

Tom Seager - 2100805 - Project Proposal

by Tom Seager

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ELECTRONIC PROJECT PROPOSAL

Thomas Seager - 2100805



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UWTSD

Automated Plant irrigation system

Thomas Seager 2100805

Electrical and Electronic Engineering

20/10/23

Objective

The objective of this project is to design, test and manufacture a microcontroller based system that can;

- Measure the level of moisture in the soil
- Dispense water to correct the moisture levels in the soil
- Use Solar power and a helio-stat to maximise energy collection
- Contain a water collection system and sensors to detect how much water is available for the system to use – before it uses water from the home.

Additionally, a design will be made for domestic and industrial settings which a difference of features and cost to suit the consumers for different applications on small and large scale.

Problem and solution

A huge percentage of plants that are grown end up dying due to a lack or a surplus of water, in the form of the soil moisture percentage. This is a huge problem that is not yet widely recognised, as forecasts for the future predict mass food shortages due to a lack of water availability worldwide. A warning of this was the droughts that the USA experienced in 2012, where a 26% decrease in maize yield occurred leaving people struggling for food [1]. Worryingly, this was not a one off occurrence and it is projected that the failure rate of maize growth will rise by “4.5 times by 2030 and up to 25 times higher by 2050” [2].

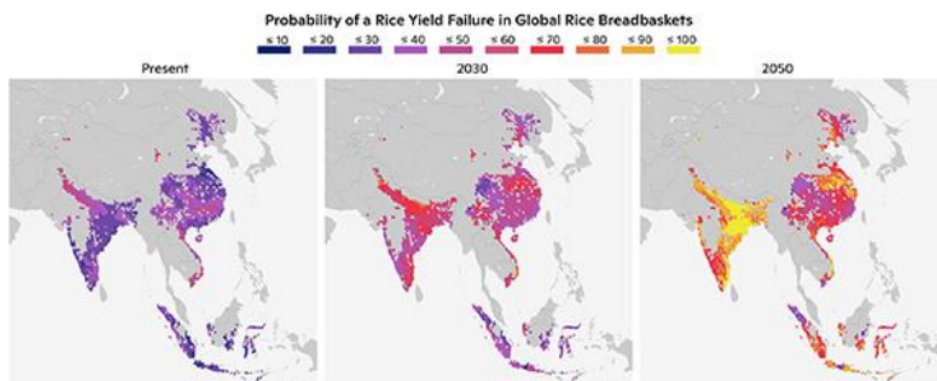


Figure 1

Figure 1 shows the massive increase in rice failure across Asia in the years 2021, 2030 and 2050. This could lead to huge worldwide food shortages and is widely regarded as inevitable

by researchers unless changes are made both regarding water use, successful crop yield percentages and the CO2 emissions worldwide.

My solution to this global issue is to design and manufacture a system that controls the water intake of plants, ensuring that they remain at an optimal level to massively increase the crop yield for both domestic and industrial use in the future. Did you know that agriculture uses approximately 65% of the worlds total fresh water intake each year?

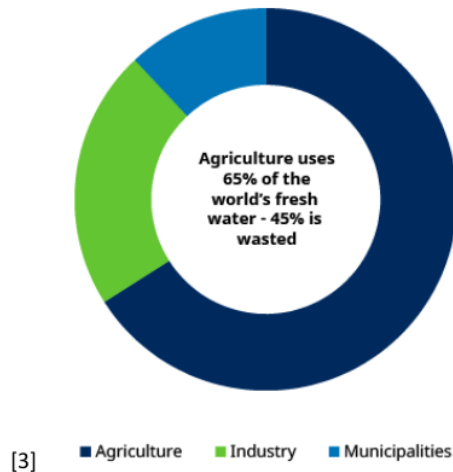


Figure 2

Schroders research concludes that 45% of the water used by agriculture is wasted through poor irrigation systems, this is an unbelievable 2.66 trillion cubic meters of water each year being used with 1.2 trillion cubic meters of water being wasted each year. That is an astronomical number which could be massively reduced to repurpose this water for more productive purposes for human consumption, or to increase crop yield worldwide. Schroders research also concludes that agricultural crop yields double where irrigation systems are used, leaving a massive expanse for innovation and development within the crop irrigation industry.

The system that this project will be dedicated to will be a domestic implementation of an automatic irrigation system with the aim to expand on the design in the future to produce a more efficient, large scale system to control the water flow for farms and mass crop producers, in order to both reduce water consumption, produce energy in an eco friendly way, and finally to increase the health and yield percentage of the crops.

This system will be constructed using a few main components;

It will use three microcontrollers that will use I2C to communicate to one another, with a central microcontroller controlling the operation of the system. Firstly, a solar panel will be

used to power the circuit, potentially using a heliostat to track the sun's rays and maximise its efficiency, this power will then be used for the circuit. The main function of the system is to measure the soil moisture level and react upon that basis, deciding whether to turn on the irrigation system, and for what duration of time to correct the levels for optimal plant growth. This will utilise two probes placed in the soil which will send and receive a signal, the strength of this signal will alternate depending on the moisture level in the soil as it will become stronger as more water is present. This then needs to be tested and carefully calibrated to make it an effective system. Research shows that most plants have a range of around 20% that is their optimal moisture level, so a resolution of around 5% could be acceptable to maintain within the boundary, however for future designs and improvements the aim will be 2% or lower.

Project Design

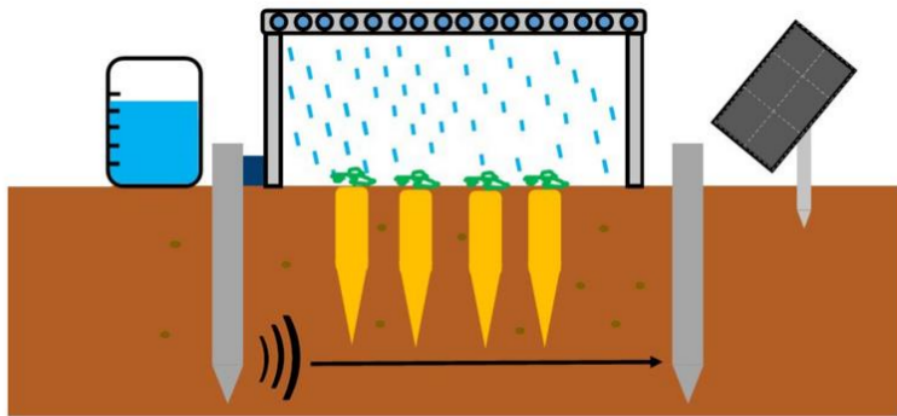


Figure 3

Figure 3 shows a basic concept drawing of the design including the water tank that will have built in sensors allowing the microcontroller to detect the amount of stored water in order to decide whether it should use the collected rain water, or the water connected via a hose attachment from a house or tap. This small feature will reduce the water usage of the system slightly, however across a large scale this would make a noticeable difference.

The irrigation aspect of the design will be simple, using industrial irrigation systems as inspiration. A hose or pipe will be installed across a frame that stands above the crops, this pipe will have holes in increments at different angles to ensure an even spread of water falls onto the crops when it is turned on, simulating natural rainfall over the bed of crops. For larger crop patches, multiple pipes could be used, or a single hose in a snaking formation across the entirety of the crop bed.

To summarise the design, the key features are;

- Microcontrollers to receive signals and control the hardware
- Solar panel to power the device
- Water collection system with sensors
- Probes to continuously measure the soil moisture levels
- Irrigation system to simulate rainfall onto the crops
- A control system for the user to input the crop and its optimal settings, also to display key information such as the soil moisture, the temperature, the power level and time

A future scaled up design could incorporate a roof or cover that is able to be opened and closed by the microcontroller depending on the soil moisture, as some plants die from drowning. The rainfall on the closed roof could then be collected and re-distributed amongst the plants when needed, effectively creating the optimal conditions for plant growth on a large scale. This would drastically improve the crop quality and yield for the farmers, helping to lower food costs and create a surplus in areas to allow for food donations to areas of need, being the homeless, areas affected by famine or even areas of conflict where it is difficult to obtain food.

Methodology

This is a large scale project that will take a number of months to complete to ensure an high level, efficient system is designed, thoroughly tested and completed to a high standard. The Gantt Chart shown in Figure 4 details the process of designing, testing and manufacturing the process across a span of 28 weeks.



Figure 4 [4]

key	
research	
construction	
analysis	
Testing	
Design	
Misc/Other	

As shown in Figure 4, the initial plan for the project is to complete it within a 28 week period. This is made easier by using the Gantt chart to dedicate time to each major task that needs to be completed. These tasks can be separated into 6 main categories that are colour coded in the chart. The largest aspects of the project will span a number of weeks, with research, circuit and physical design, construction and finally testing having the bulk of the time allocated throughout the project period.

Goals & Key Performance Indicators

It is crucial to be able to measure the success of the project through the means of setting goals and key performance indicators that can be compared with the final results to determine how successful the project was, what went well and what could be improved in the future. It is important to set goals that are ambitious, yet achievable, therefore the three KPI's that have been set for this project increase in challenge as they progress, they are;

1. To successfully design and manufacture a fully functional system, powered by solar power, that can detect soil moisture levels and control the function of an irrigation system to correct this to a set level.
2. To successfully use the microcontroller and sensors to detect the level of rainfall that's collected, and to use this to reduce overall water usage to grow the test crops. Reducing the water usage by 20% through the use of collected rainwater is the set goal. [5]
3. To improve the percentage of crop yield using the automated irrigation system when compared to the 'control' test. A percentage increase of 50% would indicate that the system is effective however a 100% increase in crop yield is the goal set as this is the number that has been cited from Schröders research.

These goals are ambitious yet achievable, and in future designs and improvements of the system as a whole, these would be worked upon further to maximise the efficiency of the system. Saving 20% of the water used could make a huge difference to industrial farming operations, while also saving local people money on their water bill. The solar power also is essentially free for the customer and a fourth goal for the future would make the device fully sustainable in parts of the world with a high rainfall, as is experienced in the United Kingdom and Wales.

References

- [1] B. R. Rippey, "Weather and Climate Extremes," USDA, 2015.
- [2] 1. Z. Z. A. D. A. C. a. C. R. S. Monica Caparas2, "IOP Science," IOP Science, 21 07 2021. [Online]. Available: <https://iopscience.iop.org/article/10.1088/1748-9326/ac22c1>. [Accessed 17 10 2023].
- [3] F. Odey, "Schroders," Schroders, 21 03 2022. [Online]. Available: <https://schroders.com/en-us/us/individual/insights/why-agriculture-holds-key-to-tackling-water-waste/>. [Accessed 17 10 2023].
- [4] Project Manager, "Project Manager," Project Manager, 2022. [Online]. Available: <https://www.projectmanager.com/guides/gantt-chart>. [Accessed 18 10 2023].
- [5] WWF, "WWF," WWF, [Online]. Available: <https://www.worldwildlife.org/threats/water-scarcity>. [Accessed 18 10 2023].

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GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

53/100

Intro / A&O (400 words)		
Project title; Identification of a specific problem to be investigated; Well-defined aims and SMART objectives; Explaining why this project is worth doing; Discussion of what the project needs to do in order to be a success; Description any deliverables that will be produced at the end of the project Reasonable Aims and Objectives specified (albeit they are not named as such) The wording of the final deliverables will probably have to be amended for the final project though – need a project meeting!	20	65% (13)
Background to the Project / Literature Review (400 words)		
Description of how the work to be done by in the project relates to the work identified in the literature review; Discussion of any ethical issues raised by the project Identifying what has already been done within the field; Topic familiarity; Brief literature review using appropriate sources – 6-8 journal papers and book chapters rather than just websites;	20	48% (9.6)

Selection of relevant models & concepts Could have done much more in describing current/existing work and methods. Limited lit review.		
Project Design (500 words)		
Clear statement of which development methods are to be used and why they are appropriate; Clear statement of which tools are to be used and why they are appropriate; Clear description of how data collected will be analysed While there is some description of the hardware that's going to be used, no real detail at all as to HOW this work is to be implemented in terms of development tools etc, or why what that has been specified is appropriate compared to other methods.	30	45% (13.5)
Resources / Planning (200 words)		
List of any deliverables; Clear diagram showing both timing and resource use; Completed ethics form; Limited and relevant appendices	15	50% (7.5)

Fairly detailed Gantt chart provided, Could have provided much more detail for all the other areas however.		
Document Presentation		
Correct spelling, grammar and punctuation; Flow of narrative/fluency; Coherence; Word processed ; Correct use of referencing with bibliography; Strict word limit Fairly well presented, although the writing style reads a little too much like a promotional propaganda brochure at times rather than an impartial academic report! Should also have included a TOC and probably a more formalised sectionalisation method such as 1.1 1.2 etc	15	62% (9.3)
TOTAL	100	53

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