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A smart farming system using Arduino based technology

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ABSTRACT

"Internet of Things" (IoT) is a technology that permits things to communicate and connect with each other. This is helpful in changing the patterns and processes in both industry and agriculture towards higher efficiency. A system is proposed which describes the smart farming in order to improve the production process in planting. Smart farming consists of two main parts which are a sensor system and a control system. Sensor system consists of a set of tools to obtain the sensed values. Control system involves a blower, watering and roofing system operated on a human interface. Two Arduino boards are programmed for sensing and the controlling system. Programming for controlling the system is done in python. The sensed values from the different sensor are viewed on an LCD display as well as a serial monitor. Results are maintained as a database in excel sheet and the graphical representation of the same is obtained. Looking on to results obtained from the sensor system, the control system is activated using the python controlling console. An increase in product quality and quantity is achieved by following the proper decision-making process.

Keywords*— Smart farming, Internet of things*

1. INTRODUCTION

Agriculture is one of the important businesses that mainly affects the mankind. From the ancient to the agricultural revolution in Great Britain England, farming is the way that human used to harvest plants and consumed them in their daily life. Farming has been improved by many technologies supporting cropping system. In addition to the technologies in the agricultural revolution era, there have been many technologies that have impacts on agriculture such as harvest machine, seed drill machine, reaper machine, and the others that can reduce manpower and waste time. Recently, there are few research works on smart farming. A wireless sensor network is used in potato fields in Egypt. The proposed system was used to monitor the potato fields such as looking for diseases and harmful fungi and record useful information for improving future planting and managing resources such as water and soil. To increase the crop yield, the smart farming technology would help. In this work, a smart farming system is proposed. Smart farming is the technology that uses the concepts of IoT to help farmers to monitor and sense useful information from their farms in order to help in the quality improvement and product quantity.

2. BACKGROUND

Several works have been carried out which aimed at making agriculture smart by including automation and IoT technologies. A smart GPS based remote controlled robot was programmed in order to perform the actions like weeding, spraying etc. It covered smart irrigation along with smart control. Another work included intelligent decision making based on accurate real-time field data and also smart warehouse management. Temperature and humidity monitoring along with warehouse safety by theft detection were included. A smart device controlled all the actions. Another work included the use of a Wireless Sensor Network. The network performed three activities like acquisition, collection, and analysis of the data. The temperature of the environment and soil moisture level was the area of interest. Benefits of irrigation process in agriculture are decreasing water consumption and good water management.

3. PROPOSED SYSTEM

Our proposed Smart Farming system consists of two main parts. The first one is a sensor system, which includes temperature and humidity sensor, a soil moisture sensor, rain sensor, water level sensor and light intensity sensor. The second part covers the control system. Our control system includes a blower, watering system and roofing system. The system provides the sensed data from all the sensors so as to help the farmer to make a proper decision about controlling the system. Along with the sensor output, we make use of a weather forecast repository from an open weather map to obtain the real-time weather forecast. Weather report obtained from the open weather map is compared with the results obtained from the sensor system and a proper decision making action is carried out. Two Arduino boards are programmed for sensing and controlling the system. Results obtained from the sensing subsystem are tabulated in an excel sheet and a proper decision is taken to control the system. Watering subsystem and a

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blower are controlled using a dc motor. Roofing subsystem is controlled by a servo motor. Programming is done with Python GUI for the control part. In order to maintain the proper humidity, we use the blower. Increase in the temperature leads to hot air presence, which is cooled down by blowing cool air by the blower. Increased temperature and sunlight intensity can be overcome by operating the roofing system to provide shelter for the crop. Roofing system also provides an aid in the presence of rain. Water level sensor indicates the amount of water in the reservoir which is used as a source for the watering subsystem. Looking on to the output value of the soil moisture sensor, the watering subsystem is turned on and off in order to maintain the proper moisture content of the soil.

3.1 Hardware design for a proposed system

Figure 1 shows the block diagram of the proposed Smart Farming system. In smart farming, the sensor subsystem is a set of tools and all the sensors are connected to a microcontroller board called the Arduino board. Sensors are used to measure the essential values of the planting process including temperature, humidity, soil moisture and light intensity. The sensed values are then maintained as a database in excel sheet. On another part, the control subsystem is a set of devices used to control the roofing subsystem, blower and watering subsystem.

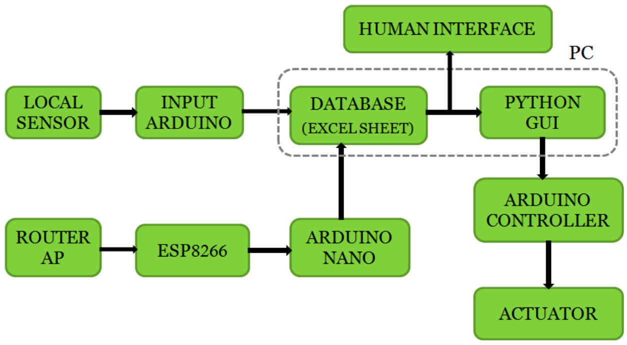

Fig. 1: Hardware design for a proposed system

3.2 Components Requirement

3.2.1 LCD display

A liquid-crystal display (LCD) is a flat-panel display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead, it uses a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images or fixed images with low information content. The information content can be displayed or hidden, such as preset words, digits, and 7-segment displays, as seen in a digital clock. They use the same basic technology, except that the arbitrary images here are made up of a large number of small pixels, while the other displays will have larger elements. LCDs are used in a wide variety of applications including computer monitors, televisions, the instrument panels, aircraft cockpit displays and many more. Small LCD screens are seen commonly in portable consumer devices such as digital cameras, digital watches, calculators, smartphones and many more. LCD screens also find their presence on consumer electronics products such as DVD players, video game devices, and clocks. LCD screens have taken over heavy, bulky cathode ray tube (CRT) displays in almost all the applications. LCD screens are found available in a wide range of screen sizes when compared to CRT displays.

Fig. 2: Front and Rear view of 16X2 LCD display

3.2.2 DHT11 sensor

DHT11- Digital Humidity and Temperature sensor is a temperature sensor as well as a humidity sensor. It constitutes two different parts which are the capacitive humidity sensor and a thermistor. DHT11 is termed as a slow sensor but it is recognized to be quite efficient for the applications where there is the necessity of some basic analog data exchange. A small chip is found inside this sensor which is designed to perform the function of analog to digital to analog conversion. This provides the results for temperature as well as for humidity in digital form. The obtained digital signal can be easily read through any micro-controller. This temperature and humidity sensor is a low-cost sensor. It is found easily in the market due to which it has become more popular among the similar type of sensors. It provides precise results with the higher efficiency. It is small in size and consumes low power. It has the capability of transmitting the signal for up to 20 meters. DHT11 constitutes a lot of features which includes low cost, long-term stability, fast response time, excellent quality, signal transmission for a long distance and many more. For real-time applications, this sensor can be used at various places like home appliances, weather stations, consumer goods and many more.

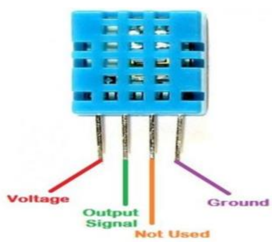

Fig. 3: DHT11 sensor

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3.2.3 Soil moisture sensor

Soil Moisture sensor is meant to measure the volumetric content of water inside the soil and serves us with the moisture level at the output. The sensor can be used in both analog and digital mode since it is equipped with both analog and digital output. The soil moisture sensor is made up of two probes. These probes are used in measuring the volumetric content of water. Current is allowed to pass through the soil with the help of the probes and then the obtained resistance value is used to measure the moisture value. In the presence of more water, the soil will conduct more electricity which indicates the presence of less resistance. Hence, the moisture level will be of higher value. On the other hand, dry soil conducts electricity poorly. Therefore, when there is the presence of less water, the electrical conductivity will be quite low which indicates the presence of more resistance. Therefore, the moisture level will be of lower value.

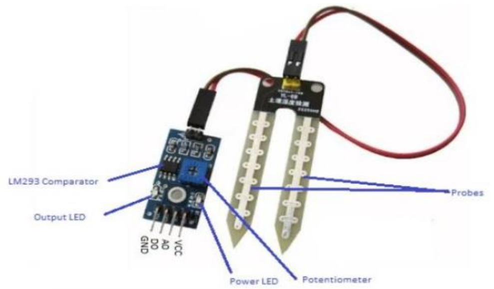

Fig. 4: Pinout a diagram of soil moisture sensor

3.2.4 Rain sensor

Rain sensors are mainly used for the detection of the presence of water beyond what a humidity sensor can detect. The rain sensor detects the water that falls on the sensor board and completes the circuits on the boards' printed leads. The sensor board acts as a variable resistor whose values will change from 100k ohms to 2M ohms. For the values nearing to 100k ohms, it indicates the wetness and for values nearing to 2M ohms, it indicates the dryness. In short, we can conclude that the wetter the board the more current it will conduct.

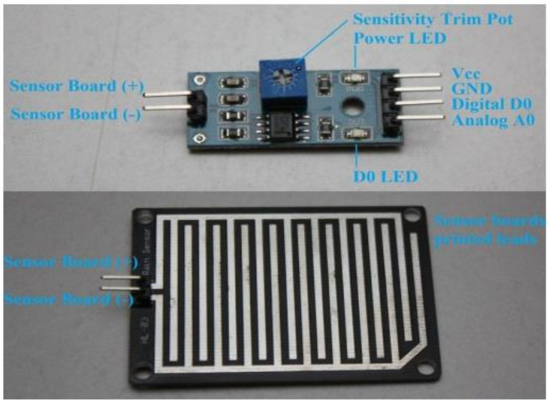

Fig. 5: Rain sensor

3.2.5 Light intensity sensor

A Light Sensor generates an output signal that indicates the intensity of light by measuring the radiant energy. It exists in a very narrow range of frequencies basically called “light”. It ranges in frequency from “Infra-red” to “Visible” up to “Ultraviolet” light spectrum. Light Dependent Resistor (LDR) is made from a piece of exposed semiconductor material such as cadmium sulphide. It changes its electrical resistance from several thousand Ohms in the absence of light to only a few hundred Ohms in the presence of light. Hole-electron pair will be created in the material when light falls on it.

Fig.6: Typical LDR

3.2.6 Water level sensor

The water level sensor is used for measuring water level in the water tank irrespective of the shape of the tank size and shape, the shape could be cylindrical well, rectangular tank, large/medium size water container. In this project for prototype demo purpose we used a larger cylindrical bottle size water container with attached four level of resistance conductive PCB that is attached with a potentiometric voltage leveler, it takes the resistive reading from the dipped PCB which is in the water tank and maps the resistive reading into 0-5 voltage range. The mapper voltage then can be given to one of the ADC pins of the Arduino microcontroller for analog voltage to digital bit conversion. The ADC pins of Arduino microcontroller convert the voltage range of 0 to 5 volt into the 0 to 1023 (10 bits) digital integer form which is easily interpretable to a human-readable form.

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Fig. 7: Water level sensor with the container for the demo

3.2.7 Servomotor

A servomotor works on PWM input signal that has 0 to 180-degree movement angle and has the high torque to produce 1 to 1.5 Kg of force with the intake power rated at 5 volts and 1 ampere. The high torque notch attached with an arm/horn that pulls the thread attached to roofer to swing the cradle up to 15 degrees from the horizontal plane.

Fig. 8: Servomotor

3.2.8 Arduino UNO

Arduino is an open-source platform (prototype platform) which is based on an easy-to-use hardware as well as software. It comprises a circuit board, which shall be programmed (usually known as a microcontroller) and a software called Arduino IDE (Integrated Development Environment), with which one can write and upload the computer code on to the physical board. The Arduino microcontroller board is very easy to use one yet a powerful single board computer. It has gained considerably a good adhesion in the hobby as well as the professional market. Arduino is referred to as open-source, which means that the hardware is reasonably priced as per the usage and the development software is free of cost.

Fig. 9: Arduino board

4. SOFTWARE USED TO DESIGN THE PROPOSED SYSTEM

4.1 Python

.Python is a high-level scripting programming language. It has features of object-oriented programming language, constructs forming and easily understandable with comparatively less syntax sub born programming language. Python has a fast interpreter and fast compiler feature when compared to other programming languages. It has the benefit of fast real-time processing

4.2 Arduino IDE

Arduino IDE consists of program editor, interpreter, built, debugger, hex file generator, input-output console (like a serial monitor). In Arduino IDE we can construct source code in two different basic structures. The former one called the setup, in which we declare the variables and initialize the input-output pin mode. The latter part is called the loop in which we write the conditional statements, iterative statements and function call all of which will run in a loop.

4.3 MS Excel

Microsoft developed a spreadsheet that can be used for analyzing and a decision-making tool for explicitly monitored data. The measuring instruments and devices that require data analyzer and report make take advantage of functionalities of the MS Excel spreadsheet. The monitored data will be stored for the future reference.

5. RESULTS AND DISCUSSION

The execution of the system designed is provided below:

Fig. 10: Output result viewed from LCD display

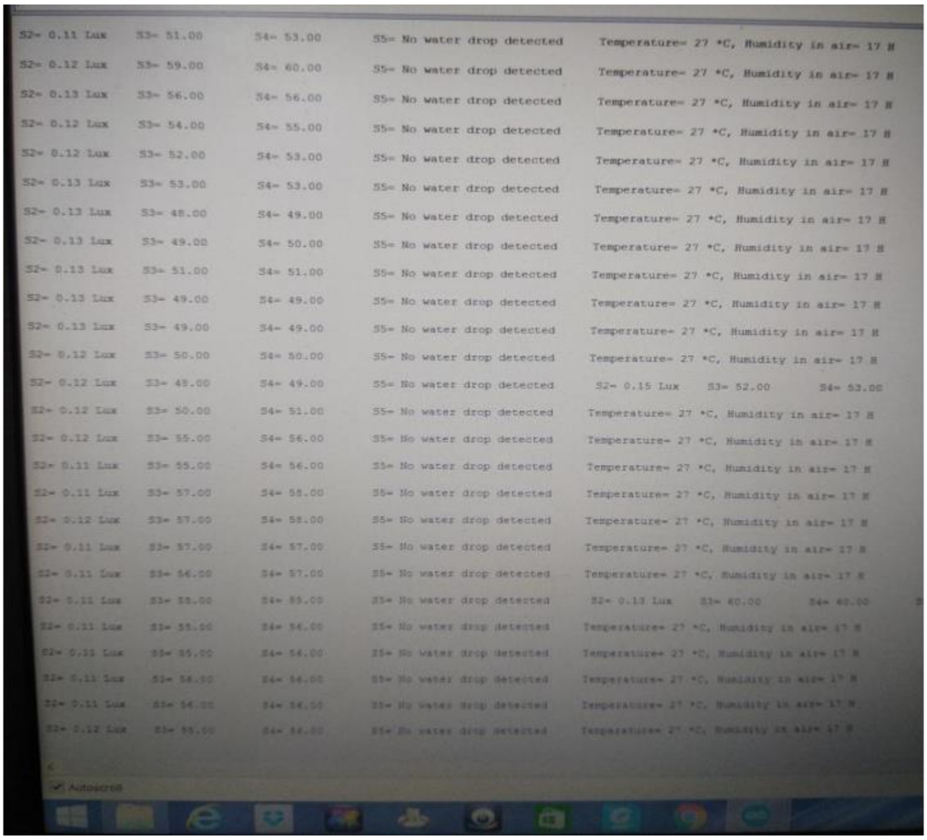

Fig. 11: Result viewed from the serial monitor

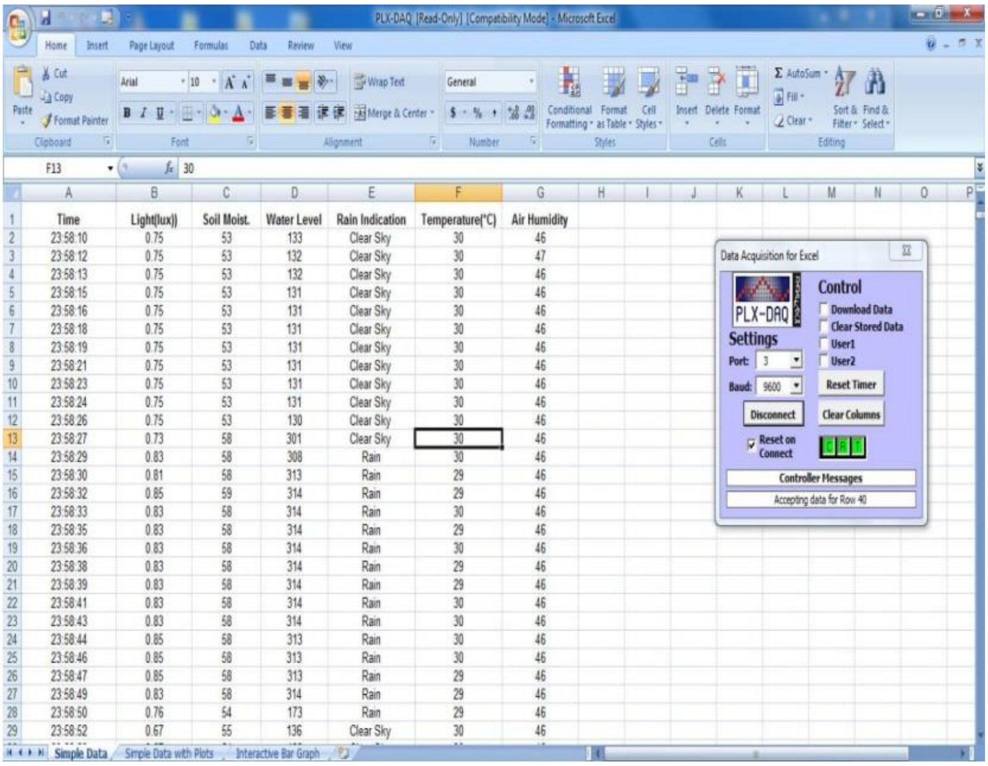

Fig. 12: Output obtained on the Excel sheet to maintain database.

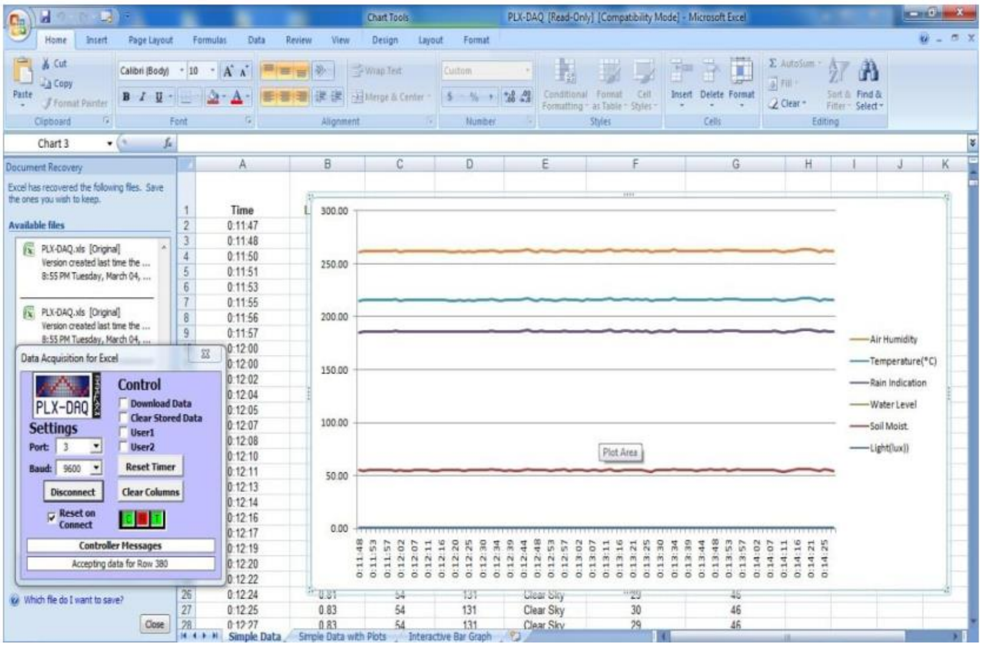

Fig. 13: Graphical representation of the obtained data.

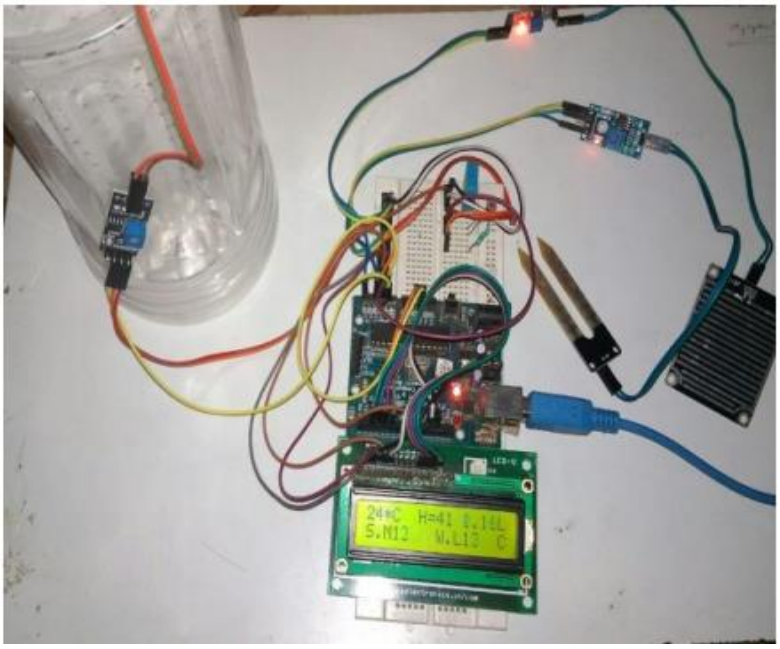

Fig. 14: Snapshot of the sensor system showing the sensed value output.

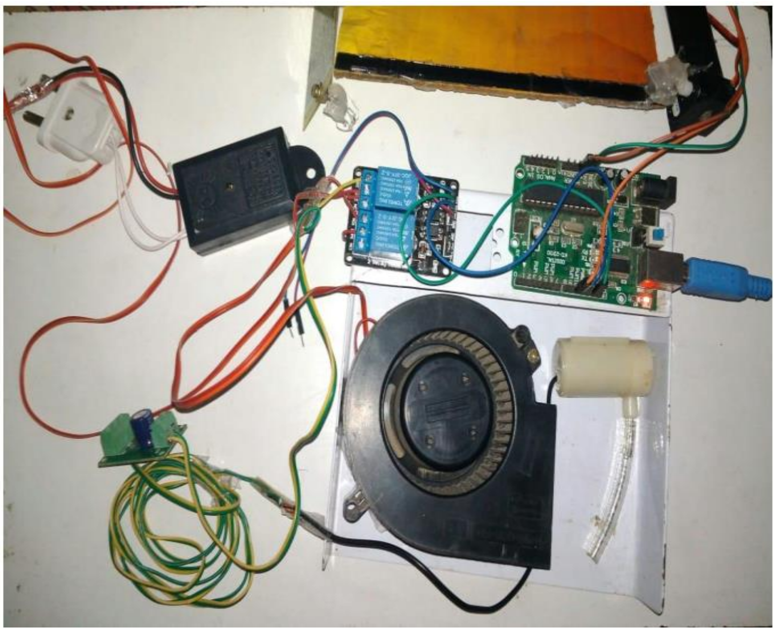

Fig. 15: Snapshot of the control system

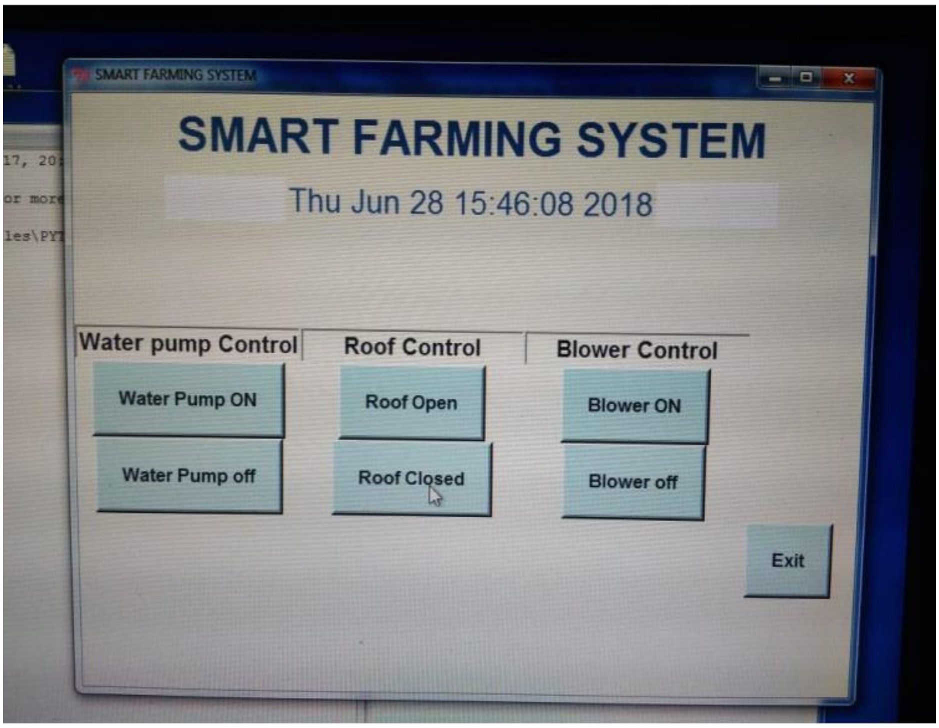

Fig. 16: Python GUI controlling console

6. CONCLUSION

This project has a vast application in the field of agriculture research and development. We can conclude that the sensors used in the sensing part of the project are ample for the reading of parameters required for the growth of plants kept in observation and the actuators are capable of providing the necessary materials to the plant. As per the data obtained in excel sheet and the graph generated in the observation period under different ambient conditions, we can infer the fast growth rate by implementing this system for different plants and can acquire data to maintain fast plant growth rate and its bi-products that too increases the lifespan of certain plants (vegetable plants).

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