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Design and Development of Android Application for Polyhouse Monitoring and Control

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Abstract: "Smart farming" is a modern agriculture technique, wherein the latest technological developments and engineering practices are used for controlling multiple climatic crop parameters such as temperature, humidity, light intensity, photo period and other conditions that affects the yield and quality of particular crop parameters. These parameters are to be controlled with naturally ventilated climatic conditions and artificially created conditions by growing them in Poly-houses. Farmers can get high production through Green Houses and Shade Net Houses, unseasonal farming through Poly-houses besides water conservation. In this paper an attempt has been made to develop an automated system by creating an exclusive interface to collect real time observations, processing them with latest techniques and monitoring the field parameters remotely in an IT based polyhouse. Here an attempt has been made to simulate an IT based polyhouse setup with required hardware, separate interface design for transferring real time data from the polyhouse to a private cloud. Programs have been written to predict various advises to the farmers and finally mobile apps are developed to transfer the results or advises to the farmers directly and also to control the polyhouse equipment directly through a mobile.
Keywords: Smart Farming, Poly house, Internet of Things, Sensors.

I. INTRODUCTION

Due to the unpredictable weather conditions that have been brought due to world's climate change, the global food shortage is being experienced. In conventional Agronomical practices, the crops are being cultivated in the open field under natural conditions where the crops are exposed to sudden changes in climate like temperature, humidity, light intensity, soil moisture and other conditions that effects the crop production. In order to overcome these problems, greenhouse practices have been in existence from a very long time, which are now modernized and deployed in many parts of the world.

Providing such a new platform for the progressive farmers as a training field, it is possible to link the laboratory (Agricultural Research stations) and land (fields) in an effective manner. Actually, 'Smart Farm' gives the farmers a platform to learn about various innovations in agronomical practices and irrigation techniques, protected cultivation and organic farming etc.. The farmers are showing keen interest in learning various techniques like high production through Green Houses and Shade Net Houses, unseasonal farming through Poly-houses and water conservation.

Smart farming is a modern agriculture technique, wherein the latest technological developments and engineering practices are used for controlling multiple climatic crop parameters such as temperature, humidity, light intensity, photo period and other conditions that affects the yield and quality of particular crop parameters. These parameters can be controlled with naturally ventilated climatic conditions and artificially created conditions by growing them in Poly-houses. Poly-house also known as poly-tunnel is a tunnel typically made from z35 Steel and covered in polythene, usually semi-circular, square or elongated in shape used for cultivation of off-seasonal crops from adverse environment such as high humidity or high temperature, insects and diseases.

The remaining paper is arranged as follows: in Section 2 Literature Review is presented. The proposed work and its methodology are discussed in Section 3. The results are presented in Section 4. and Conclusions are given in Section 5.

II. LITERATURE REVIEW

M.C.S. Geetha [1] Surveyed on Data Mining Techniques in perspective of agriculture domain. Chetan Dwarkani M [2] presented a novel methodology for smart farming by linking a smart sensing system and smart irrigaton system through wireless communication technology. Yousef E. M. Hamouda [3] designed and developed Greenhouse Smart Management System (GSMS) using WSNs to automatically control, manage and monitor the agricultural parameters and activities inside the greenhouses. Lijun Liu [4] designed greenhouse environment monitoring system based on the wireless sensor network. Liang-Ying [5] they have presented the

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overview of a sensor with low power consumption, flexible networking that can effectively meet the needs of the greenhouse environment monitoring. BeomJin Kan [6] proposed the greenhouse auto control system based on the wireless sensor network. MasayuBinti Hussein [7] proposed an automatic greenhouse watering system. S.T. Sanamdikar [8] presented programmable logic controller (PLC) to develop an automated continuous process system for maintaining the poly-house. Rahul Singhal [9] proposed a method for control of temperature and relative humidity inside a poly-house using the microcontroller. Sumit Vashisth [10] conducted a survey in Himachal Pradesh for knowing the Insect-pest problems associated with off-seasonal crops such as capsicum, tomato, cucumber and rose are cultivated in poly-houses. Yifan Bo [11] analyzed the influence in agriculture with the combination of both technologies Cloud Computing and Internet of Things. Shubhangi Bhosale [12] discussed controlling and environmental monitoring of poly-house farm using sensors to control parameters of soil, water, air to maintain necessary environment through web technologies. Soundra Pandian [13] presented an approach to control and monitor environmental parameters inside a Poly-house farm. Mark Ian Animas [14] proposed a mechanism that accepts and processes gathered data from Agricultural Research Centre using time series analysis. Seng Hansun [15] proposed a new approach to getting the forecasted value using exponential moving average (EMA) formula. Yacine Chakhchoukh [16] in his paper introduced a new robust method to estimate the parameters of a Gaussian ARMA model contaminated by outliers. D. Silverman and J. Dracup [17] extended the use of neural networks to determine important parameters of making long-range predictions using ANNs and large-scale climatological parameters. Abhishek Agrawal [18] evaluated the forecasting reliability by comparing the actual and predicted temperature values.

III.METHODOLOGY OF PROPOSED WORK

The methodology of proposed work aims at four modules. They are

The first module is Setting-up of an IT based IoT supported Poly-house with sensors and Hardware,

Second module is aimed at designing and developing a poly-house sensor interface between the sensors to the local server and then to an agro-information cloud. The crop environmental data collected in the fields is transmitted to an Agro -information Cloud database.

The third module is aimed at processing the data using latest techniques such as semantic web.

Finally mobile apps are developed to deliver the results directly to the farmer and helping them to control the poly-house function parameters.

The overall poly house system architecture implemented here is shown in fig 1:

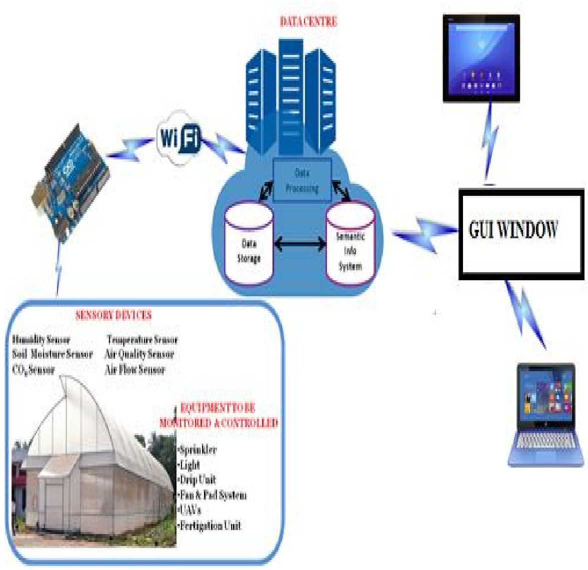

Figure 2 proposed poly-house architecture

A. *Experimental Set-up*

In this experimentation an IOT Supported Poly-House is simulated with relevant sensors and presented in Fig.1. Individual sensors are purchased in an open market and assembled and tested for their functionality.

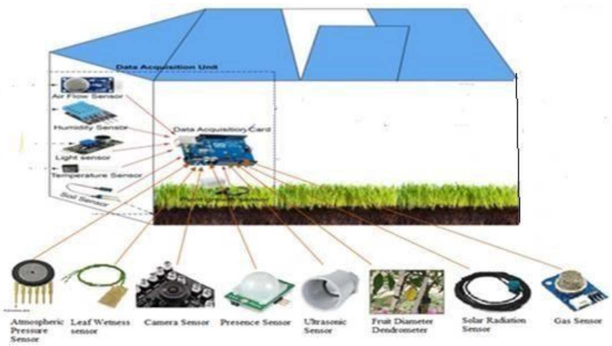

Figure 1 Sensor based poly-house

The basic important sensors used in this poly-house are: 1. Atmospheric Pressure Sensor converts atmospheric pressure to an analog voltage value. 2. Leaf Wetness Sensors (LWS) behaves as a resistance of a very high value (infinite, for practical purposes) in absence of condensation. 3. Humidity Sensor is a measurement sensor that is carried out through the analog-to digital converter. The product is 3-pin single row pin package. Convenient connection, special packages can be provided according to users need. 4. Temperature Sensor (DHT11) is small in size, low power, signal transmission distance up to 20 meters making it a variety of applications and even the most demanding applications. 5. Light Sensor is a resistive sensor whose conductivity varies depending on the intensity of light received on its photosensitive part. 6 Resistive soil sensor conductivity varies depending on the intensity of light received on its photosensitive part. 7 An image sensor detects and conveys the information that constitutes an image. 8 The PIR sensor (Passive Infra-Red) is a pyro electric sensor mainly consisting of an infra-red receiver and a focusing lens that bases its operation on the monitoring of the variations in the levels of reception of detected infrareds, reflecting this movement by setting its output signal high. 9. Ultrasonic Sensors outputs an analog voltage proportional to the distance to the object detected.10 Fruit Diameter Dendrometer (Ecomatik DF) Operates on three Ecomatik Dendrometer, DC2, DD and DF, which is based on the variation of an internal resistance. 11 Solar Radiation Sensor - PAR (SQ-110) specifically calibrated for the detection of solar radiation. 12 Gas sensor (MQ-2) is useful for gas leakage detection (in home and industry). A. Poly-house Climate acquisition using sensor. A Poly-house Climate acquisition system using sensor placed in poly-houses to collect the environmental conditions. Through the internet sensors are interfaced to cloud system and send the collected information to cloud system for further analysis. The block diagram of hard ware components is shown in fig 3:

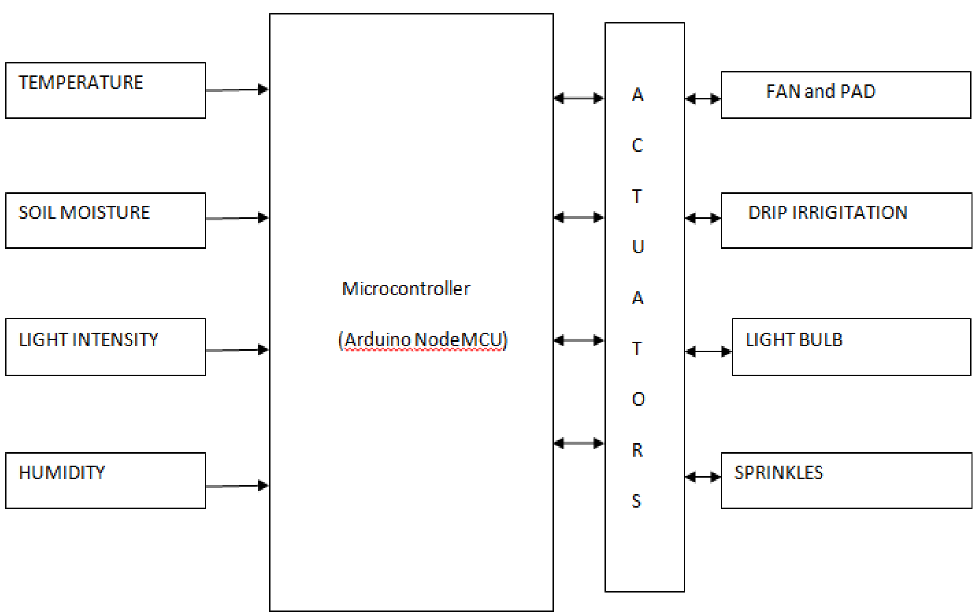

Figure 2 block diagram of hardware component

Here the main component is the microcontroller (NODEMCU). Four sensors have been used to feed the input parameters at Arduino. It reads this sensor data and can transfer data according to the program written into it. It can read both digital and analog inputs and can generate digital output.

B. Interface Design

It is implemented using Arduino Programming, camera, cloud storage, mobile app. The system features optimizes four parameters inside the poly-house namely temperature, light intensity, humidity and soil moisture. In order to measure these parameters, suitable sensors are deployed in the field which continuously monitors the environmental conditions. Microcontroller receives the data from the sensors and transmits the data through Wi-Fi. At the receiver's end, the transmitted data is received by the receiver which is read into the serial port of the system using a microcontroller. A User interface is designed for providing interactive interface inside the poly - house components. A *Data Centre system is used to store the data in a Cloud database. Data Centre system* is a cloud system developed by the authors. This cloud system manages the poly-house environmental data collected from the sensors. Further it also stores the climate predicted and intermediate results in this cloud database.

C. Data Processing and Cloud services

The Cloud services that are implemented in this system are: storing sensor data, weather prediction, reports to download, retrieval of data between dates, temperature prediction. The services are explained in the Results and Discussion Section.

D. Android Application Program

A Mobile GUI using Android Application Program is developed for Monitoring the cloud service and Control the polyhouse environmental parameters using Smart Mobile Application. Fig 3(a) and 3(b) describes screen shots for App screens. In Fig 3(a), there are seven different fields in the Menu. They are: Monitoring, Controlling, Climate, Yield, Pest control, Support and Tap me buttons. User can select any button for further processing.

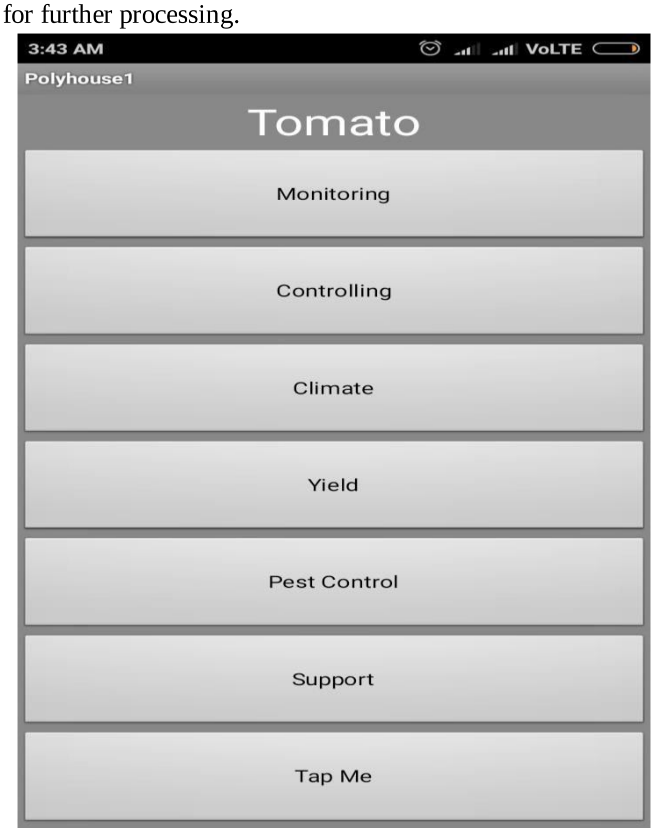

Figure 3 (a) Mobile GUI

When the user clicks the monitoring button then monitoring service screen will be opened. This screen is consisting of again seven buttons, namely, Temperature, Humidity, Soil moisture, Light, Camera, Support and Tap me buttons. The user can open any one of these screens upon clicking them for further processing. The details are given below.

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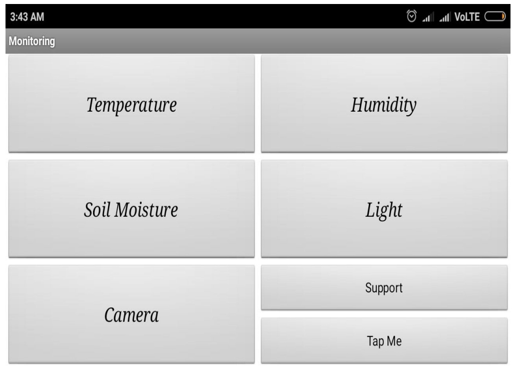

Figure 3 (b). Monitoring Services

E. Monitoring and Controlling

Users interact with this cloud service using mobile phones or systems. User can monitor temperature inside the poly-house and get advisory such as future temperature maintenance. The proposed system is carried out in two phases namely Monitoring and Controlling.

1) *Phase 1: Monitoring: In* this, user can know the current weather conditions of the crop in the poly-house remotely through an application on mobile device. It provides time to time updates of the information obtained from sensors to cloud. Allows user to monitor his poly-house via camera. Remotely monitor all the above parameters on a mobile device through internet.
2) *Phase 2: Controlling:* In this phase controlling parameters obtained in phase 1 via cloud through an android (app) application on mobile device. The following parameters are controlled in this phase namely FAN & PAD system for controlling high temperature. Heat bulb is used to produce significant temperature, Water drip system is used for controlling soil moisture.

The details of the functioning of the APP are described in the results and discussion section given below.

IV. RESULTS AND DISCUSSION

A prototype of polyhouse is constructed and depolyed with different sensors. Home page for monitoring sensor data and controlling the automation parameter like water motor, fan & pad, Light and heat bulb is shown in shown in Fig. 4(a). A photograph for Polyhouse prototype is presented in Fig 4(b).

Figure 4(a): Polyhouse Prototype

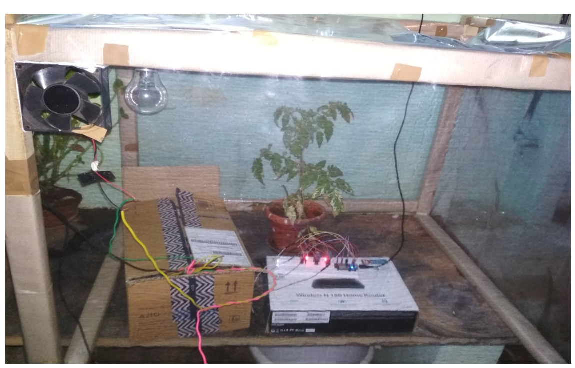

Figure 4(b): Photograph of Polyhouse Prototype

The polyhouse equipment monitoring and temperature prediction using Simple Linear Regression in Smart Mobile is shown in fig 5 (a) and (b):

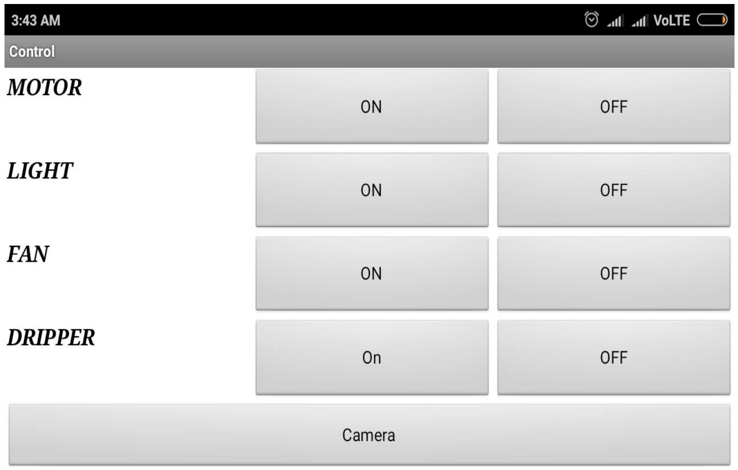

Figure 5 (a): PEM

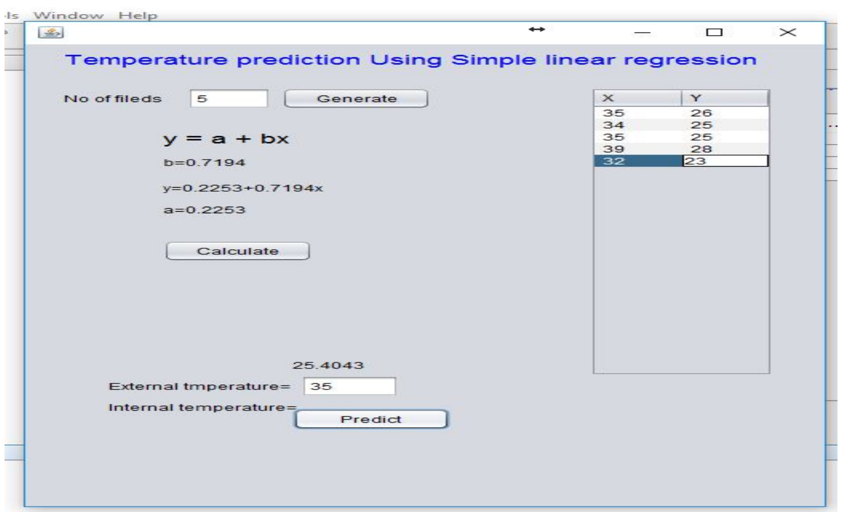

Fig 5(b) : Temperature Prediction

Temperature and humidity Plot in Smart Mobile is shown in fig 6 (a). X- axis represents time and Y--Axis represents temperature in Celsius units.

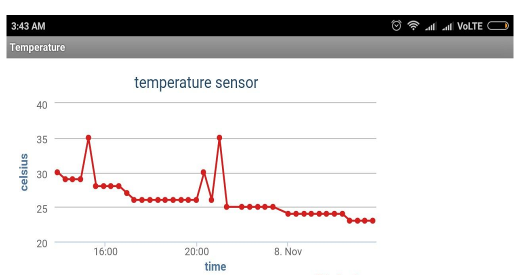

Fig 6 (a). Temperature Plot

Humidity Plot in Smart Mobile is shown in Fig.6(b):). X- axis represents time and Y--Axis represents relative humidity percentage units .

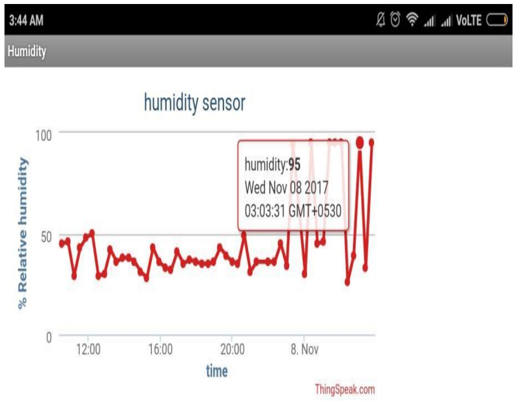

Fig 6(b). Humidity Plot

V. CONCLUSIONS

The data acquisition collects the data from sensors and transmits to the server database using Wi-Fi. The sensors are used to collect the data related to the parameters - temperature, soil moisture, humidity and light intensity. In data display unit, the data from the storage unit can be displayed on the control panel. Using this feature the farmer can monitor these parameters by checking the data values when necessary. This data can be further used for analytical process and for prediction. The data analysis provides the relationship between the environmental parameters and the growth of a plant. The data trends have been observed and are recorded accordingly. Automated IT Based System for Poly house Management that is developed can be further enhanced by adding CO2 sensor which allows the farmer to monitor the Carbon dioxide levels, Crop Nutrition and Fertilizer inside the poly house. The data analysis can be further used for prediction of the environmental conditions.

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