

Submitter Name: Nathan Brockman **Email:** mantisnb@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:

Gourd Guardian - Pumpkin Tracker - Reiman Gardens

Project Abstract:

Reiman Gardens has an annual event in October where we carve over 1000 Jack-o-lanterns. Each pumpkin is given a unique pattern. To accomplish project Reiman Gardens has over 1500 stencils on file which grows each year. To complete this large task a large pool of volunteers are used for all the steps. Reiman Gardens needs a web based tool with a mobile web interface that allows the Gardens to track each stencil through the entirety of the process. The Gardens would need the ability to trach stencils through all steps; selection, printing, cutting stencils, tracing on pumpkins and carving. The Gardens would also like some sort of barcode system that can be add to stencils to make data entry quick and easy. With the sheer volume of items we need to track the systems needs to be easy and fast for users. The system will also need a public facing side allowing tracing and carving volunteers to enter their own data.

Expected Deliverables:

We would like to use this project as part of Spirits in the Gardens 2025. Working MVP by Spirits in October 2025 for volunteer interface and full working program by December 10th.

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☐ Electrical Engineering
- ☐ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj006

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Reiman Garden

Submitter Name: Nathan Brockman **Email:** mantisnb@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:

Winter Wonderscape - Reiman Gardens - Light Pannels

Project Abstract:

Reiman Gardens has an annual light show during the winter holidays. In 2024 a senior design group worked on creating a light element for WW. This project will allow a new team to use the hardware acquired and assembled from the first group to build an interactive light show for visitor of Reiman Gardens Spirits in the Gardens and Winter Wonderscape events. Reiman Gardens is looking for a interface that will allow them to create lighting effects that can be programed on the the light displays. Will need to build/modify control boxes to power and control all of the light on the panels.

Expected Deliverables:

Would like a MVP so a beta test of light project can be displayed at Spirits in the Gardens in October with a full roll out of finished product by December 1 for the Winter Wonderscape holiday light show.

Specialized Resources Provided by Client:

n=20 50" x 16' panels in total it is 2,400 LED light.

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj007
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Akhilesh Tyagi/Iowa State University

Submitter Name: Akhilesh Tyagi **Email:** tyagi@iastate.edu

Project Contact: Akhilesh Tyagi **Email:** tyagi@iastate.edu

Project Title:

Generative AI on the Edge

Project Abstract:

This senior design project aims to develop an innovative edge computing platform that leverages NVIDIA Jetson devices (https://www.nvidia.com/en-us/autonomous-machines/embedded-systems/jetson-orin/nano-super-developer-kit/) and Kubernetes to tackle the challenges of deploying machine learning applications at the edge. The proposed system will address the critical issues of efficient GPU resource utilization, seamless ML model deployment, and robust cluster management in edge environments. By integrating Jetson's powerful GPU capabilities with Kubernetes' orchestration features, the project seeks to create a scalable and high-performance solution for real-time AI inference. This platform will be particularly valuable in scenarios requiring low-latency processing and local data handling, such as smart city applications or industrial IoT systems. The project will focus on optimizing ML model performance for resource-constrained edge devices, ensuring continuous operation in unreliable network conditions, and implementing comprehensive monitoring for the edge cluster. This project aims to expose our students to the practical application of edge AI technologies and their potential to transform various industries by bringing advanced computing capabilities closer to the data source. Specific goals are:

(1) Build a NVIDIA Jetson based AI private cloud compute; (2) Develop a dynamically scalable edge AI application for this platform;

Design constraints will depend on the chosen AI application, but real time AI responses are needed.

Expected Deliverables:

A private cloud compute platform based on NVIDIA Jetson Orin Nano kit. An edge AI application demonstration on this cloud compute platform.

Specialized Resources Provided by Client:

NVIDIA Jetson Orin Nano kit:
https://www.nvidia.com/en-us/autonomous-machines/embedded-systems/jetson-orin/nano-super-developer-kit/

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☐ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Cloud development; AI; Systems;

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☑ 2	☐ 3	☐ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj008
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Manojit Pramanik

Submitter Name: Manojit Pramanik **Email:** mano@iastate.edu

Project Contact: Avishek Das **Email:** avishek@iastate.edu

Project Title:

Wireless Data Acquisition (wDAQ) System for High-Frequency Ultrasound Signal

Project Abstract:

(a) Objectives of the Project: This project focuses on creating a Wireless Data Acquisition (wDAQ) system capable of capturing and wirelessly transmit high-frequency (MHz) analog ultrasound signals to a computer in real-time using Wi-Fi/Bluetooth technology. The system will resemble a standard commercial oscilloscope but with the added advantage of wireless signal transmission. The main goal is to minimize the use of BNC cables, especially when multiple channels are needed, thereby enhancing the mobility of any DAQ system, particularly for remote monitoring. This project offers opportunities for Circuit designers, PCB designers, and STM32 coders. A key application of this system would be in the continuous multiple rotating transducer Photoacoustic Computed Tomography (PACT) system in our Biomedical Imaging laboratory (BILab), Room 222, ASC 1.

(b) Design Limitations:

- The system should be wireless to allow for flexible and mobile data collection.
- It should be capable of real-time data transmission for immediate analysis.
- The DAQ's input should be amplified and filtered using on-board low-noise amplifiers.
- The DAQ's specifications should be: Analog to Digital Conversion (ADC) Sample Rate= 20-25 M S/sec; Record Length- 50 - 100 µs; Rise Time- <100 ns; Resolution- 12 bit; Maximum Input Voltage - +/- 2V; Input Impedance – 50 Ohm / 1 M Ohm; Channel Count- 2 channel per module (One for trigger and another for acquisition); Trigger - Software / External; Low noise Amplifier (LNA) Gain: > 50 dB; Transmission protocol: Wi-Fi (ESP32 board); Interface Program: LabVIEW

(c) Technical Approaches and Tools:

- The PCB design should utilize SMT components to minimize its size. Students are encouraged to consider flexible substrate for PCB assembly to further reduce the system's weight.
- The DAQ should use the STM32H7 series (or higher) from the STM32 family of 32-bit microcontrollers, built on ARM Cortex-M cores, as it offers the highest clock speed in the series.
- The system will utilize existing IEEE 802.11 (Wi-Fi) protocols for wireless signal transmission and reception.
- Design EM shielding of the system to minimize noise interference.
- The system should include a graphical user interface (GUI) program, preferably written in LabVIEW.
- Students will be given access to our PACT system for testing their system. The project's success will be evaluated based on the system's performance, cost-effectiveness, and its impact on the mobility and flexibility.

Expected Deliverables:

Semester 1:

- Project Planning and Design: A detailed project plan that includes task breakdown, team roles and responsibilities, key milestones, and a timeline. The design of the wDAQ system, including the selection of STM32 microcontroller, ADC, LNA, Wi-Fi modules.
- ADC and Coding: Complete the ADC system design and STM32 coding for signal acquisition.
- Wi-Fi: Interface the Wi-Fi module with STM32 for data transfer in real-time mode or buffered/batch mode.
- PCB Design: Complete the first prototype PCB design and SMT component assembly following the design constraints and technical specifications.

- Testing: Test the prototype wDAQ and report the results:

Semester 2:

- System Optimizations: Implement optimization techniques to achieve reliable performance and stable results.
- Finalize wDAQ: Complete the wDAQ design and finalize the overall system architecture.
- LabVIEW GUI: Develop the Graphical User Interface (GUI) program in LabVIEW.
- Final Testing and Evaluation: Conduct comprehensive testing of the wDAQ with our lab-made PACT systems.
- Project Report and Presentation: Prepare a final report detailing the project's execution, findings, and potential future work. Also, prepare a presentation showcasing the project's outcomes and demonstrating the functionality of the wDAQ system.

This schedule is not open-ended and aims to deliver a fully functional wDAQ system by the end of the second semester. Please note that this is a tentative schedule and may be subject to changes based on the project's progress and any unforeseen challenges.

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- ☐ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☑ 2 or more meetings per month
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj009
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Argonne National Laboratory

Submitter Name: Benjamin Blakely **Email:** bblakely@anl.gov

Project Contact: **Email:**

Project Title:

Real-time Anomaly Detection in Space Communications using Large Language Models (LLMs)

Project Abstract:

This project addresses the critical need for enhanced security and reliability in space communications by designing a real-time anomaly detection system utilizing large language models (LLMs). Aligned with the principles of engineering design, this initiative involves an iterative, creative approach to convert available resources into effective solutions for identifying potential cyber threats in space communication networks.

The primary objective is to develop and integrate an LLM-based system into a Network Simulator 3 (NS-3) testbed, specifically configured for space communication scenarios. This endeavor requires the application of basic sciences, mathematics, and engineering principles to meet specified needs while adhering to various constraints such as cost, schedule, and performance standards.

The project commences with a thorough literature review to understand existing methodologies and challenges in anomaly detection within space communications. This foundational research informs the development of system requirements and identifies opportunities for improvement. Following this, the NS-3 environment is configured to simulate realistic space communication protocols and conditions, incorporating potential vulnerabilities to cyber attacks.

Simulation data representing both normal operations and various anomalies, such as unauthorized access or data tampering, is generated and preprocessed for analysis by LLMs. This step involves careful consideration of data quality and relevance to ensure the models can effectively learn and identify patterns indicative of malicious activities.

Selected pre-trained LLMs are then integrated into the NS-3 testbed to perform real-time analysis of simulation data, aiming to detect anomalies as they occur. The system's performance is rigorously evaluated using metrics such as detection accuracy, false positive rates, and response times. This evaluation phase includes making trade-offs and considering risks to optimize the system's effectiveness under given constraints.

Throughout the project, students engage in an iterative decision-making process, applying engineering design principles to convert resources into high-quality solutions. The interdisciplinary nature of the project provides valuable practical experience in research, simulation, and artificial intelligence applications, contributing to advancements in securing space communication networks against evolving cyber threats.

Expected Deliverables:

Deliverable 1: Literature Review Report and Initial Project Plan

- A comprehensive literature review report on anomaly detection methods using LLMs, relevant communication protocols, and cyber threats in space communications.
- An initial project plan document outlining goals, methodologies, timelines, and milestones.

Deliverable 2: Configured NS-3 Testbed Environment

- A fully set up NS-3 simulation environment configured for simulating space communication conditions.
- Adapted or developed NS-3 modules for relevant protocols, documented with instructions for use.

Deliverable 3: Preprocessed Simulation Data Set
- A dataset of simulation data acquired or generated for testing anomaly detection.
- Documentation detailing the preprocessing steps applied to the data to prepare it for analysis with LLMs.

Deliverable 4: Integrated LLM System within NS-3 Testbed
- Selection documentation for pre-trained LLMs chosen for anomaly detection without fine-tuning.
- Code and configuration files integrating the selected LLMs into the NS-3 testbed for real-time analysis.

Deliverable 5: Testing and Evaluation Report
- A report detailing the real-time analysis of simulation data using integrated LLMs.
- Documentation of anomaly detection results based on predefined criteria or patterns identified by the LLM.
- Performance metrics and analysis of the LLM's effectiveness in detecting anomalies.

Deliverable 6: Final Project Report and Presentation Materials
- A comprehensive final report documenting the entire project, including methods, findings, outcomes, and recommendations.
- Presentation materials (slides, demo, etc.) summarizing the project's key points and results.

Project Schedule

Semester 1
Weeks 1-4:
- Deliverable 1: Literature Review Report and Initial Project Plan
- Start configuring the NS-3 testbed environment

Weeks 5-8:
- Continue Deliverable 2: Configuring the NS-3 testbed environment
- Develop necessary NS-3 modules for space communication protocols

Weeks 9-12:
- Finalize Deliverable 2: Configured NS-3 Testbed Environment
- Begin generating simulation data for Deliverable 3

Weeks 13-16:
- Preprocess simulation data and document steps for Deliverable 3
- Start exploring and selecting appropriate LLMs for integration

Semester 2
Weeks 1-4:
- Finalize Deliverable 3: Preprocessed Simulation Data Set
- Begin integrating selected LLMs into the NS-3 testbed

Weeks 5-8:
- Continue Deliverable 4: Integrating LLM System within NS-3 Testbed
- Conduct initial testing of the integrated system

Weeks 9-12:
- Finalize Deliverable 4: Integrated LLM System within NS-3 Testbed
- Begin Deliverable 5: Testing and Evaluation Report

Weeks 13-14:
- Continue Deliverable 5: Testing and Evaluation Report

- Analyze performance metrics and document findings
- Begin compiling Deliverable 6: Final Project Report and Presentation Materials

Weeks 15-16:

- Conduct peer reviews and make necessary revisions
- Finalize Deliverable 6: Final Project Report and Presentation Materials
- Project presentation and submission

Specialized Resources Provided by Client:

N/A

Anticipated Cost: _____ **Financial Resources Provided by Client:** N/A

Preferred Students for the Project:

☐ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☑ Cyber Security Engineering

☐ Other:

Other Special Skills: 1. Proficiency in Programming Languages:

o Strong programming skills in Python, as it is primarily used for integrating LLMs and handling data processing tasks.

2. Understanding of Networking Protocols:

o Basic knowledge of networking fundamentals and relevant communication protocols to understand the context of the simulation data.

3. Data Preprocessing and Analysis:

o Skills in data preprocessing, including cleaning, normalization, and transformation of data for input into LLMs.

o Proficiency in using tools and libraries for data analysis and visualization.

4. Familiarity with Machine Learning and AI:

o Basic understanding of machine learning concepts, particularly anomaly detection.

o Knowledge of how LLMs function and their applications in data analysis.

5. Problem-Solving and Debugging:

o Strong problem-solving skills to address challenges in data processing and integration with LLMs.

o Ability to debug code and optimize system performance.

6. Documentation and Reporting:

o Skills in writing clear and concise technical documentation, including project reports and user manuals.

o Ability to present findings effectively through presentations and demonstrations.

7. Collaboration and Teamwork:

o Effective communication and collaboration skills to work in a team.
o Ability to manage tasks and meet deadlines in a group setting.

While some of these skills may be developed during the course of the project, having a foundational understanding beforehand will significantly aid in successfully completing the project.

Anticipated Client Interaction (estimate):

- ☐ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☑ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj010

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Md Maruf Ahamed

Submitter Name: Md Maruf Ahamed **Email:** maruf@iastate.edu

Project Contact: Md Maruf Ahamed **Email:** maruf@iastate.edu

Project Title:

Smart Home Control Unit for Energy Optimization

Project Abstract:

The primary objective of this project is to develop an innovative smart home control unit designed to optimize energy consumption and temperature management through energyefficient lighting and environmental controls. This system will dynamically adjust lighting and temperature settings based on various parameters, such as ambient light levels, room occupancy, and user-defined schedules or preferences. Additionally, it will monitor and regulate indoor temperature to enhance comfort while minimizing energy usage. The project prioritizes cost-efficient solutions, aiming to make smart home technology accessible to a broader audience.
The smart control unit will integrate multiple sensors, including motion detectors, ambient light sensors, and temperature sensors, to collect real-time data. These sensors will enable the system to make intelligent decisions, such as dimming lights when natural light is sufficient, turning off lights in unoccupied areas, and adjusting heating or cooling settings based on occupancy and time of day. To provide users with full control and insights, the system will feature a mobile application. This app will allow users to remotely monitor and control lighting and temperature settings, as well as view detailed energy consumption and cost-saving statistics in real time.

Expected Deliverables:

1. Design and implementation of a smart control unit for automated lighting and temperature control, aimed at minimizing unnecessary energy use and reducing utility bills.
2. Development of a user-friendly mobile application for real-time monitoring and control of lighting and temperature settings.
3. Creation of data visualization tools to display energy consumption and cost-saving trends, enabling users to make informed decisions

Note: The successful completion of this project has the potential to result in a commercially viable product.

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering

Other Special Skills: This project may require cross-disciplinary collaboration, combining skills in embeded system development, IoT sensors, fundamental of Electrical power and circuits, data

☑ Cyber Security Engineering

☐ Other:

processing, software development, and user interface design.

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☑ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj011

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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Senior Design Project Proposal Form

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Md Maruf Ahamed

Submitter Name: Md Maruf Ahamed **Email:** maruf@iastate.edu

Project Contact: Md Maruf Ahamed **Email:** maruf@iastate.edu

Project Title:

Creating an Automated Parking System Enabled by IoT Technology

Project Abstract:

The primary objective of this project is to develop a cutting-edge smart parking management system, designed to efficiently identify and direct drivers to available parking spaces in real time. This system will leverage video camera technology, replacing traditional ultrasonic or infrared sensors, to continuously monitor the occupancy of each parking space. High-resolution video cameras will be strategically deployed within parking lots to detect vehicle presence and provide live updates on space availability through advanced image processing algorithms.
The data gathered from these video cameras will be processed in real time using a central server equipped with machine learning capabilities. This ensures accurate and timely information about parking space status, enhancing system reliability and scalability. A pivotal element of this initiative is the creation of an intuitive mobile application. This app will present real-time parking space occupancy to users, allowing them to quickly locate and reserve open spots directly from their smartphones. Additionally, the app will integrate payment functionalities for a seamless parking experience.
This innovative system aims to reduce the time drivers spend searching for parking, alleviate traffic congestion caused by parking searches, and optimize the overall utilization of parking facilities. By utilizing video camera technology, this project demonstrates an advanced application of IoT, computer vision, and mobile app development. It offers a scalable, efficient solution to a prevalent urban challenge, paving the way for smarter and more connected cities.

Note 1: This project may require cross-disciplinary collaboration, combining skills in computer vision, video and image processing, data processing, software development, and user interface design.
Note 2: This is a continuation of a previously completed project (SD-Dec24-17) in which a microcontroller system was designed to interconnect with various IoT sensors, such as ultrasonic and infrared, to persistently track the occupancy status of each parking spot

Expected Deliverables:

1. Implement a microcontroller system interconnected with high-resolution video cameras in parking areas to persistently monitor the occupancy status of each parking spot.
2. Develop image processing and machine learning algorithms to analyze video feeds and determine space availability in real time.
3. Create a user-friendly mobile application that displays current parking spot occupancy, enabling users to swiftly locate and reserve available spaces using their mobile devices.
4. Integrate secure payment functionalities into the mobile app for an end-to-end automated parking experience.

Specialized Resources Provided by Client:

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills: This project may require cross-disciplinary collaboration, combining skills in computer vision, video and image processing, data processing, software development, and user interface design.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

- ☑ Approved: sddec25-proj012
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Md Maruf Ahamed

Submitter Name: Md Maruf Ahamed **Email:** maruf@iastate.edu

Project Contact: Md Maruf Ahamed **Email:** maruf@iastate.edu

Project Title:

SmartClass: Transforming Engagement in Large Classrooms with Interactive Learning

Project Abstract:

Every instructor aims to enhance student engagement and participation to ensure a successful class. Question-and-answer sessions or instant quizzes during lectures can be an excellent way to engage students. However, in large classrooms, it is challenging for students to ask questions, especially if they are seated far away (e.g., in the middle or at the back of a large auditorium). In this project, students will design an interactive learning platform (i.e., a web-based application) that will enable students to participate in class activities (e.g., quizzes, polls, etc.) or post questions at any time (e.g., during or outside lecture hours). Instructors will provide feedback through the platform. Additionally, instructors can use the platform to post questions for immediate answers, conduct quizzes, or initiate discussions to test knowledge. This learning platform will also generate student participation statistics, which can be used for grading purposes.

Note: The successful completion of this project has the potential to result in a commercially viable product.

Expected Deliverables:

The final deliverable will be a web-based application with the following features:

1. Separate sign-up options for instructors, TAs, and students.
2. The ability for students to post questions in various formats: text, image, audio, and video.
3. The option for students to post questions either with their name or anonymously.
4. A follow-up or reply features for all conversations, allowing instructors, TAs, and students to comment in text, image, audio, and video formats.
5. Archival of all conversations grouped by categories (e.g., lectures, homework, lab, quiz, etc.), accessible to the entire class at any time.
6. A polling feature that allows instructors to instantly open polls using text or image formats. The system will provide immediate student participation data, and instructors can download participation lists for grading purposes.
7. Future scalability to convert the web-based application into a mobile app (e.g., for Android and Apple platforms).

Additional Features (if feasible):

1. Statistics on contributions, such as the number of posts and feedback response times.
2. A leaderboard displaying the top 10 student contributors by the number of contributions, including names, for potential extra credit.
3. A list of top TA contributors with their number of contributions.

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills: This project may require cross-disciplinary collaboration, combining skills in software development, data processing, and user interface design.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj013
- ☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Iowa State University

Submitter Name: Goce Trajcevski **Email:** gocet25@iastate.edu

Project Contact: **Email:**

Project Title:

Adaptive Management of Snow Plowing Fleet

Project Abstract:

Typically, a fleet of snow plowing trucks adheres to a plan/schedule, based on which specific trucks are assigned a collection of road segments to clear and/or spray with salt. However, often times in practice there are some abnormal/unplanned events that occur which, in turn, may cause a disruption to the planned service. But few examples of such exceptional scenarios include: (a) a specific truck from the fleet breaks down; (b) sudden changes in weather patterns require more resources allocated to road segments near certain priority-areas (e.g., hospitals); (c) road accidents cause delay in the planned plowing schedule; etc...

The main objective of this project is to develop an and-to-end prototype system for efficient and effective management the re-assignment of trucks from the snow plowing fleet when certain abnormalities/events occur that could disrupt the original schedule. The expectation is to have a frontend<->backend kind of a workflow and the two basic categories of interaction would include: (1) web-based system for managing the schedule and current locations; receiving particular updates; and re-calculating new routes for a subset of the trucks. (2) mobile app (to be used by the drivers) where a user can both notify the server of a particular event as well as receive an updated route.

Readings and algorithmic solutions will be provided by the client.

Expected Deliverables:

The expected schedule for the first semester is:
week #2: introductory meeting and problem overview;
week #3: introduction to literature and discussion of algorithms;
week #4: narrowing the scope of project (which algorithms to implement);
week #5: identifying requirements;
week #6: identifying use-cases;
week #7: tools and frameworks selection;
week #8: preliminary system design;
week #9: identifying testing scenarios;
week #10: completing non-functional requirements;
week #11: refining the system design
week #12: refining the testing/validation
week #13: draft of the design document
week #14: revision of the design document and preparation of presentation
week #15: presentation and final design document
The deliverable is the Design Document
Second Semester:
Weekly or bi-weekly meetings to discuss implementation issues/progress.
The final deliverable is a functional prototype system.

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

☑ Approved: sddec25-proj014

☐ Project Assigned:

☐ Advisor(s) Assigned:

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Iowa State University

Submitter Name: Goce Trajcevski **Email:** gocet25@iastate.edu

Project Contact: **Email:**

Project Title:

Interactive Visualization of Geo-location Aware Power Load Forecasting

Project Abstract:

Multiple deep learning methods have been proposed to address the problem of power-load forecasting. The rationale is that an effective forecasting of the demand can enable better planning of the operating regime of power plants as well as prediction of the price on the energy markets. Typically, the deep learning models are trained based on historical data represented as multivariate time series.

While the solutions abound and there exist interactive tools that can be used for predicting the demands at a given location/region, one functionality that has not been exploited is to have a tool that would enable a comparison of the predicted values at a given location based on different models. The main objective of this project is to develop a prototype system that would enable an interactive user to: (1) Select a location on a map; (2) Select a future time value; (3) Select a particular model for predicting the demand at that location; (4) Display the predicted value of the power demand for that location based on the selected model.

Literature, datasets and the (implementation of the) models will be provided by the client.

Expected Deliverables:

The expected schedule for the first semester is:
week #2: introductory meeting and problem overview;
week #3: introduction to literature and discussion of algorithms;
week #4: narrowing the scope of project (which algorithms to implement);
week #5: identifying requirements;
week #6: identifying use-cases;
week #7: tools and frameworks selection;
week #8: preliminary system design;
week #9: identifying testing scenarios;
week #10: completing non-functional requirements;
week #11: refining the system design
week #12: refining the testing/validation
week #13: draft of the design document
week #14: revision of the design document and preparation of presentation
week #15: presentation and final design document
The deliverable is the Design Document
Second Semester:
Weekly or bi-weekly meetings to discuss implementation issues/progress.
The final deliverable is a functional prototype system.

Specialized Resources Provided by Client:

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: The team members are expected to provide a complementary background in web-applications design/development and machine learning.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

☑ Approved: sddec25-proj015

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Iowa State University

Submitter Name: Goce Trajcevski **Email:** gocet25@iastate.edu

Project Contact: **Email:**

Project Title:

Impact of spatio-temporal data reduction on machine learning tasks

Project Abstract:

A common objective of data reduction (synonymously, compression) methods is to take a given dataset D as input and generate a dataset D1 as output such that |D1| << |D|. The most basic benefits of this process are: (a) smaller storage requirements; (b) decreased bandwidth utilization when transmitting the data. A particular kind of data reduction is the one applied to mobile/trajectory data. In addition to the storage/transmission benefits, when using the reduced dataset for training in deep learning methods, the smaller size implies higher time-efficiency.

However, using the reduced dataset often implies a loss of precision in the particular downstream tasks, such as Point of Interest (PoI) recommendation; traffic density prediction; etc.

There is plethora of deep learning methods in the literature tackling various mobility-related tasks - and, on the flip-side, there is plethora of methods for trajectory data reduction. However, to date, there has been no investigation of how a particular compression methodology on a given dataset would affect the quality of a particular model. The main objective of this project is to develop an interactive prototype system that would enable the users to: (1) select a dataset from a given collection; (2) select a particular data reduction methodology from a given family; (3) select a particular model; (4) generate a prediction for a given task (e.g., PoI recommendation); and (5) compare the quality of the outcome when reduced dataset is used for the task, as opposed to the original one.

The literature, datasets and (implementation of) the models will be provided by the instructor.

Expected Deliverables:

The expected schedule for the first semester is:
week #2: introductory meeting and problem overview;
week #3: introduction to literature and discussion of algorithms;
week #4: narrowing the scope of project (which algorithms to implement);
week #5: identifying requirements;
week #6: identifying use-cases;
week #7: tools and frameworks selection;
week #8: preliminary system design;
week #9: identifying testing scenarios;
week #10: completing non-functional requirements;
week #11: refining the system design
week #12: refining the testing/validation
week #13: draft of the design document
week #14: revision of the design document and preparation of presentation
week #15: presentation and final design document
The deliverable is the Design Document
Second Semester:

Weekly or bi-weekly meetings to discuss implementation issues/progress.
The final deliverable is a functional prototype system.

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills: The team members are expected to have a collaborative coverage of background in web-based applications and machine learning.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills,	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

and modern engineering tools necessary for engineering practice

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj016
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Santosh Pandey

Submitter Name: Santosh Pandey **Email:** pandey@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:

Force Plate Technology for Tracking Fitness, Balance and Performance

Project Abstract:

Our goal is to design a force plate technology to measure, analyze, and track biomechanical force exerted by a person during a physical exercise. Force plates are one of the trending technologies in the fitness world. Force plates are designed to measure and plot the dynamic force exerted by a person during a specific physical activity, such as jumping, walking, lifting weights, or sports training. The gathered data and post-analysis informs the user about any corrective measures and best practices for improved fitness, posture, and performance. Each force plate typically consists of force sensors, microprocessor, and wireless communication module to record the applied force and track the data on a software application. Commercial force plates are very expensive costing over $4000 per force plate and app subscription. The major players in the force plates fitness market are Vald Health, Kinvent, and AMTI as shown by google search.

In this project, we propose to design, build, and test force plates that are low cost while still having the necessary engineering features available in commercial force plates. The user may choose to use up to 4 force plates for a given physical test. Each force plate (1 feet wide, 3 feet long, 6 inch thick metal alloy) will be wireless, light-weight, and portable to be placed in any location (indoor or outdoor). Each force plate will be designed to withstand 500 to 800 pound of weight and record the dynamic force data from 4 force plates on a mobile app. The mobile app will display the current test measurements and the historical data for post-analysis. The force plate should be weather-proof and robust enough to handle sudden mechanical/electrical forces. The internal sampling frequency of force measurements can be 10-100 Hz. The force plates will be calibrated and tested in the 1050 Coover Lab, and characterized for standard physical activity such as jumping. Our laboratory has been building different prototypes of these force plates and have developed several modifications of the hardware and software modules. The lab resources and our expertise will be accessible to the team members.

Expected Deliverables:

The first semester will deliver two prototypes of the force plate hardware, and one working version of the mobile app. The hardware will have wireless capability for reliable data communication with 4 force plates for long testing times. The second semester will focus on user testing and modifications to improve the reliability, robustness and user experience.

Specialized Resources Provided by Client:

All resources to build the force plate and software app will be provided by the client including lab access to 1050 Coover, access to other students working on this project, and any costs of materials and software.

Anticipated Cost: _____ **Financial Resources Provided by Client:** Client will provide the resources

Preferred Students for the Project:

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills: none

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj017
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

_____

Senior Design Project Proposal Form

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization:

Submitter Name: Henry Duwe **Email:** duwe@iastate.edu

Project Contact: **Email:**

Project Title:

ASIC Chip Fab

Project Abstract:

Fabrication of a digital ASIC (application-specific integrated circuit) requires significant investment not only in design, but also in software development, verification, analog component design (e.g., PLLs, ADCs, DACs, voltage reference, voltage regulators), circuit and system level design and simulation, system level digital/analog/mixed-signal/power/IO circuit block integration for chip fabrication, PCB design, and materials. Coupled with the closed-source nature of hardware designs, this has meant that, for several decades, the number of unique ASICs fabricated declined and students (even graduate students) had the opportunity to work on a design that was fabricated. However, with a concerted push for open-sourced hardware (e.g., https://www.fossi-foundation.org/ and https://riscv.org/) and industrial support (https://efabless.com/open_shuttle_program), ASIC fabrication is within the grasp of individuals and, indeed, motivated and talented undergraduate students.

This project's goal is to design and fabricate a fully-functional digital ASIC using the efabless process. The specific choice of the fabricated chip's design goals will be up to the team in consultation with Prof Duwe and limited by the constraints of available area and open IPs. A few possibilities:
1. Entirely ChatGPT-constructed design from below (i.e., the prompt engineering process is part of the deliverable)
2. Visual or audio wake-word accelerator
3. Out-of-order processor
4. Point-of-care signal processing accelerator
5. Crytpo core resistent to power side-channel
6. Custom multi-wire I/O bus
7. Custom FPGA fabric for intermittent computing (e.g., rapid-on FPGAs for sensing)
8. Customizable / large-precision FPU
9. E-ink screen driver, external HDMI codec, or OLED SPI controller + PMOD board
10. ...your imagination...

Additionally, this team will have the opportunity to help bring-up the second chip successfully submitted by an ISU team the first semester and potentially get small designs fabricated for bring-up during their second semester.

Expected Deliverables:

* Well-organized repository of the hardware and software components of the system.
* Simulation-based testing framework demonstrating functional correctness of design.
* Submitted MCU + accelerator project repository to efabless (https://efabless.com/open_shuttle_program/5) that passes precheck verification.
* Detailed bring-up plan, including test plans, test software (pre-verified in simulation or on a real RISC-V processor), and any test hardware (e.g., PCBs) needed.

Specialized Resources Provided by Client:

Prof Duwe has significant resources to aid with the design, verification, and bring-up for a digital ASIC, including the

following:
oscilloscopes, logic analyzers, solder-station, test RISCV boards, servers that can run any CAD software required
Perhaps most importantly, you will also have access to multiple semesters worth of student experiences.

Anticipated Cost: _____ **Financial Resources Provided by Client:** Funding for 130nm tapeout.

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills: All students should have completed CPRE 381. Completiong of CPRE 465, 487/587, 488, or 480/580 a plus.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj018
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization:

Submitter Name: Henry Duwe **Email:** duwe@iastate.edu

Project Contact: **Email:**

Project Title:

Open-sourced Radio Microcontroller for Fabrication

Project Abstract:

There are many radio microcontrollers (MCUs) that support BLE, Zigbee, or LoRA-WAN, they are all closed-source. Some FPGA-based solutions exist, but the goal of this project is to eventually provide a complete end-to-end silicon proven radio microcontroller. This will require significant development work from software, computer architecture/digital design, and analog VLSI. Likely the extent of the project will span multiple teams, but the first team will have the opportunity to help scope the project, includuing overall software-hardware architecture. The specific components developed by this team will depend on the experience and interests of the team that rises to the challenge.

WARNING:
This project is guaranteed to be challenging and will require a team of students with diverse skill-sets (including some SE/DevOps and analog VLSI / RF), a willingness to learn and work together, and persistence.
*** Given these, this experience is also guaranteed to be a highly-rewarding capstone experience you can leverage for years to come.

Expected Deliverables:

* Well-organized repository of the hardware and software components of the system.
* Simulation-based testing framework demonstrating functional correctness of design.
* Submitted MCU + radio subcomponent project repository to efabless (https://efabless.com/open_shuttle_program/5) that passes precheck verification.
* Detailed bring-up plan, including test plans, test software (pre-verified in simulation and on a real RISC-V processor), and any test hardware (e.g., PCBs) needed.

Specialized Resources Provided by Client:

Prof Duwe has significant resources to aid with the design, verification, and bring-up for a digital ASIC, including the following:
oscilloscopes, logic analyzers, solder-station, test RISCV boards, servers that can run any CAD software required
Perhaps most importantly, you will also have access to multiple semesters worth of student experiences.

Anticipated Cost: **Financial Resources Provided by Client:** Funding for 130nm tapeout.

Preferred Students for the Project:

☑ Electrical Engineering

Other Special Skills: All students should have completed CPRE

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

☑ Computer Engineering
☑ Software Engineering
☑ Cyber Security Engineering
☐ Other:

381 OR have a VLSI focus.

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
  ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj019
☐ Project Assigned: _____
☐ Advisor(s) Assigned: _____
_____

Senior Design Project Proposal Form

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Henry Duwe

Submitter Name: Cheng Wang **Email:** chengw@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:

ReRAM Compute ASIC Fabrication

Project Abstract:

Resistive Random Access Memory (ReRAM) is a non-volatile RAM that has the potential to also be used to perform computations in the analog domain. Such computation has the benefit of requiring less data movement and less energy than traditional digital computation where individual pieces of data are moved from memory to a processor's digital ALU for execution and the results moved back to memory. However, there are many challenges in building variation-tolerant ReRAM accelerators and converting data between the digital and analog domains. Profs Wang and Duwe would like to evaluate a real ReRAM crossbar for compute potential.

This project's goal is to design and fabricate a small ReRAM compute crossbar ASIC using the efabless and Skywater 130nm process. Note that this will almost invariably require the choice, modification, and/or design of analog components. The specific choice of the fabricated chip's design goals will be up to the team in consultation with Profs Wang and Duwe and limited by the constraints of available area and open IPs.

Warning, this project is guaranteed to be challenging and will require a team of students with diverse skill-sets (including SW and DevOps), a willingness to learn and work together, and persistence.
*** A team should have at least two students with a VLSI background and two who have taken 381.
*** Given these, this experience is also guaranteed to be a highly-rewarding capstone experience you can leverage for years to come.

Expected Deliverables:

* Well-organized repository of the hardware and software components of the system.
* Simulation-based testing (i.e., SPICE-level) framework demonstrating functional correctness of design.
* Submitted MCU + ReRAM project repository to efabless (https://efabless.com/open_shuttle_program/5) that passes precheck verification.
* Detailed bring-up plan, including test plans, test software (pre-verified in simulation or on a real RISC-V processor), and any test hardware (e.g., PCBs) needed.

Specialized Resources Provided by Client:

Profs Duwe and Wang have significant resources to aid with the design, verification, and bring-up for a digital ASIC, including the following:
oscilloscopes, logic analyzers, solder-station, test RISCV boards, servers that can run any CAD software required.

Anticipated Cost: _____ **Financial Resources Provided by Client:** Funding for 130nm tapeout.

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☐ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: At least two students should have a VLSI focus. At least two should have completed CPRE 381.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj020
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

Senior Design Project Proposal Form

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Shakil Ahmed

Submitter Name: Shakil Ahmed **Email:** shakil@iastate.edu

Project Contact: **Email:**

Project Title:

Hardware Setup for EE 2850 Lab: Enhancing Embedded Systems Learning with C Programming

Project Abstract:

The EE 2850 course introduces students to embedded systems programming using C, but its effectiveness relies heavily on the availability of a well-structured hardware setup that complements theoretical concepts. This project aims to design, develop, and integrate a modular hardware platform to support hands-on learning for EE 2850 labs. The primary objective is to create a scalable, cost-effective, and reusable hardware setup that enables students to experiment with microcontrollers, peripherals, and real-time applications while improving their understanding of low-level programming in C. The project will focus on hardware-software integration, ensuring seamless communication between the designed hardware and programming exercises.

Key technical areas include:
Microcontroller-based development (ARM, AVR, or MSP430)
Peripheral interfacing (sensors, actuators, displays, communication modules)
Embedded C programming for real-time operations
Power management and connectivity considerations
Integration with existing lab infrastructure

Design constraints include cost efficiency, ease of deployment, scalability for future labs, compatibility with existing EE 2850 lab exercises, and student accessibility.

Expected Deliverables:

Semester 1: System Design & Prototyping
Research and select suitable hardware components (microcontrollers, communication interfaces, I/O devices).
Develop preliminary circuit designs and schematics.
Implement basic software drivers for selected hardware using C.
Deliverable: Initial prototype with basic interfacing and documentation.

Semester 2: Integration & Deployment
Finalize hardware integration with lab exercises.
Develop comprehensive C programming assignments for students.
Conduct testing, validation, and debugging of hardware-software interactions.
Create instructor and student guides for the new lab setup.
Deliverable: Fully functional hardware platform with curriculum integration, along with a user manual and documentation for future use.

Specialized Resources Provided by Client:

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: C and hardware

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj021
- ☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Shakil Ahmed

Submitter Name: Shakil Ahmed **Email:** shakil@iastate.edu

Project Contact: **Email:**

Project Title:

Design and Implementation of a Quantum Networking Testbed for Secure Communications

Project Abstract:

Quantum networking represents the next frontier in secure communication and high-performance distributed computing, leveraging principles of quantum mechanics to enable ultra-secure, high-speed data transfer. This project aims to design, simulate, and implement a small-scale quantum networking testbed, focusing on Quantum Key Distribution (QKD), entanglement-based communication, and quantum cryptographic protocols. The project will explore the feasibility of integrating quantum networking techniques with classical network infrastructures, demonstrating how quantum-enhanced security can be applied in real-world scenarios such as financial transactions, defense communications, and critical infrastructure protection.

Key technical areas include:
Quantum Key Distribution (BB84, E91 protocols)
Entanglement-based networking and teleportation
Hybrid quantum-classical network architecture
Simulation of quantum network behavior using QuNetSim, Qiskit, or SimulaQron
Security analysis of quantum-resistant cryptographic frameworks

Design constraints include scalability, interoperability with existing networking infrastructure, minimizing decoherence effects, and cost-effective implementation using available quantum hardware and simulators.

Expected Deliverables:

The project will be completed over two semesters, ensuring a systematic approach:

Semester 1: Simulation & Algorithm Development
Develop a quantum network model using QuNetSim/Qiskit.
Implement Quantum Key Distribution (QKD) protocols for secure communication.
Simulate quantum entanglement-based message passing and analyze network stability.
Deliverable: A fully functional simulated quantum networking framework, demonstrating secure quantum communication in a controlled environment.

Semester 2: Real-World Testing
Integrate quantum hardware (e.g., IBM Q, photonic-based quantum devices) with classical networking.
Design and implement a hybrid quantum-classical communication protocol.
Conduct security analysis and performance benchmarking against classical encryption techniques.
Deliverable: A working quantum networking prototype with documented security performance metrics and real-world applicability.

Specialized Resources Provided by Client:

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Python

Anticipated Client Interaction (estimate):

- ☐ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☑ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

- ☑ Approved: sddec25-proj022
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Joon Park

Submitter Name: Joon Park **Email:** park2@iastate.edu

Project Contact: Joon Park (student proposal) **Email:** park2@iastate.edu

Project Title:

Cost-Effective Crop Evaluation System Network

Project Abstract:

Nowadays, microcontrollers are affordable and versatile. Using a microcontroller(ESP32 or RP Pico W), it is possible to add sensors such as humidity, CO2 level, temperature, soil moisture, sun exposure, and whatnot. Once integrating the sensors in the microcontroller, our team members can install them(more than 2) like a beacon, in a farm environment and track the crop production. It will have a solar panel, and with its low energy consumption, the system will be automated.

Continuously, as data is collected, the team will match the data to predict and prevent the crop growing process. This process will be eventually be automated with the help of deep learning. Past weather data, harvest yield, genetics, and etc will be the variables for the learning.

Expected Deliverables:

Week 2: get microcontrollers and build a simple code using micropython
Week 3-4: Finishing the rough design and the scope of work for individuals
Week 4-5: Have the microcontrollers being able to communicate both ways using BLE and Wifi
Week 5-8: Integrate sensors one by one, and test out the communication to the server, write code for both peripherals and server
Week 8-15: Debugging, fixing design flaws, and rigorous testing in the field and lab
Week 12-15: Build LLM model for the crop growth prediction and visual representation/wrapping up for the semester, fixing and debugging automation process

Specialized Resources Provided by Client:

Previous research on RP Pico W-"Using Data Mule in mining sites to communicate via BLE beyond Line of Sight"
3 Raspberry Pi Pico W
One Macbook laptop

Anticipated Cost: _____ **Financial Resources Provided by Client:** OK.

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Python, circuit building, and interest in the project

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj023
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization:

Submitter Name: Eric Wittrock **Email:** ejw3@iastate.edu

Project Contact: **Email:**

Project Title:

Vision-Based Camera Motion Tracking

Project Abstract:

Camera motion tracking is a technique used in the visual effects industry. Oftentimes in the production of films or advertisements, a visual effects team needs to composite a 3d object into footage from a real-life scene. To do this, the object must move appropriately to match the camera's motion over time, therefore it is necessary to know precisely how the camera moved during the shot. With the video file as an input, it is possible to reconstruct the camera's path with vision-based motion tracking.

The most popular free and open source tool for creating visual effects is a software suite called Blender. Blender has a built-in camera tracking tool, but it is difficult to use and requires skill to get a reliable result. Our project goal is to create a plugin for Blender that offers a superior camera-tracking solution.

To compete with the existing tool, our project must abide by the following constraints.
Performance: computation must take a reasonable amount of time.
Accuracy: the accuracy of a camera track is measured in px error. We want less than 1.0 px error.
Simplicity: The software should have no learning curve to use.

Our development approach involves breaking the problem into smaller subproblems that are each easier to solve on their own. For example, before trying to understand depth in a 3d scene, we will first try to recognize viable tracking points on a single image. The complete technical approach is outlined in the schedule.

This product is a software-only project, however we will require physical tools, namely cameras. The software-based tools we will use are open-source libraries including, but not limited to, OpenCV.

Expected Deliverables:

Final deliverable:
We will create a plugin for the 3d software, Blender, that is able to solve for a camera's motion in 3d space. Our product will be heavily automated and therefore easier to use than the existing built-in feature while having similar performance.

Schedule:
Jan
- Research existing software
- Find research papers. Decide on structural-based or point-based technique.

Feb
- Collect camera footage
- Solve for camera motion with existing software and collected footage. Get the camera motion data, which we will

use to check correction once we have a working prototype
- Project set up: decide on a language and library to use, e.g. C++ with OpenCV. Set up the development environment.
- First step up development: be able to load in image or video data

Mar
- Detect high contrast points on single image
- Persistence of points over multiple frames (this step is hard and will take a while)

Apr
- Manually check correctness of results by observing the tracking marks (output). Iterate development on the previous step until we have a satisfactory result.
- Predict point depth and triangulated planes in scene

May
- Solve the camera's motion path in 3d space. At this point, the user will manually input some of the camera's parameters, which will later be calculated automatically. This will mark the completion of a working prototype

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Aug, Sep
- Reduce error by removing outlier points. Automatically detect new points
- Solve for K1 and K2 distortion parameters

Oct
- Object permanence, persistence of points that leave the viewport. This will improve the accuracy.
- Test on multiple cameras, a DSLR and a smartphone. Fix issues that arise from this test

Nov
- Track points through motion blur (this step is hard and will take a while)
- Test on blurry footage

Dec
- Create user interface
- Integrate into blender as a plugin

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☐ Electrical Engineering
- ☐ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Required:
C++ or Python experience

Recommended experience in at least one (not necessary all) of the following:

Blender camera tracking, Blender Python API, or Blender Plugin Creation
OpenCV or any experience with computer vision
The mathematics of 3D scenes

Bonus:
Experience with the nuances of cameras

Anticipated Client Interaction (estimate):

- ☐ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☑ 1 meeting per semester
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☑ 1	☐ 2	☐ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj024
- ☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Sudipta Halder

Submitter Name: Sudipta Halder **Email:** sudipta@iastate.edu

Project Contact: +1 (515)-771-0915 **Email:** sudipta@iastate.edu

Project Title:

Outdoor Romba

Project Abstract:

Outdoor Roomba is a project aiming to create a Roomba that picks up trash in public areas like parks, streets, etc, to lower pollution. The Roomba should mainly pick non organic trash like plastic bottle, metals, ad etc . There can be multiple Outdoor Roombas to clean together. This Roomba needs to detect trash from its sensors (cameras, sonar, etc), and optionally, it can use a drone to survey for trash that the Roomba can pick up. The Roomba must be about navigating all kinds of terrain, from muddy and rocky terrain to snowy areas, including places with no proper roads or sidewalks (since those kinds of areas need these Roombas the most). It should intelligently avoid civilians and vehicles in their sounding via sensors and other Roomba's detection of civilians and vehicles which will be communicated through the servers or optional drones can also detect obstacles nearby. It should be able to gather data on the trash it picks up and determine if it's recyclable, what kind of product or item it is, and its location. If it's unable to reach a location we a lot of trash, it should mark it. All this data can be used to determine many things, from people's habits to the leading cause of lettering and more.
Roomba can be developed with a potable computer like Raspberry Pi with a Coral Accelerator (https://coral.ai/products/accelerator/), but using an FPGA is recommended for the most control. There can be servers for the Roomba to connect to send and receive data, and a camera sensor and other sensors can detect trash and so on. Most importantly, CAD will be required to design the Roomba and the 3D-printed version of it, which I can provide.

Expected Deliverables:

The project should take 1.5 semesters of active work(I chose 1.5 semesters in case something goes wrong over the summer so we have time to fix it). The first deliverable will be to build a working prototype hardware for the Roomba that can navigate most terrain so it can go from point A to point B and be able to pick up trash and create multiple of these Roomba (at least two). The secound deliverable can need to be done within the first Semester. Second deliverable: we need to develop a way to find and detect trash, people, and vehicles via camera and other sensors by using an already available model online or training it ourselves, and this will be running on the Roomba. The second deliverable can also be done in the first Semester alongside the first delivery. The third deliverable is to develop a server for the Roombas to take to and send data of the trash it picks up and store the real-time positions of the Roombas and detect civilian, vehicle, and uncollected trash so the other Roombas can navigate fast and to above accidents with people and other Roombas. The fifth delivery is to develop a model that recognizes the kind of trash and item/product on the server. The fourth delivery is to make the final version of the Roomba and make it work with the servers and modules used to detect trash and obstacles, which should be done in the second Semester. The fifth delivery should be done toward the end, and it's ok if it's unable to be complete.

Specialized Resources Provided by Client:

Acces to 3D printers, machines at Student Innovation, a LongBoard and maybe a motor

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Anticipated Cost: _____ **Financial Resources Provided by Client:** All I can give is 100$ every month

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☑ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Setting up and using servers, Programing, Embedded Systems(CPRE 288 is enough)

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj025

Senior Design Project Proposal Form

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

_____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Gelli Ravikumar

Submitter Name: Gelli Ravikumar **Email:** gelli@iastate.edu

Project Contact: Gelli Ravikumar **Email:** gelli@iastate.edu

Project Title:

GridGPT-3.0: Grid Agentic AI Virtual Assistants for the Smart Grid Applications

Project Abstract:

The GridGPT project (https://sddec24-20.sd.ece.iastate.edu/, https://sdmay25-42.sd.ece.iastate.edu/) is an innovative and evolving software project initiative aimed at creating a virtual assistant for GridAI, our indigenous electric power grid software. GridAI is designed to support power utility operators, energy producers, and energy consumers in managing and optimizing electric power grid operations. The project leverages advanced AI tools and technologies to enhance the capabilities of GridAI, making complex grid data more accessible and actionable.

Project Goals and Design Constraints: The goal is to develop an AI-driven virtual assistant that seamlessly integrates with GridAI, assisting users in understanding and interacting with intricate electric power grid data to make informed decisions. The project will operate within constraints such as data security, system integration, and user accessibility while addressing the limitations of AI in interpreting technical language specific to the electric power grid domain.

Technical Approaches and Tools: Students will work with a tech stack that includes a React frontend and a backend developed primarily in Go and Python. The project will also involve utilizing AI and Machine Learning APIs, such as OpenAI API and Langchain to power the virtual assistant's capabilities. This hands-on experience will offer students exposure to highly sought-after technologies and frameworks.

Learning Opportunities and Outcomes: This project provides a unique opportunity to gain practical experience in AI, full-stack development, and the energy sector. By the end of the project, students will have developed an AI virtual assistant that enhances GridAI, demonstrating AI's potential to improve electric power grid management. The project also allows students to address real-world challenges in the smart grid technology, equipping them with valuable skills in today's tech landscape.

Why Join? This is an exciting chance to work on cutting-edge AI technologies and develop a tool that can impact the energy industry. We encourage you to consider this project for your senior design, but the decision is ultimately yours. For more details and the latest updates, visit https://sddec24-20.sd.ece.iastate.edu/ and https://sdmay25-42.sd.ece.iastate.edu/.

Expected Deliverables:

(1) Customized Agentic AI Models:
Development of specialized AI models leveraging services such as OpenAI API and Langchain, tailored for electric power grid applications, including efficient grid data interpretation and responsive handling of user queries.
(2) Software Code and Prototype Application:
Delivery of well-documented source code for a fully integrated full-stack application, featuring a React-based frontend and a Go/Python backend.
A functional prototype demonstrating the AI virtual assistant's capabilities within a user-friendly interface, showcasing seamless interaction and data management.

(3) Testing Reports and User Documentation:
Comprehensive documentation outlining testing procedures, results, and model validation to ensure reliability and performance of the AI assistant.
Detailed user manuals and guides facilitating easy understanding and operation of the system for end-users, including instructions for interacting with the AI assistant.
(4) Project Report and Presentation:
A thorough final report and professional presentation summarizing the project's objectives, development processes, challenges encountered, solutions implemented, and overall outcomes.
Inclusion of insights and recommendations for future enhancements and potential scalability of the GridGPT systems.

Specialized Resources Provided by Client:

(1) GPT API access (e.g., OpenAI's API or Langchain)
(2) Grid-related applications and data resources
(3) PowerCyber private cloud testbed hosted at Iowa State University

Anticipated Cost: _____ **Financial Resources Provided by Client:** NA

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☐ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Students possessing one or more of the following skills will find this project particularly rewarding:
(i) AI and Machine Learning: A basic understanding of AI principles, particularly in natural language processing, will be beneficial for developing and fine-tuning the AI virtual assistant.
(ii) Programming: Proficiency in programming languages such as React for frontend development, and Python and Go for backend development, is crucial for building and integrating the project components.
(iii) Understanding of Electric Power Grid: Familiarity with the electric power grid, including any power grid simulators like OpenDSS, will help in contextualizing the AI models within real-world grid applications.
(iv) Data Handling: Skills in managing and interpreting large datasets, as well as familiarity with database systems, will be essential for ensuring the AI models can effectively process and respond to grid data.
(v) Research Aptitude: An ability to conduct research and adapt to emerging technological developments is valuable for staying ahead in this rapidly evolving field.
(vi) Problem-solving: Strong analytical and problem-solving skills will be key to addressing the complex challenges that arise during the development and implementation of the project.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week

☑ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj026

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Gelli Ravikumar

Submitter Name: Gelli Ravikumar **Email:** gelli@iastate.edu

Project Contact: Gelli Ravikumar **Email:** gelli@iastate.edu

Project Title:

Grid-UI: Developing Advanced Web-Interactive Interfaces for GridAI Power Grid Management Software

Project Abstract:

This senior design project focuses on the development of an advanced, intuitive and responsive front-end interface for GridAI, an indigenous electric power grid management software. GridAI is designed to support power utility operators, energy producers, and consumers in optimizing electric power grid operations. It is a continuous project and latest SD project on this chain can be found at https://sdmay25-43.sd.ece.iastate.edu/. The primary goal of this project is to create a user-friendly, aesthetically pleasing, and highly functional front-end using React, ensuring seamless interaction with the backend systems and AI-driven tools.

Project Goals and Design Constraints: The main objective is to develop a robust and dynamic front-end that enables users to easily navigate and interact with GridAI's powerful features. The design must adhere to modern web standards, prioritize user experience (UX) and accessibility, and seamlessly integrate with the existing backend architecture developed in Go and Python. The project will also focus on optimizing performance, ensuring that the interface is responsive and efficient even when handling large datasets.

Technical Approaches and Tools: Students will primarily work with React, a popular JavaScript library for building user interfaces, to develop the front-end of GridAI. The project will involve creating custom components, managing state efficiently, and ensuring that the UI is both scalable and maintainable. Additionally, students will be expected to implement responsive design principles to ensure the application performs well on various devices and screen sizes. Integration with backend services will be facilitated through APIs, requiring a basic understanding of RESTful services.

Learning Opportunities and Outcomes: This project offers students a unique opportunity to specialize in front-end development using React while contributing to a real-world application in the energy sector. Participants will gain hands-on experience in building scalable and maintainable web applications, optimizing for performance, and ensuring a seamless user experience. By the end of the project, students will have developed a professional-grade front-end interface for GridAI that enhances its functionality and user appeal.

Why Join? If you are passionate about web development and want to apply your skills to a meaningful project with real-world impact, this is the perfect opportunity. You'll work with cutting-edge technologies, collaborate with backend developers, and play a key role in enhancing a critical energy management tool. For more details on a previous version of GridAI developed by a past team, visit https://sdmay23-38.sd.ece.iastate.edu/ and https://sdmay25-43.sd.ece.iastate.edu/.

Expected Deliverables:

(1) Front-End Interface: An advanced, fully functional, and orchastrated front-end developed using React, complete with custom components, state management, and responsive design features.

(2) User Experience (UX) Enhancements: Design and implementation of UX features that improve the usability and accessibility of GridAI, tailored to the needs of power grid operators and other users.

(3) Integration with Backend Services: Seamless integration of the front-end with the existing backend services (Go and Python), ensuring smooth data flow and interaction.

(4) Testing and Optimization: Comprehensive testing of the front-end for performance, usability, and compatibility across different devices and browsers, along with any necessary optimizations.

(5) Documentation: Detailed documentation covering the design process, implementation details, and user instructions, ensuring that the interface is easy to maintain and extend in the future.

Specialized Resources Provided by Client:

(i) We will provide GridAI backend and frontend source codes, (ii) Customized front-end docker for testing and validation, (iii) Basic wireframes and frond-end requirements, (iv) PowerCyber private cloud testbed hosted at Iowa State University for the development and testing.

Anticipated Cost: _____ **Financial Resources Provided by Client:** NA

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☐ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Graphical designs with Figma, Front-end software code design and development, preferably using React

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE,	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

and SE

This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj027
- ☐ Project Assigned: _____
- ☐ Advisor(s) Assigned: _____

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: Envrionmental Sensor Interfaces

Submitter Name: Randall Geiger **Email:** rlgeiger@iastate.edu

Project Contact: Randall Geiger **Email:** rlgeiger@iastate.edu

Project Title:

Humidity and Gas Sensors

Project Abstract:

This project will focus on developing environmental sensors with a particular emphasis on sensing humidity but other gases such as CO2 or environmental pollutants could also be considered. There is a growing demand for accurate and reliable sensors that monitor the presence of various components in the atmosphere. One of the most successful approaches is based upon the observation that the dielectric properties of some polymers are dependent upon the concentration of various gases and pollutants in the atmosphere. This project abstract will focus on monitoring the relative humidity levels though the approach or emphasis, depending on student interest, could focus on other components in the atmosphere.

In the context of humidity sensors, emphasis will be placed on hygroscopic polymers where the dielectric constant changes predictably with relative humidity. The transducers (electrical device that converts physical input into electrical parameter) are typically co-planer capacitors formed by applying a thin layer of the polymer over an interdigitized grid that forms the two electrodes. Since the capacitance, as determined by the real part of the dielectric constant, is a function of the relative humidity, the humidity can be determined from the measured value of the capacitance. Though the transducer in commercial humidity sensors is typically very small so that it can be included in a very small integrated circuit package, the properties of the co-planer structures can be studied with much larger structures that can be measured with equipment existing in our electronic laboratories.

One of the challenges with using existing transducers is that the dielectric properties of a polymer are also affected by other components in the atmosphere. For example, if a polymer is affected by both humidity level and CO2 level, it is difficult to tell if a change in capacitance of the transducer is due to the humidity or the CO2 level thereby adversely affecting the accuracy. But if both the real part and the imaginary part of the dielectric constant are measured, possibly at different frequencies, and if both respond in different ways to components in the atmosphere, it may be possible to eliminate the interference of different atmospheric components thereby providing a more accurate sensor.

Initially, in this project, transducers will be developed for measuring humidity. We will be working with one of the world's largest manufacturers of humidity sensors for guidance on polymer materials and for feedback on the practical applications of sensors that are developed. Of course, we will also have access to the technical literature where characteristics of various polymers are reported. Participants will fabricate the co-planer capacitor grid, coat the grid with a thin layer of the hygroscopic polymers, and take measurements of the electrical characteristics of the transducers. Included in the project will be the development of a test environment whereby the humidity levels and the mixture of humidity and other gases can be added.

Expected Deliverables:

The deliverables of the project will include a functioning humidity transducer, an analytical formulation of how this transducer operates, experimental measurements obtained from this sensor, and an assessment about the potential for commercialization of the device.

Specialized Resources Provided by Client:

All physical resources needed for this project will be provided.

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☐ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills: Students should have an interest in developing problem-solving skills and in taking a project from concept to completion by combining fundamental engineering concepts and approaches.

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☑ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj028

Senior Design Project Proposal Form

☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: ISU

Submitter Name: Randall Geiger **Email:** rlgeiger@iastate.edu

Project Contact: Randall Geiger **Email:** rlgeiger@iastate.edu

Project Title:

UAV-Assisted Energy Delivery

Project Abstract:

This project will focus on developing a method for drone-assisted (alternatively termed an Unmanned Aerial Vehicle or UAV) energy delivery for powering untethered nodes which are critical components in the emerging Internet of Things (IoT). There are fundamental trade-offs in data communication networks between distance, bandwidth, spectrum allocation, and power. When network nodes are tethered to the power distribution grid, power is of secondary concern but on untethered nodes, a source of power is of critical concern and many of the emerging IoT applications will come to fruition only if a practical source of energy becomes available. There is a lot of research ongoing on harvesting energy to power these untethered nodes. However, it appears that there are fundamental physical limits on essentially all proposed methods of harvesting energy that will doom these approaches to low-distance , low data-rate applications with limited availability and reliability.

Drones are widely used in military applications for reconnaissance and unmanned targeted attacks and by hobbyists primarily for mobile camera applications. Proposals for other applications such as package delivery have been forwarded by Amazon and others.

This project will focus on using drones as a system component for energy delivery to untethered nodes and for the bidirectional shuttling of data between the grid and the untethered nodes. Energy will be delivered-scheduled from a tethered location to an untethered location on-demand. While transferring energy, the drone will dock with the untethered node rather than "hoover" to minimize energy loss. It is envisioned that these drones can become an extremely low-cost commodity that can be readily replaced if failures do occur thereby achieving good availability and system reliability.

Aspects of this project will include developing autonomous drone docking methods and methods for drone-assisted energy delivery. The project will also include a WEB interface that can be used to interface data collected from the untethered nodes to the cloud.

It is expected that participants will use existing commercially available drones and commercially available network components to develop and demonstrate performance capability of these drone-assisted networks. It will be expected that all participants demonstrate competence in piloting drones using existing commercial software.

Expected Deliverables:

Review of methods of drone-assisted data transmission/shuttling and drone-assisted energy delivery. Development of a low-cost drone-assisted system that can be used for both energy and data delivery. The drone should be able to autonomously go back and forth between a grid-connected docking point and an untethered node shuttling energy from the grid-connected docking point to the untethered node and shuttling data between the two nodes. Demonstration of the performance of this network using commercially available drones and network components.

Specialized Resources Provided by Client:

An UAS (unmanned aircraft systems) pilots license and/or experience flying drones would be useful but is not required.

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

- ☑ Approved: sddec25-proj029
- ☐ Project Assigned: _____

☐ Advisor(s) Assigned: _____

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IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Senior Design Project Proposal Form

Client/Company/Organization: US Department of Energy

Submitter Name: James McCalley **Email:** jdm@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:

HVDC development in the Midwest US

Project Abstract:

The Midcontinent Independent System Operator (MISO) has recently proposed "Tranche 2.1" to develop 765 kV AC transmission through Iowa. However, it is possible that High Voltage DC (HVDC) transmission could complement and/or displace some of the 765 kV transmission. This project will investigate the extent to which this is true using one or both of two tools: a commercial grade power flow solved called PSS\E and a research-grade cooptimized expansion planning (CEP) tool developed at ISU. The objective of this project is to (i) develop an alternative design to Tranche 2.1 that includes HVDC; (ii) evaluate the design in terms of cost and in terms of steady-state power system performance.

The minimal HVDC line to be integrated with the Tranche 2.1 765 kV design is a proposed SOO-Green line from Mason City, Iowa to Plano, Illinois. However, the team will be encouraged to consider other areas/regions of the MISO system, particularly in Iowa, where HVDC might be attractive.

The team will be expected to have at least two members attend the ISU Electric Power Research Center (EPRC) meeting May 20-23 in Ames. This meeting will include a 765 kV transmission workshop on the afternoon of May 22 and an all-day HVDC transmission workshop on May 23.

Expected Deliverables:

March 1, 2025: Summarize of MISO Tranche 2.1 765 kV design
March 31, 2025: Solve power flow case in PSS\E without HVDC
March 31, 2025: Identify criteria for good HVDC developments
April 30, 2025: Identify good HVDC development opportunities in Iowa, with rationale
May 15: Present findings to-date
May 21-23: Attend ISU EPRC meeting, 765 kV and HVDC workshops
September 1: Implement HVDC design in PSS\E
September 15: Perform manual assessment of design economics
October 15: Use CEP to evaluate design economics
November 15: Complete N-1 contingency analysis of design (using PSS\E)
December 1: Complete project report

Specialized Resources Provided by Client:

Client will provide PSS\E and CEP software; client will also enable 765 kV and HVDC workshop attendance in May.

Anticipated Cost: _____ **Financial Resources Provided by Client:** None.

Preferred Students for the Project:

☑ Electrical Engineering
☐ Computer Engineering

Other Special Skills: Most team members should have taken EE 456 or are taking EE 457 and/or E 452.

☐ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☑ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

	0 – Not at all	*1 – A Little*	*2 – Somewhat*	*3 – A Lot*	*4 – Completely*
On this project, students will need to apply knowledge of mathematics, science, and engineering	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	☐ 0	☑ 1	☐ 2	☐ 3	☐ 4
This project requires students to identify, formulate, and solve engineering problems	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	☐ 0	☐ 1	☐ 2	☐ 3	☑ 4

Project Approval – *for use by ECpE Senior Design Committee*

☑ Approved: sddec25-proj030
☐ Project Assigned: _____
☐ Advisor(s) Assigned: _____
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Senior Design Project Proposal Form