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IOT Based Smart Greenhouse

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ABSTRACT: In this era of digitization and automation, the life of human beings is getting simpler as almost everything is automatic, replacing the old manual systems. Nowadays as internet has become an integral part of day to day life, all the devices also need be brought on the network. This is basically the motive of Internet of Things. Internet of Things (IoT) is one of the promising technologies which can be used for connecting, controlling and managing intelligent objects which are connected to the Internet using various protocols and means. This paper discusses about IoT and how it can be used for realizing smart greenhouse parameters monitoring system using Raspberry pi 3 (microprocessor) and various sensors connected over the internet. The various parameters are monitored and the data can be sent to different devices like PC, smartphones, etc.

KEYWORDS: Internet of Things, Raspberry Pi 3, Intelligent Objets.

I. INTRODUCTION

Today due to the growing influence of the internet on day to day lives, we have the infrastructure to connect billions of devices together. Nowadays, due to advancements in the sensors and the sensor fusion technology, various sensors are available to monitor different environmental parameters. So this technology finds a great application in the agricultural domain to make the life of a farmer a bit easy. Thus, the various sensors and controllers can be used to collect environmental data in a greenhouse and send it to the control station over the internet.

The 3 sensors connected to the raspberry pi collect various environmental data like temperature, humidity, soil moisture and light intensity. This data is sent to the raspberry pi which collects it and sends it to a cloud in real time. The data on the cloud can in turn be seen on an android application.

II. RELATED WORK

Illuminum Greenhouses' affordable smart greenhouses enable African farmers to monitor and manage their crops remotely. The smart greenhouses are equipped with five **sensors that monitor temperature, humidity, and soil moisture** of the greenhouse. A solar-powered system relays this information from the sensors to the farmer's cell phone via SMS. This way, the farmer can monitor and regulate conditions from afar simply by sending an SMS back to the greenhouse.

Many systems use various sensors to collect environmental data and then use Radio Frequency (RF) technology to send the data over to the receiver station. Some systems have started using Xbee technology for communication between the wireless sensors and the controller.

The initial method that was followed to send the data was to use GSM band spectrum. The controller used to collect the sensor data and send it to the user using GSM.

Many research and projects have been done to improve conditions of greenhouse. Quin et al [2] proposed wireless system for greenhouse monitoring and control which was integrated with PIC 16F877 and ZigBee module and the data is stored and displayed on LCD.

Ibrahim and Munaf [3] proposed system for controlling and monitoring environment condition inside the greenhouse which consist of local and central stations. Local station are used to measure parameter and to control the actuators and for each local station a PIC microcontroller is installed which gets the data and send it to central station and receive the control signal that are required for the operation of the actuators

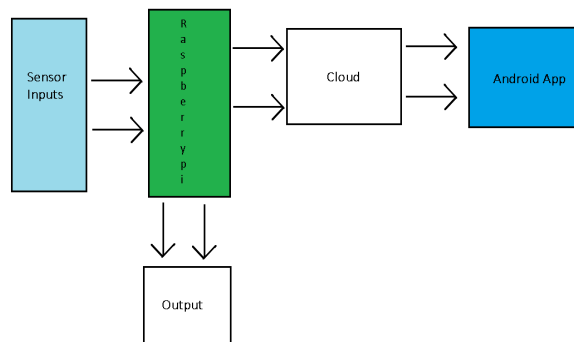
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III. SYSTEM OVERVIEW



The architecture of the system is as shown in the block diagram above. The various sensors that are there in our hardware system collect data about the environmental conditions in our greenhouse like temperature, humidity, soil moisture and light intensity. This data is continuously monitored and uploaded on the ubidots cloud service in real time. The user can access this data from anywhere. Now as the value of any of the above mentioned parameters crosses the threshold set in our program, it notifies the user about the same on the app provided on his smartphone.

IV. COMPONENTS USED

Raspberry Pi 3 Model B:

We have Raspberry pi which acts as a main controller of our system and small in size, is an open source and its flexible platform for experimentation. Since it is an open source, changes can be made to it as and when required. The raspberry pi runs an raspbian OS and is program using python 3, One can install various different softwares's for different purposes. We have used model B of raspberry pi which uses system on chip(SoC) BCM2835. It comes with 1 GB of RAM memory and does not have any storage drive but uses SD card for booting and long term processes, external storage devices can be added through the USB port which includes an ARM11 microcontroller having clock frequency of 1 GHz.

DHT22 Temperature and Humidity Sensor:

The AM2302 is a wired version of the DHT22, in a large plastic body. It is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

Simply connect the red 3-5V power, the yellow wire to your data input pin and the black wire to ground. Although it uses a single-wire to send data it is not Dallas One Wire compatible! If you want multiple sensors, each one must have its own data pin!

Compared to the DHT11, this sensor is more precise, more accurate and works in a bigger range of temperature/humidity, but its larger and more expensive.

KG003 Soil Moisture Sensor:

This Soil Moisture Sensor Module can be used to detect the moisture of soil or judge if there is water around the sensor, let the plants in your garden reach out for human help. Insert this module into the soil and then adjust the on-board

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potentiometer to adjust the sensitivity. The sensor would outputs logic HIGH/LOW when the moisture is higher/lower than the threshold set by the potentiometer.

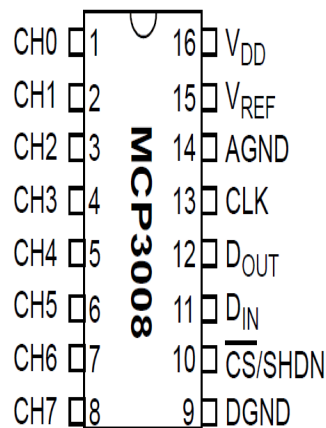
The sensor works on a 3.3 to 5 V operating voltage. It has an on board LM393 comparator a power indicator LED — and digital switching indicator.

LDR (Light Dependent Resistor)

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. LDR's are light dependent devices whose resistance is decreased when light falls on them and that is increased in the dark. When a light dependent resistor is kept in dark, its resistance is very high. This resistance is called as dark resistance. It can be as high as 1012 Ω and if the device is allowed to absorb light its resistance will be decreased drastically. They are often used as light sensors. They are used when there is a need to detect absences or presences of light like in a camera light meter.

MCP3008 ADC (Analog to Digital converter):

The MCP3008 is a low cost 8-channel 10-bit analog to digital converter. The precision of this ADC is similar to that of an Arduino Uno, and with 8 channels you can read quite a few analog signals from the Pi. This chip is a great option if you just need to read simple analog signals, like from a temperature or light sensor. The MCP3008 connects to the Raspberry Pi using a SPI serial connection. You can use either the hardware SPI bus, or any four GPIO pins and software SPI to talk to the MCP3008. Software SPI is a little more flexible since it can work with any pins on the Pi, whereas hardware SPI is slightly faster but less flexible because it only works with specific pins.



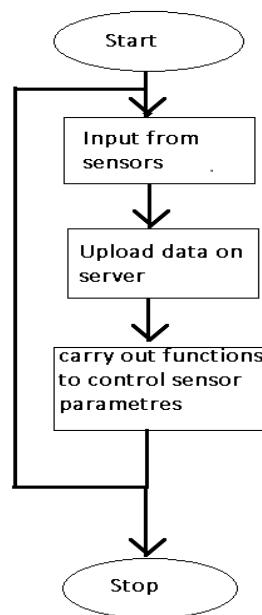
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V. PROGRAM FLOWCHART



VI. HARDWARE IMPLEMENTATION AND WORKING

The sensors interfaced to the raspberry pi collect environmental data like temperature, humidity, soil moisture and light intensity. This data is collected by the program and sent to the ubidots cloud service using the API client technology. The API is a set of functions and procedures that allow the creation of applications which access the features or data of an operating system, application, or other service. The networking protocol used in this entire system is HTTP and RESTful API service used by the cloud.

REST is the underlying architectural principle of the web. The amazing thing about the web is the fact that clients (browsers) and servers can interact in complex ways without the client knowing anything beforehand about the server and the resources it hosts. The key constraint is that the server and client must both agree on the *media* used, which in the case of the web is *HTML*.

An API that adheres to the principles of *REST* does not require the client to know anything about the structure of the API. Rather, the server needs to provide whatever information the client needs to interact with the service. An *HTML form* is an example of this: The server specifies the location of the resource and the required fields. **The browser doesn't know in advance where to submit the information, and it doesn't know in advance what information to submit. Both forms of information are entirely supplied by the server.** (This principle is called *HATEOAS: Hypermedia As The Engine Of Application State.*)

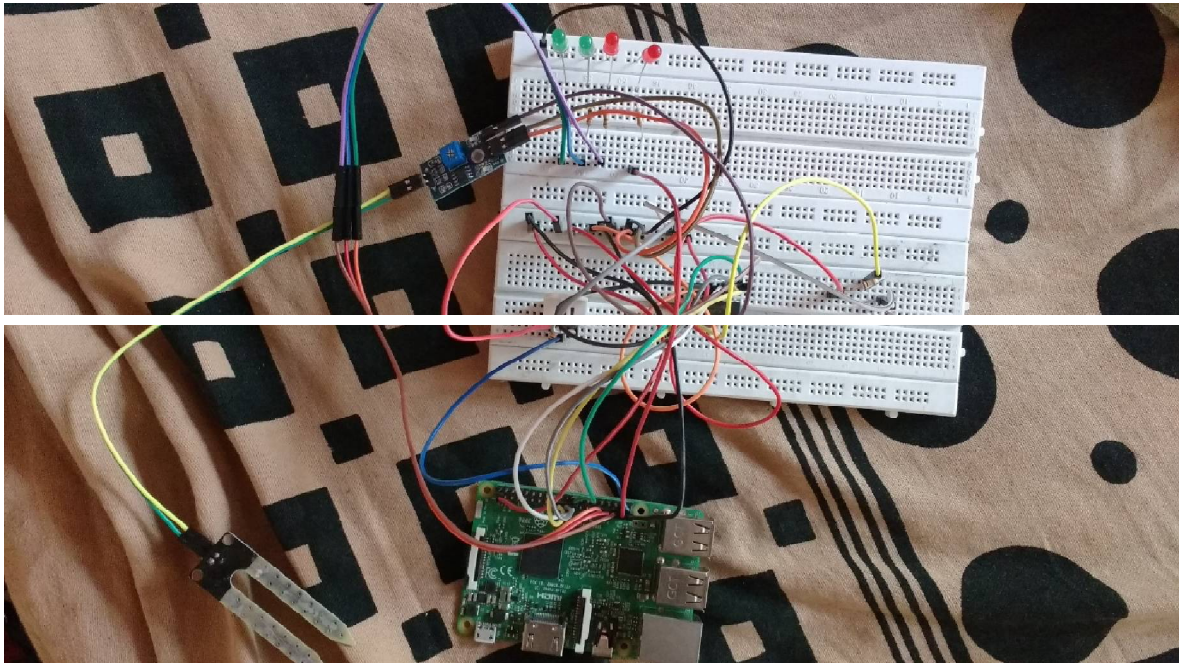
This data can be accessed by the user on the ubidots dashboard directly or using an android app which will show the results of continuous monitoring of various parameters.

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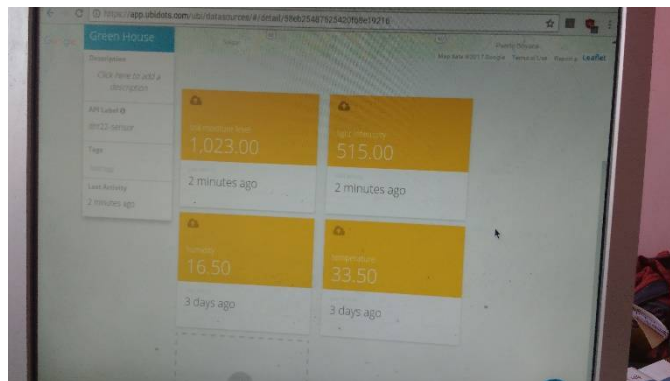
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VII. RESULTS AND OUTPUT

The variation in the parameters was observed on the Ubidots. The images below shows the different graphs that were plotted. Each and every parameters can be observed and controlled. The graphs shown represent the data uploaded on the cloud at different time intervals over the period of several days. Various variables were defined on the Ubidots cloud service to create a dashboard for our user. The cloud then generated an API key for the user account and a variable key for every variable created on the dashboard. These variable keys are used in the Python program to upload parameter data to the specific variables on the cloud.



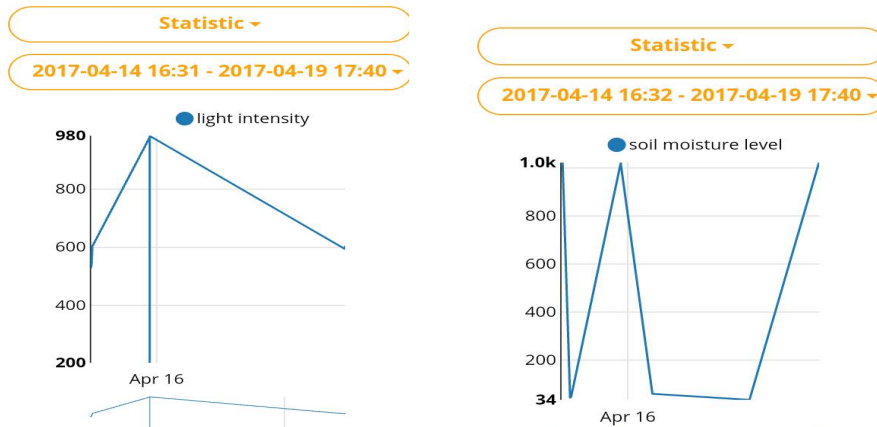
The following photos show the data uploaded to specific variables for the corresponding environmental parameters, viz. Temperature, humidity, soil moisture and light intensity.

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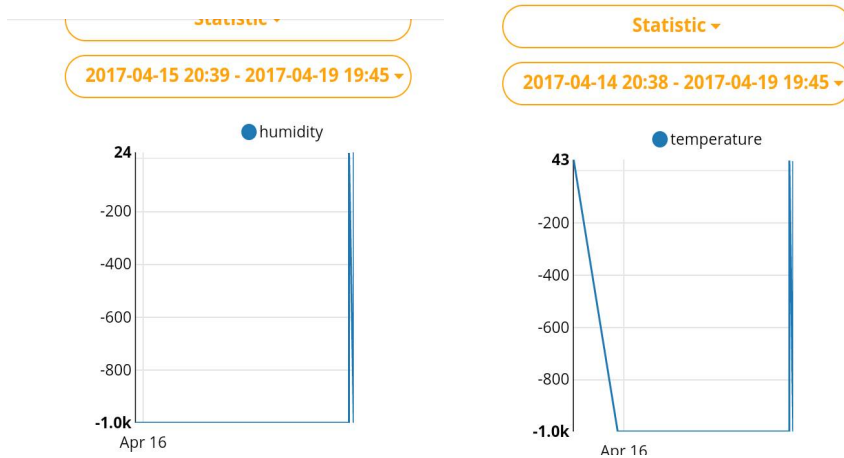
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As shown in the above screenshots, the end user can view the values of environmental parameters on ubidots cloud service by logging into his account from anywhere in the world.



VIII. CONCLUSION

This paper presents design and implementation of a low cost greenhouse management system for general users. The control over the parameters is increased as the data is always sent to the cloud. Since the data is saved to the cloud the data is always available for future analysis. This helps the farmers to control it better. The system uses Internet of Things technology, due to this the parameters can be controlled from anywhere in the world. This enables the farmers to grow crops properly. The humidity threshold can also be changes as per the crop requirement. Use of this system ensures better farming for the user.

IX. FUTURE SCOPE

The app can be enhanced to give notifications to the user when any of the parameter gets above or below a certain value. This could act as an alarm for the user. Some of the things can also be automated, for example, if the temperature increases above a certain predefined value the fans would automatically turn on to reduce the temperature. Such automation and alarm systems can be added to our system to make it more accurate. We can enable the user to set the threshold values for the automation triggers.

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