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COST EFFECTIVE OPTIMIZATION OF GREENHOUSE MANAGEMENT USING RASPBERRY PI

A. J. Jadhav[1], Mandar Ulape[2], Sahil Khadilkar[3], Shubham Thanekar[4],Niraj Salokhe[5]

[1]*Computer Science & Engineering, DYPCET, aprjadhav@gmail.com*
[2]*Computer Science & Engineering, DYPCET, m.ulape@gmail.com*
[3]*Computer Science & Engineering, DYPCET, sahil.khadilkar@gmail.com*
[4]*Computer Science & Engineering, DYPCET,shubhamthanekar94@gmail.com*
[5]*Computer Science & Engineering, DYPCET, niraj.salokhe@gmail.com*

Abstract **-** Greenhouse farming is a method to provide growing environment closed to weather pressures and pest access but open to the natural rays of the sun. To produce more at less cost is one of the biggest challenges in the today's husbandry world. Greenhouse automation is an important milestone in achieving this challenge and is ever exciting field that has exploded over the past few years. Introducing the Raspberry Pi to the world of greenhouse automation provides numerous customizations to turn a regular greenhouse into a smart greenhouse. This technology offers opportunities to greenhouse owners to improve the productivity and quality of plants by making efficient use of resources and reduced labour. This paper promotes the idea of implementing cost effective and interactive greenhouse automation system based on the Raspberry pi. To measure and control parameters like temperature, humidity, light and moisture as well as guidance for crop and fertilizer selection. Fecundity of greenhouse can be rectified through this work.

Keywords*: Raspberry Pi (Rpi) , Greenhouse Automation, Smart Farming, Macroclimatic Parameters, Sensors.*

I. INTRODUCTION

Food shortage is one of the biggest problems confronting mankind in the 21st century. Global warming [8] and weather elements have affected substantial land mass that was available for crops cultivation. The world climate change has brought about unpredictable weather conditions that have resulted in the global food shortage being experienced. In order to address these problems, Greenhouse practice [2] which has been in existence for a very long time is now modernized and deployed in many parts of the world. Greenhouses are typically equipped with glass or clear plastic walls, which allow them to conserve heat while still allowing light to filter through. This creates an ideal environment for growing numerous varieties of plants. The automated greenhouse control system achieves monitoring and control of a greenhouse environment by using sensors and actuators which are operated on microcontroller running a computer program. The controller used with the actuators/sensors station ensures that the microclimatic parameter stays within the predefined values and set by the user in the raspberry pi prototyping platforms. The climatic conditions of the greenhouse and the data given by the sensors are transmitted to the controller and compared with the standard values of the parameters which are stored in the database and the appropriate action will be taken as discussed in the paper later. Automation of greenhouse brings about efficient data acquisition and control of the microclimatic parameters. It helps the farmer to make him familiar with the standard values of required parameters of various crops. The most important factors for the quality and productivity of plant growth are temperature, humidity, light and moisture. Continuous monitoring of these environmental variables gives information to the cultivator to better understand, how each factor affects growth and how to manage maximal crop productiveness. The optimal greenhouse climate adjustment can enable farmer to improve productivity and achieve remarkable energy savings. In modern greenhouses, several measurement points are required to trace down the local climate parameters in different parts of the big greenhouse to make the automation system work properly. We are defining a cost effective optimized greenhouse management system using Raspberry Pi technology. Cost effective system can be defined in context of resource utilization, simplicity in design and easy handling. The

system periodically measures the temperature, moisture, and humidity and light levels inside the greenhouse. Rpi [1] will check the information coming from the sensors and it will check with the database for the standard values for that particular crop. The values will be stored in database at the rate of six values per hour sample. When the temperature, humidity, moisture or light values crosses the threshold level, Raspberry pi will automatically activate the control mechanism to maintain the suitable environment for crop. Presence of the greenhouse manager is not required at that instant.

The soil fertility also plays an important role to obtain the optimal quality and productivity. To do so the smart system will suggest the required fertilizer with quantity and the next crop to be taken to maintain the specific ingredients of soil at constant rate, so that the crop will get the necessary ingredients for its growth. So the system will be very much useful for the greenhouse farmers, gardeners and agricultural researchers.

The Raspberry Pi and the subject of greenhouse automation is a remarkable one. The Raspberry Pi can be used to automate a greenhouse at a relatively low cost. It operates on the concept as the IoT [3]. There are numerous things that make the Raspberry Pi essential for greenhouse automation but the one that stands out the most has to be the remarkably affordable cost. The vast amount of sensors at extremely low cost makes it superb for greenhouse automation. C or Python code can be used to program the sensor and control mechanism. Figure 1 shows the Raspberry Pi B model with its specifications.

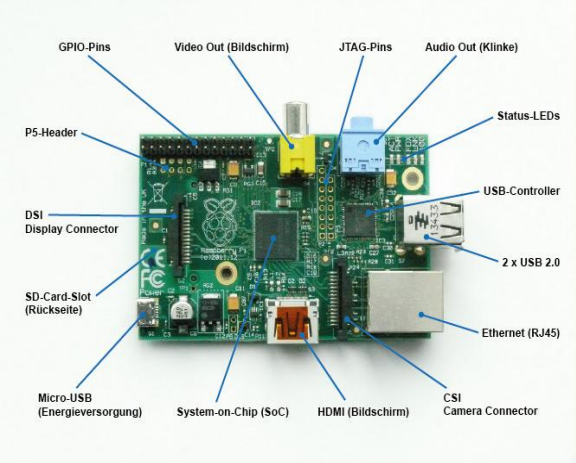

Figure 1. Raspberry Pi Model B

II. SYSTEM ARCHITECTURE

The system architecture comprises of three main components mainly the controller i.e. Raspberry Pi, the greenhouse and sensors which observe the macroclimatic parameters from the greenhouse. After selecting the crop, raspberry pi will take values form the database for the particular crop and will be shown on the display with auto and manual modes.

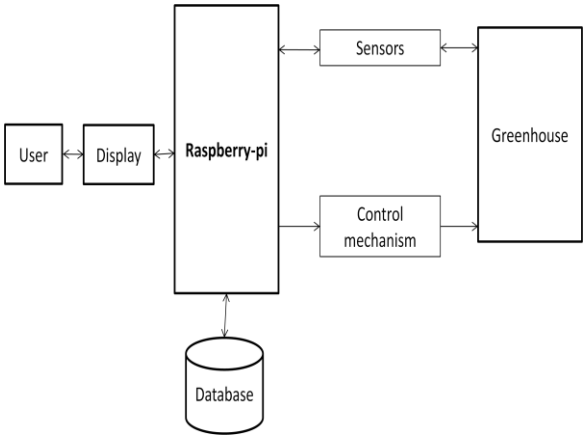

Figure 2. System Architecture.

In auto mode farmer is not allowed to change the standard values of parameters for that crop. So raspberry pi will take default values from the database and will monitor for the values accordingly where as in manual mode farmer is allowed to change the default values as per his convenience.

2.1. Monitoring and Control Mechanism

Database residing in raspberry pi consist of information details like temperature, moisture, humidity requirements for crop.

In the control mechanism sensors connected to the raspberry pi are going to abstract the environmental conditional data from greenhouse and sending this data back to raspberry pi for analysis. After getting the value from the sensors raspberry pi will compare the database values i.e. standard values which are supposed to be maintained for the particular crop at greenhouse. If values are as per requirement no action will be taken otherwise according control mechanism will activate. That is suppose temperature in greenhouse for a particular crop crosses the threshold value which is required then exhaust fan will start to maintain the suitable temperature. In case of humidity foggers will be used to control required humidity whereas for moisture level in soil the water will be supplied. The control mechanism will take place for certain period of time. If the condition goes according to prescribed way the mechanism will go for monitoring state otherwise it will display an error message to set for manual work.

2.2. Suggestion system

Along with environmental condition, crop information like fertilizers used for more productivity, expected diseases that can affect particular crop etc are also stored in database. After selecting the crop user will be shown the standard values for that particular crop and also suggest the farmer with the fertilizer through which he can yield more with better productivity. After getting the soil report from the user the defecting values are checked and the crop that he should take is suggested so as to keep the fertility of the soil and for better crop management.

III. EXPERIMENTAL SETUP

The raspberry pi operates s on a Linux based open source operating system called Raspbian [3]. This allows more control and flexibility in software therefore making it easy to program the pi. The raspberry pi communicates with attached device through c code to control their functions. The Raspbian operating system was installed onto raspberry pi, which was obtained by downloading 'NOOBS' onto SD card form the manufactured website. For the storing the data MySQL packages were installed along with PHP and Apache2 for web interface. All the sensors for greenhouse automation e.g. DHT11 sensor, moisture sensor etc. were connected to raspberry pi. Table 1 shows the list of major components used during this study.

Table 1. List of Major Components

SN.	Component	Picture	Purpose
1.	DHT11		To measure temperature and humidty in air
2.	Soil moisture		To measure moisutre level in soil

3.	Fan		To Control the temperatur e
4.	Foggers		To Control humidity in air
5.	Water Supply		Irrigation System

Table 2 Required software used during this work.

S.N.	Software	Purpose
1.	MySQL	Database
2.	Apache	Web server
3.	C/PHP	Sensor Coding
4.	SSH	Remote Login
5.	Wheezy Raspbian	Operati.ng System

IV. ALGORITHM

Sensors form the greenhouse will send the data continuously to the raspberry pi for controlling and maintaining the appropriate environment in the greenhouse. After getting the values from the sensor raspberry pi will check it with standard database value

Step 1:

Source: sensor

Destination: raspberry pi

Data: sensed information

On receiving sensed information

Task: control and maintain environmental parameters

Step 2:

At raspberry pi check for standard values

Step 3:

Monitor and repeat

V. FUTURE WORK AND CONCLUSION

By extending this project with centralized system, greenhouse can be handled remotely by using personal computer or even by a mobile with an internet connection more information can be achieved by increasing the number of parameters to monitor. Cost effective greenhouse management system can be built using the above approach, which provide several advantage over traditional/conventional greenhouse system. The quality of crops and soil can be improved by

considering different parameters and processing them with the help of Rpi and predict the required actions as a technology that would be affordable for a common farmer.

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