EE 475 Project Proposal

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The proposed product is a robot that automatically detects and waters plants. By automating plant watering, the robot reduces costs and frees up human labor, increasing efficiency. A key advantage over current automated irrigation systems is that no infrastructure needs to be built. Furthermore, the robot can potentially handle varying scales (small vs large gardens) and varying plant layouts, which fixed systems cannot.

Market Relevance

Instead of traditional irrigation systems that either implant a large number of hoses or sprinklers to irrigate a large area of lawn, the smart robots are used in gardens where the plants are equally spaced and spread out. One single smart robot saves both man-hours and equipment costs. Since the coverage of gardens is quite extensive, and 18.3 million U.S. households started gardening in 2021, this robot will definitely meet the needs of the market. Similar products such as automatic weed killers or automatic lawn mowers already exist but at a very high cost. Existing products on Amazon.com cost anywhere from $500 to $3~4k. While the purpose of this project is smart irrigation, the product can easily be converted to a weed killer to compete with existing solutions. The gardening market will continue to expand globally, and increasing consumption and climate change require increased efficiency. Automation/digitization is also an expanding trend with smart home devices and IoT. This product is a good fit for either market.

Feasibility

With the constraint of having such a limited amount of time for our product implementation, it is important to consider decisions we make, both in the short and long term. We recognize that we are also college students who also have other roles and responsibilities that we need to fulfill in our own lives, and we are aware of the amount of availability that each member has to work together to create our final product. However with careful consideration and attention to planning, creating a working product by the end of the quarter will be feasible for us.

In 10 weeks, we aim to implement robot movement for it to move around a small garden and be able to water plants that it encounters as needing attention. We will largely focus on robot design and plant recognition (object detection) aspects of our robot. If we have extra time, we plan to add more features that make the robot more useful in the garden such as spraying weed killer and spreading fertilizer.

Components

The robot will be controlled using a STM32 and Raspberry Pi board, and contains camera(s) (thermal, distance, ultrasound, etc.) and water tank/bottle. The simplest robot is a flat frame with four wheels.

Basic use would be in a small garden with a flat surface, where the plants are equally spaced and spread out. Using AI (computer vision), for each plant, the camera first detects it, moves the robot to it, and finally waters it.

Potential Risks and Plan B

One potential risk is that outdoor conditions like rain, or snow could damage the robot. Furthermore, dirt and dust particles could easily get into the robot as the robot will be stationed outside. One solution to this issue would be to develop a protective waterproof shell around the robot to prevent outdoor particles and rain/snow from infecting the robot. One additional outdoor risk is that the robot could have trouble moving on certain outdoor surfaces like dirt and grass. A solution to this would be to ensure the motor we use is powerful enough to move on uneven surfaces and to use larger wheels with higher tractions. One last potential risk is that the robot could end up watering the same plant multiple times. One way to combat this would be to implement a memory system within the robot and ensure that the robot only waters plants that are not in its memory.

Overall, the two main sections of our project are the AI plant image detection component and the robot random movement component. In case we are not able to fully implement the AI image detection aspect, we can implement a remote or manual control system of the water. In addition, if we aren't able to fully implement the random movement aspect, we can use remote or manual controls to command the robot movement.

How Work Will Be Split Among Team Members

We plan on dividing the project into two main sections. One section will focus on the AI image detection component and the other will focus on the robot's random movement and water spraying capabilities. We plan on dividing our group in half to focus on each of these sections. Within each of these groups, we can divide in half again with one half focusing on the software component and the other focusing on the hardware component such as assembling the wiring and various necessary devices.

Budget and Fundraising plan

Our budget for the autonomous plant-watering robot project includes various essential components, with the total estimated cost being around $130. The robot's base, consisting of wheels, frame, and motor, is allocated a budget of $50; this cost will depend on whether we decide to build it ourselves or purchase a pre-made one. For visual detection and plant recognition, we have set aside $30 or more for one or more cameras. The water container or tank, essential for storing the water used by the robot to water the plants, has an allocated budget of $10 for materials. To navigate and interact with the environment effectively, we plan to spend around $30 on various sensors, including distance, moisture, and thermal sensors. Finally, batteries, crucial for powering our autonomous robot, are budgeted at $10. This comprehensive budget plan is designed to cover all necessary components, ensuring our robot is well-equipped to perform its intended functions efficiently.

Table 1. Current Budget

Materials	**Cost**
Robot (wheels, frame, motor), self-built vs. bought pre-made TBD	$50

Materials	**Cost**
Camera (1+)	$30+
Water container / tank materials	$10
Sensors (distance, moisture, thermal, etc)	$30
Batteries	$10
Total	$130

Our fundraising plan for the autonomous plant-watering robot is multifaceted, targeting various sources to cover our projected budget of $130. We intend to launch a Kickstarter campaign, capitalizing on its wide reach to attract potential backers interested in innovative home gardening solutions and technology. This campaign will be supplemented by outreach to our personal networks, including friends, family, and fundraising groups, who may provide both financial support and word-of-mouth promotion. Additionally, we plan to approach companies in the plant and agriculture sector, presenting a tailored proposal that highlights the mutual benefits of supporting our project. These benefits include brand exposure associated with an innovative, eco-friendly technology and potential future collaborations. Our strategy combines online crowdfunding with more traditional fundraising methods, ensuring a diverse range of potential funding sources to increase our chances of meeting our financial goals for the project.

Schedule

We expect to complete a prototype by the end of week 6, and add additional features and/or troubleshoot issues for the remaining weeks.

Table 2. Proposed Schedule

	AI / Camera	Robot
Week 3	Get started on AI / pseudocode main functions	Finish design of robot and begin setting up with Pi/STM
Week 4	AI plant recognition	Connect camera/sensors to robot / robot movement control
Week 5	AI integration with STM/Pi/Robot	Connect camera/sensors to robot / robot movement control
Week 6	Have prototype done (at least: moving robot that can manually water + detect plant)	
Week 7	Extra features / troubleshooting	Extra robot design
Week 8	Extra features / troubleshooting	Extra robot design
Week 9	Extra features / troubleshooting	Extra robot design

Week 10	Increase AI accuracy, finish presentation	Optimize functions/sensors, add weed killer / fertilizer