The Green Machine - Gardening for a Better Future

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Our project aims to provide a smart, user-friendly, domestic mini-greenhouse management system to enable users to grow and efficiently monitor and tend to plants within their own homes. This encourages people to grow their own food plants by removing the difficulties related to gardening

Application Scope

Operating as an automated greenhouse where the plants can grow under an optimal environment to achieve highest yield.

Expanded up to large scale indoor and vertical farming by combining multiple units.

The gathered data from the greenhouse will be stored in Microsoft Azure. These can be used to study the behavior of plants under certain environmental conditions.

Plant based research which may include tracking the growth and production using the data recorded under controlled environments.

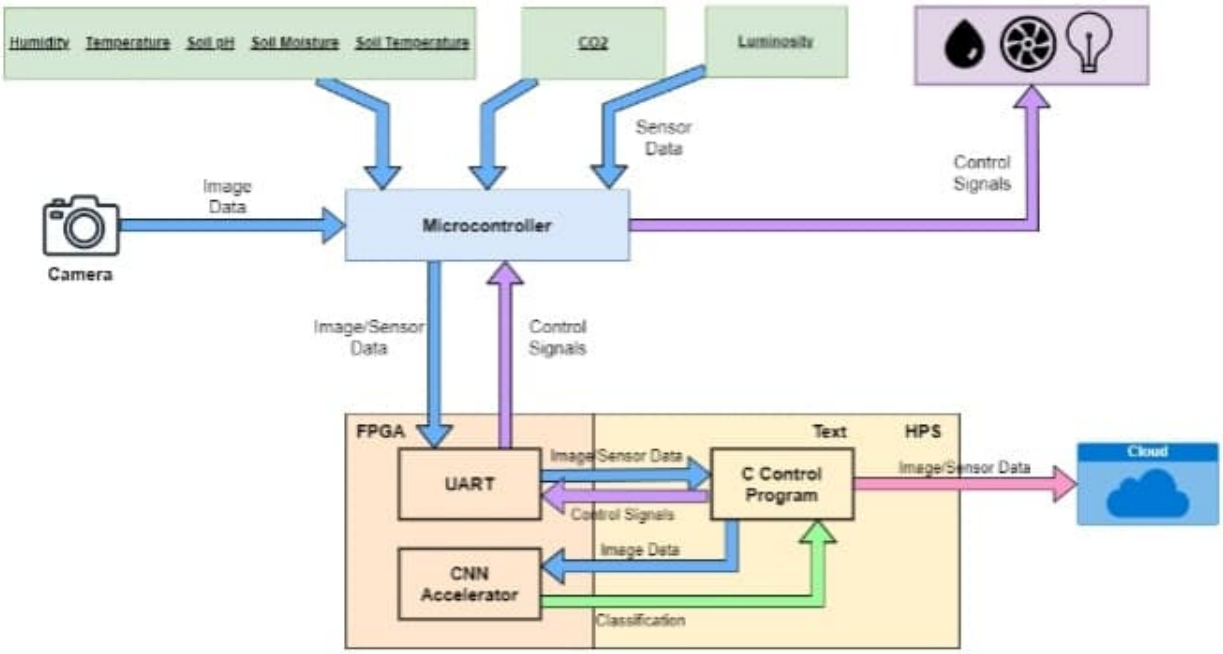
For exhibition and individual relaxation purposes

Targeted Users

Traditional farmers

Our system could be introduced to traditional farmers as a new and more efficient way of maintaining cultivation.

The following diagram illustrated how the CycloneV SoC is being utilized to handle and process data.



3. Expected sustainability results, projected resource savings

Our project relates to two sustainable development goals (SDG);

Goal 2: Zero Hunger

Food security is achieved by allowing users to determine their own chemical levels and have fresh organic diets with improved nutrition. Through our project, the urban

Home owners

Homeowners can adopt our mini greenhouse system for indoor farming to grow a portion of their own food without the hassle of tending to it.

Researchers

Researchers can make use of this mini greenhouse system to study the behavior of plants over time under a controlled environment.

Why do we use an Intel FPGA?

The system will be controlled by a centralized controller. We identified the following features as the capabilities our controller should possess to manage the required functionality as an IoT solution.

I/O capability

Computational power

Networking capabilities

A graphical user interface

An architecture that is upgradable

Affordable

Compact with low power consumption

Purpose of Design

With the climate changes and the increase of population, the demand for food supply has seen a rapid increase throughout the past years. Therefore, the attention has been given to developing smart technologies like precision agriculture to improve the quality and yield in large scale agricultural farms. However, as the demand increases, it has been challenging to match the supply with the demand and to maintain the ever-expanding supply chain. Also, with the world facing a severe pandemic situation, many countries in the world have faced a crisis of food shortage and breakdown in the supply chain.

Our solution aims to provide a smart and automatic mini-greenhouse management system for food plants targeting the local urban community. There are conventional systems without automatic control already available in the market (in the figure above). However, they have not been commonly adopted due to the difficulty in continuously maintaining them in the busy lifestyle. Our goal is to bridge this gap and use electronic control to monitor and tend to the plants. This will encourage more users to adapt to this concept of growing their own food. Also, this will help to supply fresh, organic food from their garden which the users can safely

Application Scope

The basic functionality and the monitoring aspects of our system are as follows.

The data from the sensors will be sent to the FPGA to process and determine the requirement of irrigation, fertilization, nutrients, ventilation and light at the edge.

Camera footage will be used to allow users to remotely observe their mini-greenhouse, track plant growth, predict yield and identify abnormal behavior such as over-growth.

This data will also be sent to a cloud database hosted on Microsoft Azure, where they will be efficiently stored and processed to monitor the performance of the mini-greenhouse in the long run.

Using the flexibility of the FPGA and the abundance of sensors available, monitoring aspects can be expanded in the future using system updates.Also, a centralized database could be created in the cloud with data from multiple gardens in a local community to better share and manage their yields.

Targeted Users

We mainly focus on developing a product for the average domestic urban household. A single FPGA can cater to several mini-greenhouses within its vicinity. Therefore, small-scale farms can also benefit from this technology.

Why do we use an Intel FPGA?

For the control system, we specially consider using an Intel CycloneV FPGA because of the following reasons.

Low power consumption

High computational power for a lower cost

Reconfigurability

Combination of Hard Processor System (HPS) and FPGA

To test our implementation, we will use the DE-10 Nano development kit from Terasic.

We will need to perform amplifications and analog to digital conversion on sensor data in high precision and speed. Also, we expect to monitor environmental factors such as temperature, humidity, light intensity, etc. For these purposes, we plan to use sensors and evaluation kits such as CN0398 from Analog devices.

8. Conclusion

The field of agriculture has the potential to increase its net produce by incorporating the latest technology available in the world. But not enough solutions have been introduced to the world that harness the power of such technologies to improve the quality and efficiency of agricultural processes.

The concept of green machines open up a new pathway for the urban households to engage in agriculture willingly and effortlessly. Also, it provides the farmers with an efficient way of managing their products by combining several of such green machine modules together. Also, by integrating the internet of things to the system, we are able to provide the data obtained from such green machines for research and other experiments that improve the quality of the agricultural yield.

When this concept is implemented on a larger scale, it is possible to create a local community within a vicinity with localized data from several green machines that grow different types of plants. The community can efficiently share their organic products with the other members of the community that improves their overall quality of life and food safety.