Seed Incubation Plant

GROUP 10

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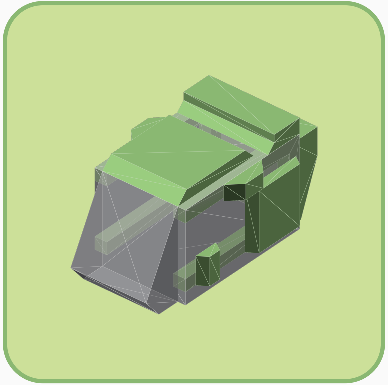
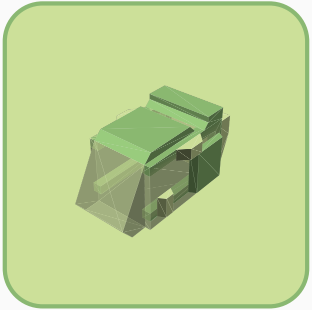
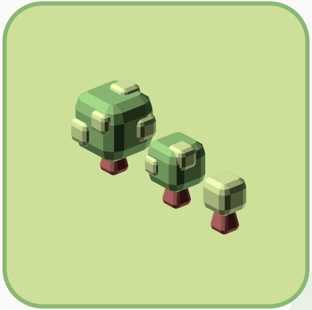


- **Seed Incubation Plant** aims to optimize the germination and growth process of seeds by providing a controlled and monitored environment.
- **Environment Monitoring and Control Unit** (EMCU) part of the incubator takes care of environmental factors such as temperature, humidity, lighting, O_2, etc.
- **Growth Monitoring Unit** (GMU) closely monitors and collects growth related information from each of the germinating saplings.
- With the help of **SINC**, a companion app, the status of the incubator can be closely watched.

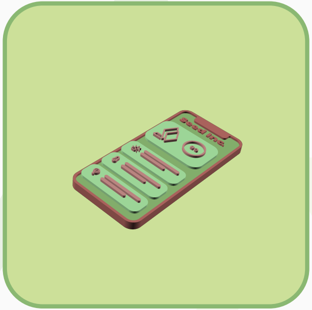
Objectives



- Implement the sensor and actuator sides of the EMCU, thus driving it into a cohesive system.



- Implement an ESP32 CAM based Growth Monitoring Unit (GMU) powered by a TinyML model.

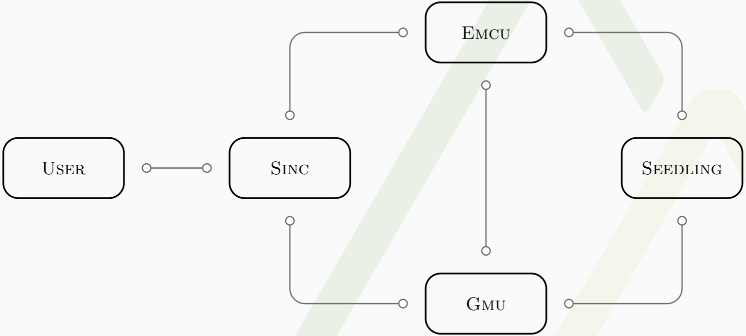


- Take the development of SINC, a companion app, to the alpha stage.

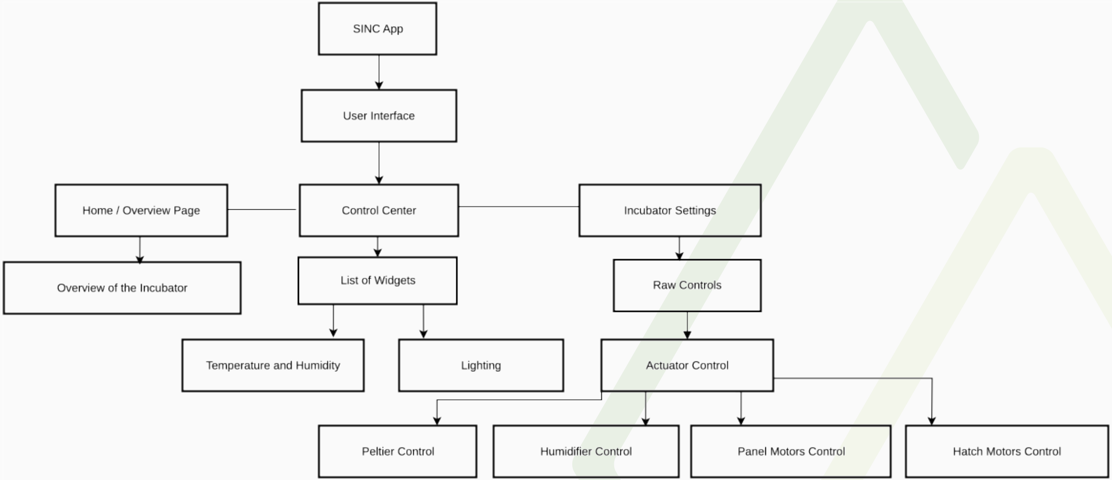
Block Diagram: Overall

Major Components

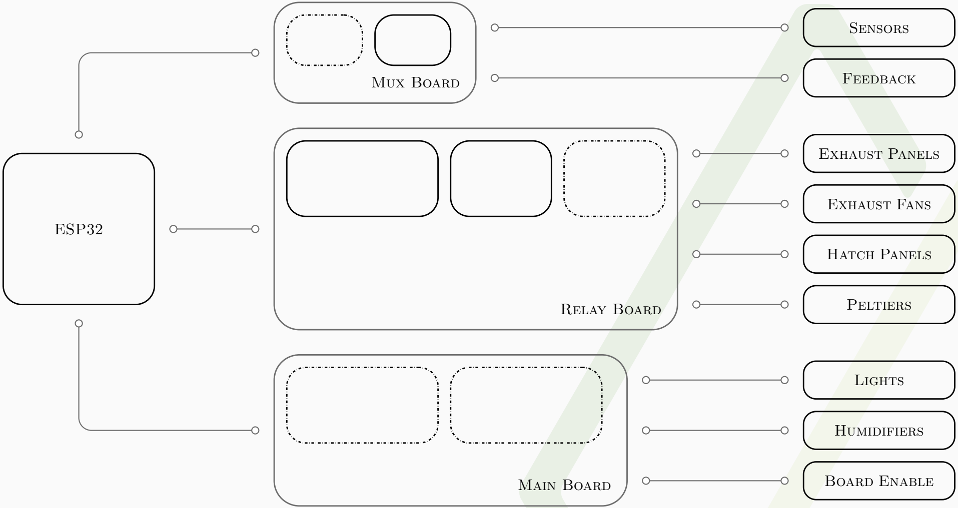
- EMCU
- SINC
- GMU



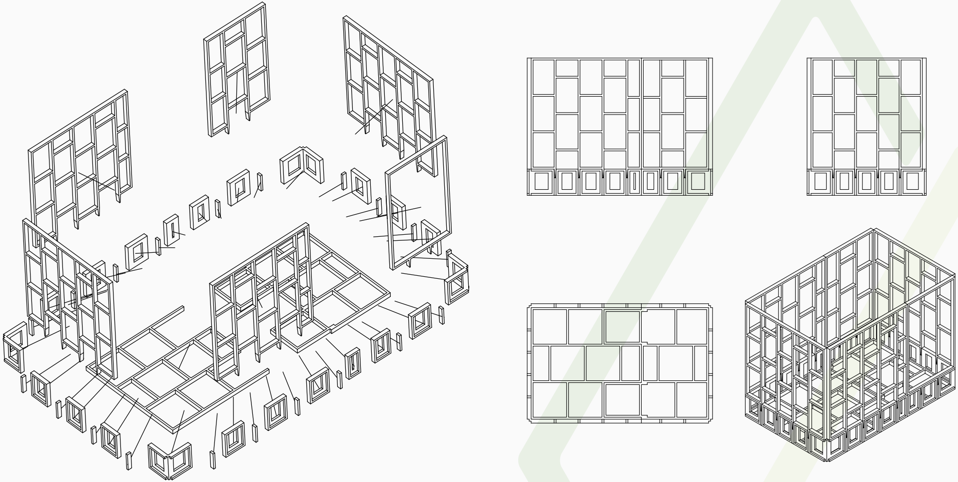
Block Diagram: Sinc App



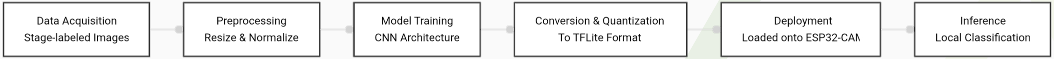
Block Diagram: EMCU



EMCU Frame



Block Diagram: GMU - TinyML



Title:	**Internet of Things (IoT) Based Greenhouse Monitoring and Controlling System Using ESP-32**
Authors:	J. Seetaram, A. Bhavya, C. Tarun and V. Sameera
DOI:	10.17148/IJARCCE.2024.13605
Publisher:	*International Journal of Advanced Research in Computer and Communication Engineering*
Result:	The system successfully performed real-time monitoring and automated environmental control. Demonstrated fully autonomous and remote operation, reducing human intervention.

Relevant Features & Insights:

- IoT-enabled remote control with real-time sensor data visuals.
- User-friendly UI designed on Blynk for farmers.
- Focus on sustainability, resource optimization, and precision agriculture.

Title: **Non Plant Specific Smart Greenhouse with Convective Drying Unit**
Authors: J. Mukherjee et al.
DOI: 10.1109/TQCEBT59414.2024.10545221
Publisher: *International Conference on Trends in Quantum Computing and Emerging Business Technologies (TQCEBT), 2024*
Result: Developed a smart greenhouse that included an integrated convective drying system, supporting a variety of plant types and optimizing both growth and post-harvest processing.

Relevant Features & Insights:

- Unique addition of convective drying unit supporting post-harvest processing within the smart greenhouse.
- Designed for versatility—accommodates diverse crops beyond plant-specific solutions.
- Included a comprehensive control mechanism for climate and drying, with IoT-based user monitoring.

Title:	**Real-Time Environmental Monitoring in Smart Agriculture Using TinyML and Machine Learning**
Authors:	D. S. Kulkarni and S. Bhudhwale
DOI:	`10.1109/ICISAA62385.2024.10829307`
Publisher:	*2024 International Conference on Intelligent Systems and Advanced Applications (ICISAA), 2024*
Result:	Implemented real-time environmental monitoring in smart agriculture using TinyML, enabling local data processing and actionable insights directly on microcontroller hardware for improved responsiveness and minimized latency.

Relevant Features & Insights:

- Leveraged TinyML models on edge devices for on-site data analysis (no constant cloud dependence).
- Enhanced detection and immediate response to abnormal environmental conditions, aiding in automation and safety.
- Demonstrated practical benefits in water and resource optimization, supporting sustainable agricultural practice.

Title:	**TinyML for Smart Agriculture: Comparative Analysis of TinyML Platforms and Practical Deployment for Maize Leaf Disease Identification**
Authors:	Dan Gookyi et al.
DOI:	`10.1016/j.atech.2024.100490`
Publisher:	*SSRN (Preprint), April 2024*
Result:	Achieved high-accuracy (94.6%) real-time crop disease identification by deploying optimized CNN models on Arduino BLE 33 Sense, validating feasibility of TinyML-based field diagnosis with fast inference and minimal resources.

Relevant Features & Insights:

- Direct comparison of Edge Impulse and TensorFlow Lite for TinyML, with Edge Impulse offering better usability and memory, TensorFlow higher accuracy.
- Large image dataset, rapid 7.6ms inference on microcontrollers.
- Demands no cloud or high-power resources—enabling rich, offline field use, especially in resource-limited areas.

Work Plan

Week 01 - 02	Refinement of Enclosure design, data collection for TinyML model, and setting up the specification for the communication protocol and UI of SINC.
Week 03 - 04	Reimplement the Electronics Bay, including the connections that binds Multiplexer and Relay boards. Implement the outer frame of the Enclosure. Starts developing GMU and SINC app.
Week 05 - 06	Implement Thermal / Exhaust system along with the Top and Side Hatches. Testing the User Interface of SINC app.
Week 07 - 08	Implement Air Moisture and Lighting systems along with the Rail Mechanism for GMU. Testing of TinyML model on ESP32 CAM module. Testing of SINC app to its full specification.
Week 09	Integration of subsystems and further testing. Report preparation and documentation.

Work Plan: Completion Status

Week 01 - 02

- Refined Enclosure design.
- Data collection for TinyML - Done.
- Purchased components for GMU: ESP32 CAM, SD Card, Programmer Board.
- SINC UI specification done, protocol specification in progress.

Week 03 - 04

- Reimplemention of Electronics Bay in progress.
- Completed frame designing.
- Started developing SINC App and GMU.

Week 05 - 06

- Purchased materials for outer frame: PlyWood, Glue, Fasteners.
- Completed Enclosure Base.

Week 07 - 09

[1] J. Seetaram1, A. Bhavya, C. Tarun, and V. Sameera, **"Internet of things (iot) based greenhouse monitoring and controlling system using esp-32,"** *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 13, pp. 29–35, 2024. DOI: 10.17148/IJARCCE.2024.13605.

[2] A. Battikh et al., **"Greenhouse automation using esp32: A comprehensive study on monitoring and controlling environmental parameters for optimal plant growth,"** in *2nd International Engineering Conference on Electrical, Energy, and Artificial Intelligence (EICEEAI)*, 2023. DOI: 10.1109/EICEEAI60672.2023.10590110.

[3] J. Mukherjee et al., **"Non plant specific smart greenhouse with convective drying unit,"** in *International Conference on Trends in Quantum Computing and Emerging Business Technologies (TQCEBT)*, 2024. DOI: 10.1109/TQCEBT59414.2024.10545221.

[4] D. S. Kulkarni and S. Bhudhwale, **"Real-time environmental monitoring in smart agriculture using tinyml and machine learning,"** in *2024 International Conference on Intelligent Systems and Advanced Applications (ICISAA)*, 2024, pp. 1–6. DOI: 10.1109/ICISAA62385.2024.10829307.

[5] D. A. N. Gookyi et al., **"Tinyml for smart agriculture: Comparative analysis of tinyml platforms and practical deployment for maize leaf disease identification,"** *Smart Agricultural Technology*, vol. 8, p. 100 490, 2024, ISSN: 2772-3755. DOI: https://doi.org/10.1016/j.atech.2024.100490. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2772375524000959.

Thank You