Autonomous Greenhouse

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***Abstract*— This report describes a autonomous system for growing different types of crops. The system is build on an miniature greenhouse in plastic, with different kinds of sensors that send information to an Arduino and Raspberry Pi, that controls a Fan, LED light and water pump. The system is used for extending the life off the plants growing in the greenhouse by making sure the temperature, humidity and more always is set to the plants ultimate growing condition.**

I. INTRODUCTION

A. Background

Agriculture has been around for a long time and practiced by the vast majority of human civilizations. Over time through experimentation, they have worked towards extending the life expectancy of plants and improving the yield. Growth of various plants depend on the geographical area and environmental surroundings. With the help of Greenhouses, it is possible to grow any different number of plants anywhere. The improvements made in greenhouse technology can also help reduce hunger problems around the world. Plant growth depends on a number of different parameters such as light, temperature, humidity, soil moisture, etc. The sustainability of the plants depends on the parameters mentioned above.

Having a greenhouse at home for growing your own food can be both economical and more environmental friendly since less greenhouse gases are produced per plant [2].

II. AUTONOMOUS GREENHOUSE

A. The Concept

Autonomous Greenhouse is a greenhouse which has the ability to control itself and relay information regarding the greenhouse back to a web-application. The web-application will have monitoring techniques which will help the user to have an overall view of how the plants are being taken care of.

B. Delimitations

The main restrictions for this project are scale and time. The scale of the greenhouse is very small compared to other similar projects out in the web and the time for this project is only eight weeks.

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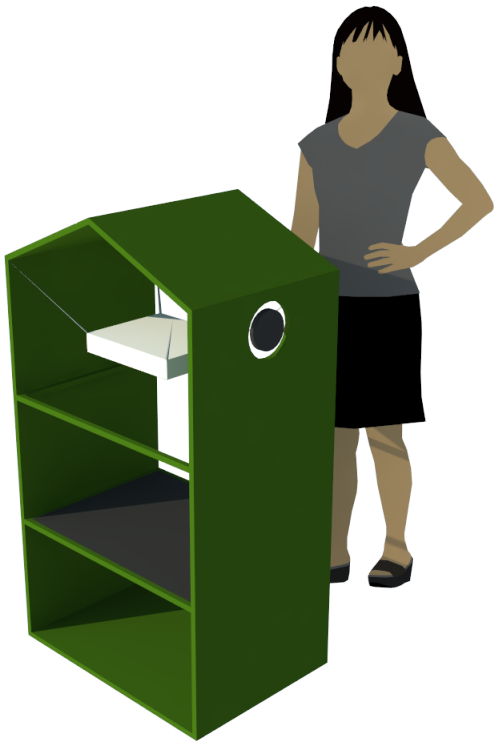

Fig. 1. 3D rendering of the concept idea

III. ARCHITECTURE AND TECHNOLOGIES

A. Node Hardware

To make the greenhouse automated the physical components must interact with each other by appropriate software on the respective computer. The architecture design strives for cost reduction and the possibility of expanding the system by adding more sensors and actuators. To achieve those requirements an Arduino was selected as sensor reader and actuator controller. The Arduino is great for sensor interacting and actuating, since $3.3V$ and $5V$ pins can easily be programmed by using the c-based ”arduino-language”.

Furthermore the Arduino reads analog input from the light sensor and moisture sensor. The temperature sensor and humidity sensor send digital value to the Arduino. The sensor values is then passed from the Arduino to the Raspberry PI.

The Raspberry receives the sensor data and makes a decision whether watering, cooling or lighting the full-spectrum LED is needed. If so, an actuating message is sent back to the Arduino through the serial communication (UART). The Arduino acts according to the actuating message.

Since there are 4 different voltage levels a wiring diagram was needed to sort things out. The full-spectrum LED runs on $230V$, which makes the system dangerous if it's not properly wired. To reduce the risk of injuries the $230V$ and the $12v$ network is handled by a relay. Figure 2 shows the wiring of the system.

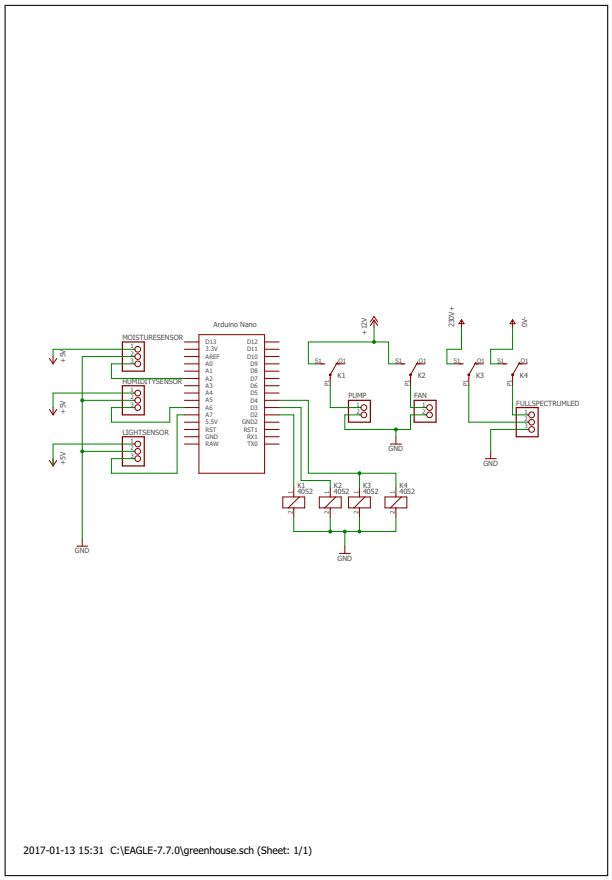

Fig. 2. wiring diagram

1) Raspberry PI: Runs the webserver and database which a user can connect to and view the state of the greenhouse. A python script runs on the device to control the entire system.

2) Arduino: All sensors are connected to the arduino which gathers the information and sends it to the raspberry pi.

3) Temperature Sensor: Temperature Sensor is used to measure the temperature inside the greenhouse. Operates at $5V$.

4) Humidity Sensor: The Humidity sensor is used to measure the relative humidity in the greenhouse. Operates at $5V$.

5) Soil Moisture Meter: Measures the moisture level in the soil. Operates at $5V$.

6) LED Light: Provides a source of light when a natural source is not available. It runs on 230V and is actuated through the relay by a $5V$ signal from the Arduino.

7) Water Pump: Waters the plant when the soil is dry. Due to high pressure it waters the plant in short bursts. Operates at $12V$.

8) Fan: Will activate if the temperature gets to high inside the greenhouse. Operates at $12V$

B. System Architecture

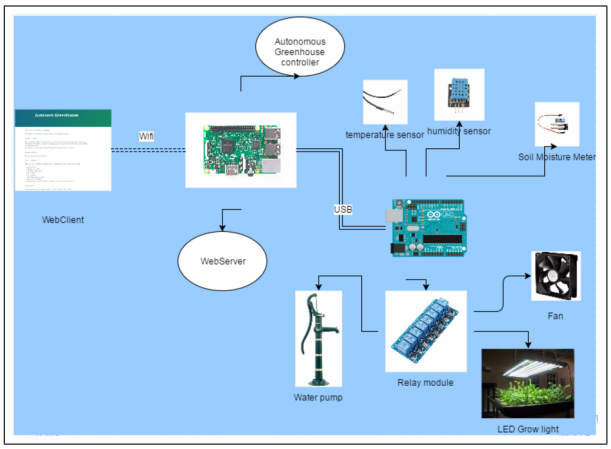

Fig. 3. System Architecture of the entire system with hardware nodes.

IV. Results

The final product is a greenhouse that is regulated by various sensors to make sure the plant has the best conditions for survival. The sensors are all connected with a Arduino board which is then connected with a serial bus to a Raspberry Pi. The sensors all have various thresholds that will activate the fan, pump or lights depending on values. Information about the temperature, soil moisture, air humidity and light can be displayed on the webserver in the form of graphs or text.

V. Future Development

The Autonomous Greenhouse can handle everything a plant would need to stay alive and theoretical live in the best condition possible for that plant.

Something the group talked a lot about, was the effect of long term testing of the system, to see how well it actually worked. The chilli seeds used in this project could take up to three months before fully grown. So it would be good to know how the Greenhouse would make it, running for such a long period off time.

Because the system as a whole is done the group don't see much future work be done on that part, instead it's looked at the possibility to add new functions and sensors to the existing one. What would be a perfect development is a camera that monitors the plant, the camera should run a software that detects when for example the chillies are fully grown and needs to harvest, or if a plants weed need to be removed. The system would take a picture and should automatically notify the gardener that it's time to attend the plant.

The possibility to have different plant that require different kinds of environments in the same greenhouse is something that also is a future development, to have different section where the humidity, temperature and light isn't the same, this would need smarter planing off the placement of the hardware and even a larger greenhouse to make possible.

On the webpage where the sensors data are displayed as graphs, what should be added is a better representation of the data value. Right now it only shows the default data value. For example, the light sensor data value is between 100 and 600, when above 400 it's quite dark, this could be converted to a string saying "Lights out" in the graph etc. Also even do the system is fully automatic, it's a good idea to have buttons on the webpage for turning the light and watering on for a certain period of time. This would be perfect if the user of the system needs to help the plants in preventive purposes.

VI. CONCLUSION

Autonomous Greenhouse is the concept idea to solve the problems of world hunger by giving the ability to grow different types of crops in different environments with the help of computers connected with sensors. There is a lot of research still to be done around the greenhouse technology. Autonomous Greenhouse focuses on extending the life expectancy of plants and to increase the yield of plants grown in home based greenhouses for personal needs.

The small size of the Greenhouse makes it possible for everyone to have one at home. You will only need a WIFI and power outlet to connect everything to.
With this project we hope too have attracted interest in people interested in IOT and show them that you don't need an entirely own garden to be able to cultivate your very own food.

ANNEX A - INSTRUCTIONS

Everything runs by a single python script. First make sure that all the component are well connected and that the Raspberry Pin has a internet connection. Start the script from terminal by entering "python controlprogram.py". Then program will take care of the rest.

For the database, you can name it what you want. In the file "controlprogram.py" it's named Greenhouse, and the table is named measurements. In measurements, four int values are saved as, light, soil_moist, air_humidity and air_temp. You will have to change the code so that it fits your system.

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[4] Autonomous Greenhouse (2016). **Webpage** Available at: `https://autonom-greenhouse.github.io/`.