The Carousel:
An Exploration of Agriculture and Technology in Israel

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ABSTRACT

The goal of this project was to learn about the systems that are used for agricultural research and development (R&D) efforts in the Arava region of Israel and how R&D workers and members of local communities feel about the state of agriculture in Israel. We worked to bring modern principles of automation to the Southern Arava R&D's Carousel Irrigation System (CIS). This document reports on our work at the Southern Arava R&D: the integration of a new automated irrigation system for the CIS and the construction of a booklet that explores the relationship between technology and agriculture through the lens of those living in the southern Arava. The CIS can be used to conduct experiments, and our booklet offers insight into the current perceptions of agritech from those living in the Arava.

ACKNOWLEDGEMENTS

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AUTHORSHIP

Each member of the project team contributed equitably to the authorship of our deliverables, including the writing and editing of each file. Joseph Cybul focused on the technical aspects of the project, including programming the Raspberry Pi and user interface. Brendan McClelland constructed the physical system and contributed to the background context of the booklet. Allison Steeves spearheaded the story efforts, including write-ups of our interviews, and the formatting of our booklet. Ella Torregrosa handled the creation of a user manual for the final system and contributed to the vision and design of the zine project.

TABLE OF CONTENTS

The Integrated Irrigation System

The Carousel Irrigation System (CIS) is located at the Southern Arava Research and Development (R&D) station near Kibbutz Yotvata. The Southern Arava R&D, established in 1985, works to test and develop efficient methods of farming for kibbutzim in an area classified as hyperarid. With research into water conservation, alternative pest control methods, soil quality, and potential desert crops, workers and researchers collaborate to improve farming at large. The CIS is a 25-year-old rotating mechanism designed for small-scale agricultural experiments with 24 barrels that serve as the environment for the plants. The CIS had been refurbished last year by a team of three students who restored the mechanism’s ability to rotate, as well as cleaned and repaired necessary components. Although it was in working order since last year, it still has not been used for experiments due to problems with irrigation components and the computer program. Our group focused on finding ways to once again make the CIS useful and relevant to researchers on the R&D.

We sought to improve the efficiency of experiments conducted with the CIS by implementing our own automated irrigation system to supplement the CIS’s existing subsystems. Ideally, the implementation of an automated system would help minimize research errors and reinvigorate researchers’ excitement with the 25-year-old system, which is not currently used for experiments. Through the introduction of modern principles of automation, we wanted to highlight an old system’s relevance in addressing current agricultural challenges in the Arava, like water scarcity. The creation and integration of this automated irrigation system consisted of several parts:

- Proof-of-Concept Plant Experimentation
- The User Interface
- The Physical System
- System Tests
- The User Manual

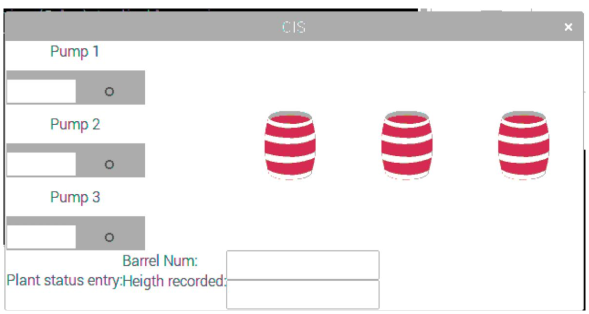
Proof-of-Concept Plant Experimentation

To inform the design of our automated irrigation system, we conducted our own small-scale, proof-of-concept agricultural experiment to better understand how the CIS could be utilized by researchers at the Southern Arava R&D and what types of experiments they may want to run. Since the availability of non-saline water is limited in the Arava, we based our exercise on how the electrical conductivity (EC) of irrigation water impacts plant growth.

We planted a mix of flower seeds in each pot of the CIS, giving 500 mililiters of water each day. Half of the pots received water with an EC of 0 milligrams per liter of nitrate ions, while the other half received water with an EC of 2.3 milligrams per liter of nitrate ions. Using our developing database and user interface (UI), we took daily recordings of the heights and observations of the plants.

The User Interface

We developed a UI application, shown in Figure 1, that allows for data collection and manual control of the system. This application was written using Python as the base language, GTK for the design library, Glade as the design interface, and a MySQL database for storing all the data. Through the UI, the user can perform four main functions: access pot summaries, manually control irrigation, perform automatic irrigation, and manage the database.



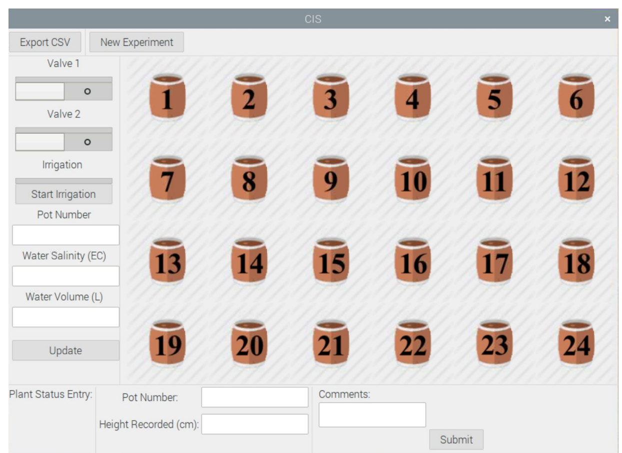


Figure 1. First and Final UI Iterations

The Physical System

The construction process of our physical system was divided into two parts: wiring of the electronics and setup of the structure that holds the ball valves and piping. In order to have permanent wired connections, we used a soldering iron and a soldering board for the Raspberry Pi microcontroller. We made several modifications to a standing metal frame, including adding a wood shelf for electrical components and metal brackets for holding the ball valves, pipes, and flow rate sensors. The final hardware components of the physical system can be seen in Figure 2.

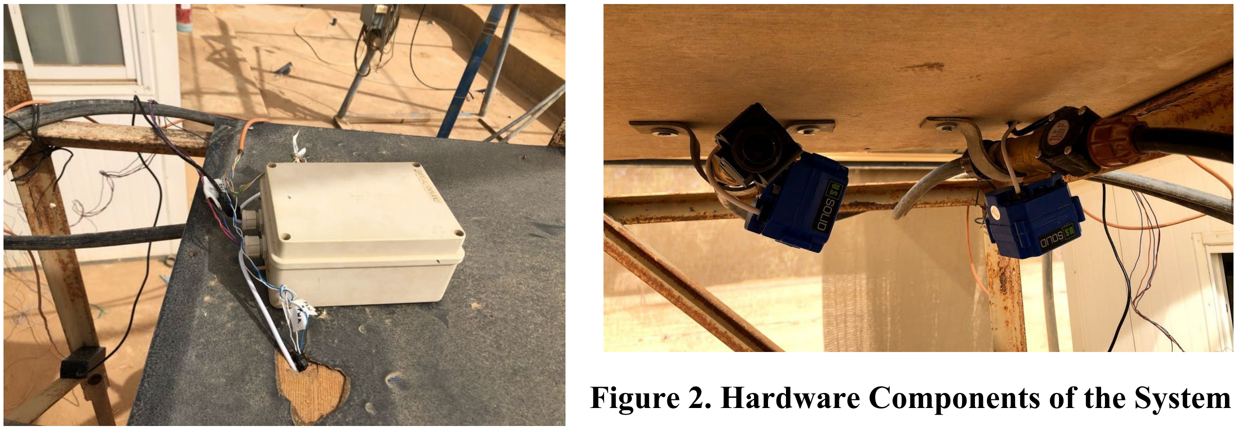


Figure 2. Hardware Components of the System

System Tests

We ran some basic tests to verify the connection between the hardware and software.

We tested the accuracy of the flow rate sensors:

1. Connected the flow rate sensor to the computer.
2. Collected a specific amount of water into a measuring cup (0.5L).
3. Ran a program that displayed the amount the sensor read.
4. Ran the water through the sensor.
5. Repeated previous steps until our readings had a negligible error.

We tested the maximum allowable distance between the RFID scanner and the tags:

1. Turned on the CIS with the tags placed under each one of the pots.
2. Ran a program that displayed what the scanner read.
3. Adjusted the position of the scanner until error was negligible.

We tested the irrigation functionality from the UI:

1. Turned on the CIS.
2. Clicked on the irrigation button in the UI.
3. Ensured that every time an RFID tag was scanned one of the ball valves opened and closed after a consistent time.

We were unsure about the long-term efficacy of the system, such as how it would hold up in the harsh environment of the Arava, where dust and extreme temperatures could cause problems. For example, the Raspberry Pi generates heat when in use—and can only operate at temperatures up to 85℃—and the high temperatures during summer months in the Arava could cause the microcontroller to become too hot and malfunction. We were unable to test the system in extreme heat since we left in March before it got too warm; however, we tried to prepare for these challenges by installing a cooling fan on the back of the Raspberry Pi, shown in Figure 3.

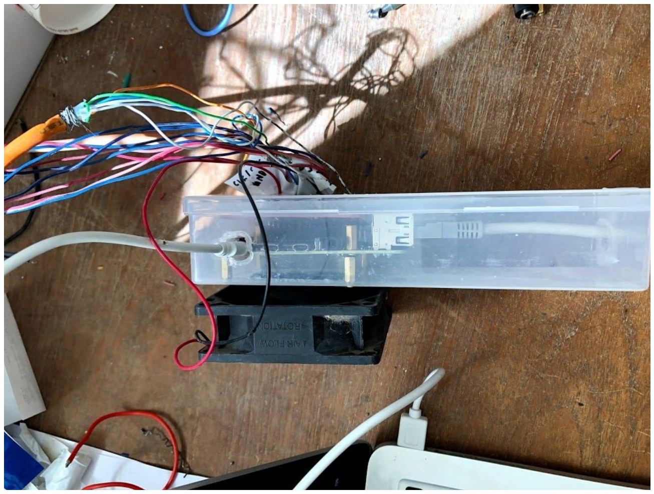


Figure 3. Raspberry Pi with Cooling Fan

We worked with very limited resources and were not quite able to construct a system exactly as we would have liked to. We brought components from the United States and had limited space to transport everything to Israel, so we had to choose carefully what to bring. For example, we ran out of wires and resorted to using scrap wire from the Southern Arava R&D's extensive junkyard.

The User Manual

To help teach workers at the R&D how to use our system and the UI application, we created a user manual. We divided the manual into four sections:

- **Part List and Functions:** Includes a general explanation of each hardware component and what their function in our system was.
- **System Design:** Features a logic flowchart of the system, which is meant to assist the user in finding and solving problems, as well as wiring specifics and diagrams.
- **Setup Procedure:** Assists the user in starting the main computer, connecting to the Internet and to the Raspberry Pi desktop.
- **The IIS User Interface:** Walks the user through the UI application, explaining its functionality with screenshots and detailed explanations.

Roots Story Zine

To communicate the importance of agriculture and R&D efforts in Israel and how our work at the Southern Arava R&D is relevant, we wrote a story that could be accessible to the WPI community and other non-Israeli audiences. We structured our story to be non-technical in nature and include personal accounts of our interviewees that would resonate with readers. Additionally, since this story was in lieu of a traditional IQP report, we chose a format that would allow for the interweaving of the historical context of agriculture and technology in Israel, personal anecdotes, and our own experiences on IQP.

To demonstrate the impact of agriculture on Israeli society and introduce our project to a WPI audience, our team created a printable zine. Zines, short for fanzine or magazine, are experimental pieces that explore a topic through a collection of photos, stories, written works, etc. Taking inspiration from alternative storytelling methods, especially in the digital age of *PostSecret*, *Humans of NY*, and *The Strangers Project* (see Appendix on page 11), we created a zine with five main sections:

1. A history of agriculture and technology in Israel to introduce our topic.
2. Personal stories of kibbutz members and R&D workers to highlight the influence of agriculture on everyday life.
3. A collection of handwritten responses and drawings from the community about the effect of agriculture on everyday life.
4. Thoughts about the future of agriculture and technology in Israel.
5. A summary of our work on the CIS and its relevance in the context of Israeli agricultural and technological interactions.

History of Agriculture and Technology in Israel

For the section on history of agriculture and technology in Israel, we conducted background research on the role of agriculture in Judaism and the development of modern-day Israel. The goal of this section was to give the reader the necessary context to appreciate the perspective of our interviewees.

Personal Stories

Through in-person interviews we tried to get a better look into the lives and perceptions of workers and researchers at the Southern Arava R&D, as well as residents of Kibbutz Ketura. By gaining more insight into how locals feel about life in the desert, R&D efforts, and agriculture in the Arava, we could better tell a story about the role of agriculture in Israel that was true to the people that live there.

During interviews, a TASCAM recorder was used in conjunction with the Google Record app, which automatically creates a transcript of the conversation. The goal of each interview was to understand the influence of agriculture on each individual interviewee. As such, questions were not pre-prepared and often a product of the flow of the conversation.

We wrote short-form stories based on personal accounts from five of our interviewees. Additionally, we asked for photos of the interviewees that could be added to the zine to create a more personal connection for our audience. In some cases, we took portraits that portrayed the interviewee in a comfortable and agricultural setting.

Community Responses

For shorter reflections on agriculture from kibbutzim community members, we created eight written prompts—in both English and Hebrew—that ask responders to reflect on their connection to the area:

1. What is your favorite memory of the Arava?
2. Draw something that represents the kibbutz to you.
3. What is the first thing that comes to mind when you hear the word “Arava”?
4. “To make the desert bloom.” What does this mean to you?
5. Draw your favorite fruit, trees, and other plants.
6. What do you want to be when you grow up?
7. How has Israel changed since you were younger?
8. What do you hope for future generations living here?

We had participants select one or more prompts to write about in any language they chose. The responses were scanned digitally and formatted within the zine using Canva, an online graphic design platform. The drawings acted as decorative elements, while handwritten responses provided powerful, personal perspectives. If responses were written in a language other than English, they were translated for our audience at WPI.

Future of Agriculture and Technology in Israel

To highlight our work on the CIS, we explored the rise of importance and current state of technology in Israel. Using research and statistics, we illustrated the rise of startup culture. We explored the possibilities for collaboration between agriculture and technology, especially speaking from our own experience at the Arava Open Day exhibition.

Summary of Our Work on the CIS

Finally, we looked to the future by explaining how we brought modern technologies to the dated carousel mechanism. We illustrated a metaphor for the potential for further growth of agritech that can be used in conjunction with previously established farming systems in Israel.

Appendix

Link to Previous CIS Project:
https://digitalcommons.wpi.edu/cgi/viewcontent.cgi?article=6505&context=iqp-all

Zine Inspiration:

PostSecret: https://postsecret.com/
Humans of NY: https://www.humansofnewyork.com/
The Strangers Project: http://strangersproject.com/