Interdisciplinary Senior Capstone Project

Automated Planter

A Design Project Final Report submitted to the Department of Computer Engineering, College of Engineering and Applied Science at the University of Cincinnati in partial fulfillment of the requirements for the degree of Bachelor of Science

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Abstract

Our automated planter is a smart plant-care system designed to minimize plant maintenance from the end-user. The system will use an ESP32 microcontroller, temperature/humidity sensors, a water pump, and a mobile app to monitor the plants' environment and automatically adjust watering and lighting based on plant care parameters retrieved from the plant care API Perenual. The goal of the project is to improve plant health outcomes, reduce user workload, and provide an affordable way to automate plant care.

Project Description

Problem Statement: Design a device that is capable of automatically watering controlling the amount of light a plant receives. It should also be able to collect data on plant health and alert the end if any maintenance is required via an application.

Existing Solutions: While there already exists both automatic watering devices and plant lights, also both for reasonable prices, the combination of the two doesn't seem to exist for a reasonable price. The solution most similar to our idea (Gardyn), has all of the features we wish to have but comes in at $439 and the AI and application features require a monthly subscription that costs $14-25/month (depending on length of subscription purchased).

Objectives/Scope/Success Criteria:

- Come in at a reasonable price (<$100)
- Have the device be modular, meaning that it can be fitted to an existing planter or enclosure
- Maintain a low cost and 3D-printable hardware design
- Utilize open-source technologies and public APIs.

Design Constraints

- Client and/or Stakeholder Mandated Constraints
    - N/A
- Ethical and Professional Responsibilities (ABET 4)
    - Avoid doing any harm to the plants maintained by our device
    - Make as much of the project open-source as possible
- Health and Safety Constraints and Considerations (ABET 2)
    - Electronic components must be integrated safely, especially considering our design requires a water reservoir and pump
- Cultural Diversity and Accessibility (ABET 2)
    - Mobile app must be intuitive and accommodate all users
- Economic Constraints and Considerations (ABET 2)
    - Price of <$100
- Environmental Constraints and Considerations (ABET 2)
    - N/A
- Sustainability Considerations (ABET 2)
    - N/A
- Legal and Regulatory Considerations
    - Use of Wi-Fi will come with regulatory requirements from the FCC and following
    - Electrical components will also require knowledge of regulations and we must ensure that the electronics will operate safely and reliably
- Security Considerations (E.G. Cybersecurity and/or privacy concerns)
    - User data and network credentials will need to be secure

- Manufacturability Considerations
    - All physical components should be readily available for purchase or 3D-printable

Engineering Standards and Codes

One engineering standard we plan to follow in our design is the IEC 61131-2 standard which covers the design of low-voltage electronics and will help us remain compliant with our safety and regulatory constraints.

Although originally intended for industrial programmable controllers, many of its safety principles apply directly to our design. The key sections that apply are guidelines for proper insulation, safe wiring practices, I/O protection, and design considerations for systems operating below 50V.

Design Considerations

Several design considerations have been and will be considered in our design such as:

User Experience: The app UI must be intuitive and accessible

Cost: Component choices were optimized to keep total cost below $100

Maintenance: Minimal and simple

Open-Source: Both hardware and software designs need to be easily accessible and modifiable.

Design Process, Alternatives, and Basis for Selection

Methodology

We started with the project goals: keep a plant alive, automate watering and lighting, budget, safety, and ease of use. While there are a number of ways to achieve this goal we compared the following ideas and selected the one we felt best met our goals and worked well with our constraints.

Design Alternatives Considered

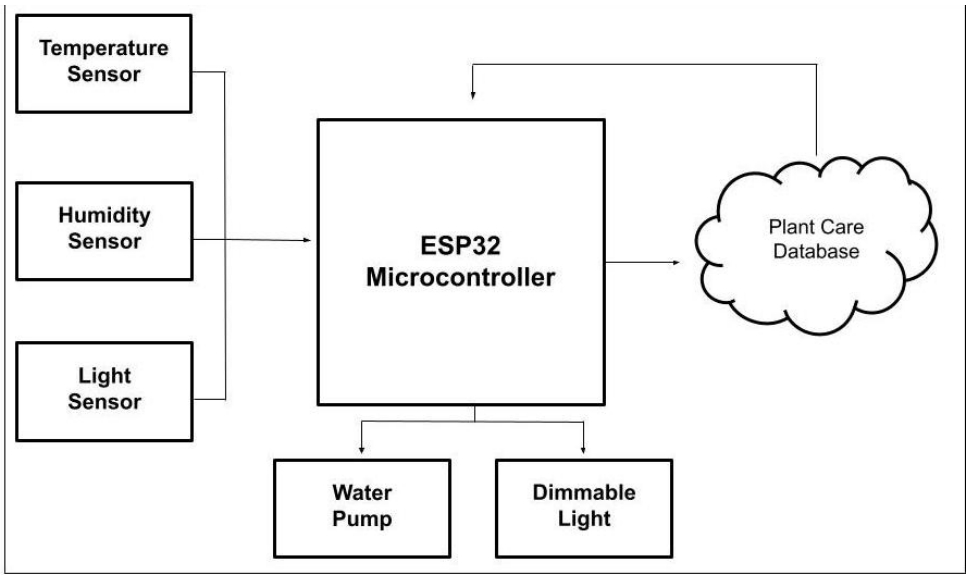
- Timer based design
  - Pros: Simple to implement, cheap
  - Cons: Static, cannot respond to environmental conditions
- Camera Based AI Detection System
  - Pros: Potentially extremely reliable
  - Cons: Expensive and complex
- Microcontroller/Sensor Controlled System
  - Pros: Reasonably priced & adaptable
  - Cons: Requires internet connection and electronics near water

Basis for selection

We chose the Microcontroller/Sensor Controlled System because it best fit our project goals. It will be low cost coming in under $100. It will be adaptable to any plant in any condition. It will require minimal maintenance from the end-user.

Design Overview

Item	Purpose	Cost
ESP32 Microcontroller	Take in data from the sensors and output data to the lights and water pump	$7.00
Water Pump	Will either trick water in slowly or pump adequate amount of water in when needed	$6.00
Misc Sensors/ICs	Give valuable environmental data to the controller to make decisions on light and water control	$6.50
Misc Hardware	Wires, Boards, Power, etc. Will help tie everything together	$25.00
Test Environment/Enclosure	Allows us to test our design in a controlled environment to ensure proper functionality	$20.00


Temperature Sensor
Humidity Sensor
Light Sensor
ESP32 Microcontroller
Plant Care Database
Water Pump
Dimmable Light