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Polyhouse Cultivation using Embedded System-A Review

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Abstract - *In India, agriculture is the main profession for majority of its population. By combining the technology with agriculture, a new approach, known as Polyhouse Cultivation is being developed to achieve good crops with less labour cost. It lessens dependency on rainfall and makes the optimal use of land and water resources. Polyhouse is a structure that is made up of polyethylene sheet having semi-circular or rectangular shape to grow the crops in a controlled environment even in unfavourable conditions. By using automated system, crucial parameters like temperature, humidity and water level necessary for the growth of plants can be maintained automatically. In this paper different techniques of Polyhouse Cultivation have been reviewed and compared.*

Key Words: **Polyhouse cultivation, Microcontroller, GSM module, Zigbee technology, RF technology, Bluetooth technology.**

1. INTRODUCTION

For Indian economy, agriculture plays an important role. Generally there are different environmental and soil conditions in different parts of the country which affect the quality of the crops [1]. Conventional methods used for cultivation require more time, human effort and continuous monitoring. There may be unpredictable weather conditions, inappropriate soil quality which may affect the quality of crops [2].

Greenhouse is a structure which is covered by some material to provide controlled environment for cultivation. Greenhouse can be classified into two types - Glass greenhouse and Plastic greenhouse [3]. Both the structures are used to grow the crops under adverse conditions of climate. In Glass greenhouse, glass sheet is used for covering the plants which works like a selective transmission medium for the spectral frequencies of different types. Glass sheet generally trap energy within the house which is used to provide heat to plants and ground inside [4]. Polyhouse is generally built up by using bamboos or pipes which may be made up of iron material to cover the surroundings of the house by an ultra violet plastic sheet. The thickness of sheet can be varied according to the requirement that depends on the crop type to be grown. Generally Polyhouses are directed from east toward west to utilize the maximum amount of sunlight.

Parameters like temperature, humidity, CO2 levels, Ph of soil, soil moisture content and water level plays an important role for the growth of plants [2] [5]. By sending the data of various sensors through wired or wireless method to a microcontroller based system, desired atmospheric conditions can be maintained by using various output devices. The working of a Polyhouse system is shown in fig. 1.

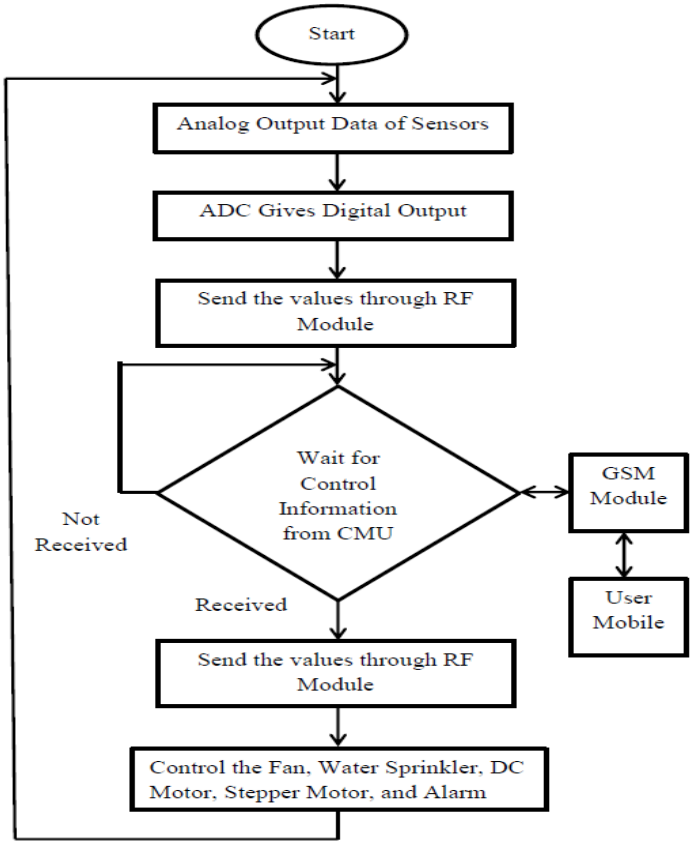

Fig -1: Flow Chart for Polyhouse System

Literature Review based on different technologies used along with their advantages and disadvantages is discussed in section II. The complete comparative analysis is explained in section III. Finally, the conclusion is given in section IV.

2. LITERATURE REVIEW

Review and comparison of various Polyhouse systems based on different technologies have been discussed in this section.

A. Wired Technology.

In this technology input sensors are connected directly with the microcontroller. Analog output of the sensors is sent to ADC which gives the digital output to the controller for further processing. To obtain the required conditions necessary actions are taken by using the output devices.

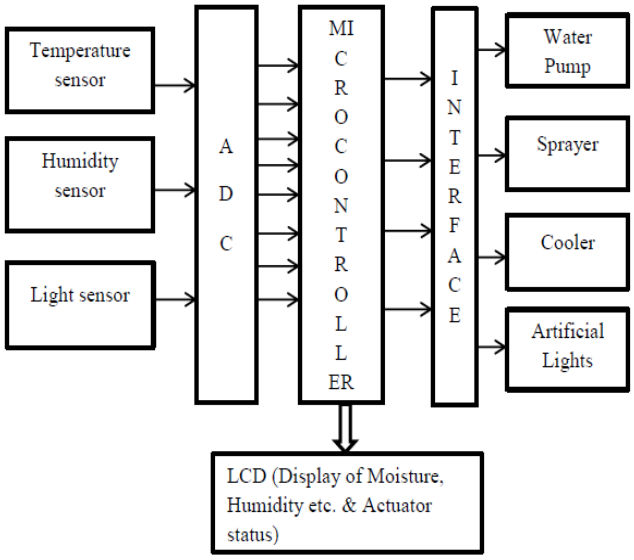

Fig -2: Block Diagram of Polyhouse cultivation using Wired Technology[10]

Few surrounding parameters like ambient temperature, humidity percentage, light intensity range and soil moisture content inside polyhouse are controlled [8][10][11].

Advantages:

1. With the use of less hardware system, the efforts made by human can be reduced.
2. The system can be used for controlling the greenhouse automatically without human intervention.
3. System performance is quite reliable and accurate.

Disadvantages:

1. The system is not so advanced.
2. ADC is used separately due to which power consumption is more.

B. GSM Based Technology.

Generally the atmospheric conditions are varying from place to place, therefore it becomes necessary to make uniformity in the environment to enhance the quality of crops. Android based system can be used to maintain uniform environmental conditions. The updates about the field condition can be sent to the user through GSM (Global System for Mobile Communication) facility in the form of SMS. Farmers can check the status of environmental conditions from their mobile phone at any remote location. Therefore human efforts are reduced to maintain the desired condition [3][4][6][7].

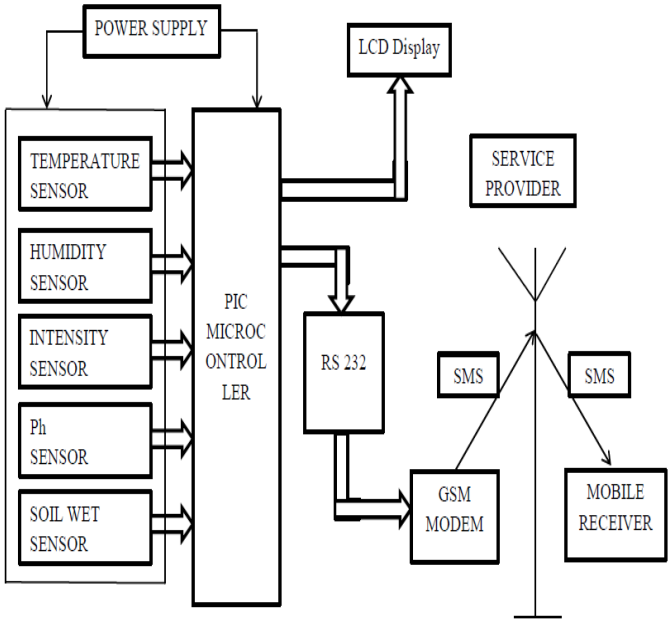

Fig. 3 Block Diagram of Polyhouse based on GSM Technology[4]

Fig. 3 shows block diagram of Polyhouse based on GSM technology, there is no ADC required separately if PIC microcontroller is used which reduces the power consumption and complexity of the circuit. If the microcontroller used other than PIC, like ARM and AT89S52 which are not having inbuilt ADC then more power is consumed which increases the cost of the system. This problem can be solved by using Arduino which is easy to program and has inbuilt ADC [12][13][14][15].

Advantages:

1. Manual monitoring of system is not required which reduces human efforts.
2. The system avoids over irrigation, under irrigation and saves the water.

Disadvantages:

1. SMS charges increases the cost of the system.
2. Wireless transmission of data is also absent.

C. GSM & Bluetooth Based Technology.

This type of technology mainly includes GSM and Bluetooth for the communication purpose from the remote area. The given block diagram mainly includes the PIC microcontroller which has ADC built inside, RS232 interfaces and sensors. Efficient utilization of water resources and man power can be achieved by the system. The sensors output is sent to the

microcontroller which further processes and takes necessary actions. The complete information about the system is sent to the user's mobile phone through GSM module. To make the system more cost effective, Bluetooth technology has been used alongwith GSM facility when it is within sufficient range [5][16].

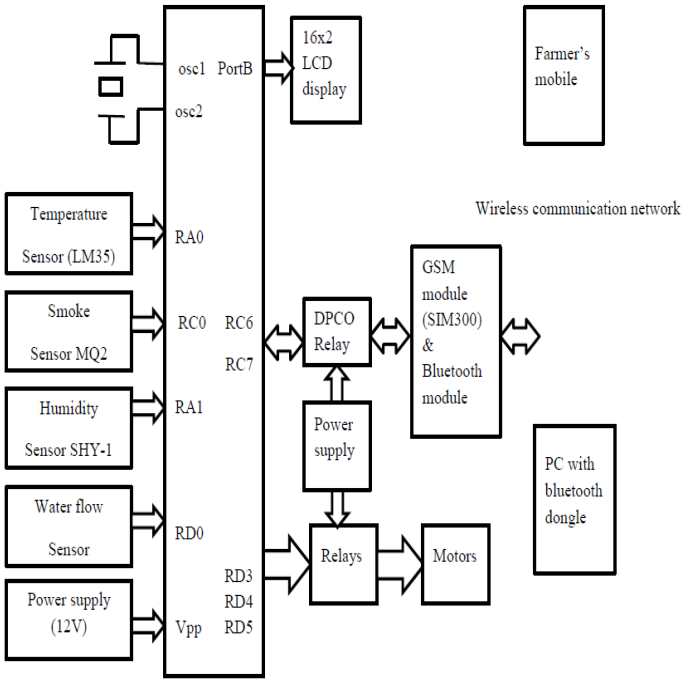

Fig. 4 Block Diagram of Polyhouse based on GSM and Bluetooth Technology[5]

Advantages:

1. It uses inbuilt ADC which reduces hardware.
2. Power consumption is low.
3. By using Bluetooth facility SMS charges can be saved.

Disadvantages:

1. Initial cost for the set up is high.
2. Wireless transmission is used only for output and not for input.

D. Wireless Technology Using Zigbee.

Block diagram of wireless network using Zigbee technology has been shown in fig 5.

Few surrounding parameters like ambient temperature, humidity percentage, light intensity range and soil moisture content inside polyhouse are controlled. The atmospheric conditions are different during day time and night time. Therefore the threshold values for the sensors are programmed according to that in the CMU and the necessary actions are performed at actuator node to maintain the required environmental conditions. Wireless transmission of sensors data using Zigbee module makes the system automatic and human efforts also get to reduce [2][17].

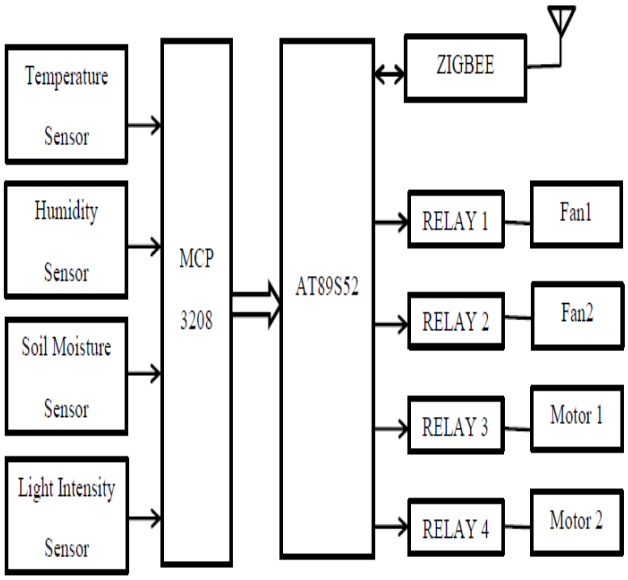

Fig. 5 Block Diagram of Polyhouse using Zigbee[2]

Advantages:

1. The system has more flexibility.
2. Power consumption is low, therefore cost effective.
3. Wireless transmission of data using Zigbee module.

Disadvantages:

1. Zigbee wireless range is limited.
2. Batteries needed after some interval of time, therefore overall installation cost is high.

E. Wireless Technology Using RF Module.

Wireless Sensor Network (WSN) technology is used for the controlled environment farming to provide the thermal comfort to the crops.

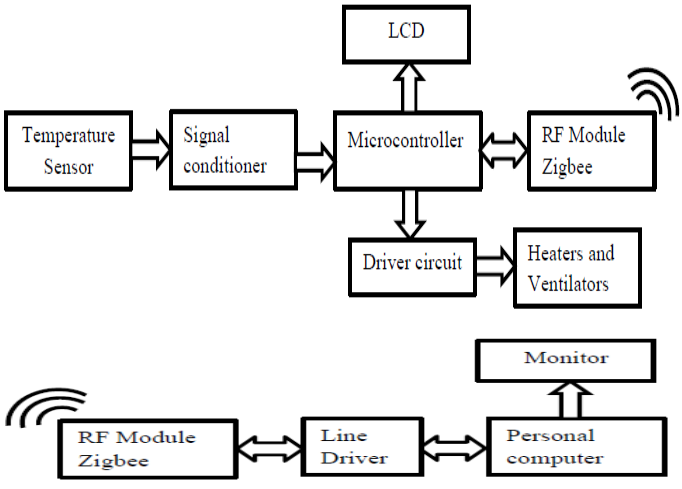

Fig. 6 Block Diagram for Wireless Technology using RF Module[9]

For wireless network, RF module is used which operates within ISM band and supports IEEE standard 802.15.4. To monitor the environmental thermal status within the Polyhouse, AVR ATmega 8L microcontroller is used. On chip A/D converter is used to convert analog data from sensors into digital data with 10 bit resolution. To monitor the thermal status LM35 temperature sensor is used. RF Module is used only for the output but can be used both sides. Remote access is not possible in the given system due to absence of GSM Modem [9]

Advantages:

1. The system has more flexibility.
2. Wireless transmission of data using RF module.
3. The wireless range is increased because of RF module.
4. Human efforts get to reduce.

Disadvantages:

1. The system hardware is very complex.
2. Overall installation cost is high.

3. COMPARATIVE ANALYSIS

Table 1 shows a comparison of various techniques based on some common parameters such as type of sensors, technology used, microcontroller used, power consumption etc.

Table -1: Comparison of various Polyhouse cultivation systems.

Author (year)	Technology Used	Sensors Output Transmission Method	Microcontroller used	Inbuilt ADC	Circuit Complexity	Power Consumption
Jonnala & Sathyanarayana. (2015)	Zigbee	Wireless	AT89S52	No	More	More
Pavithra & Srinath (2014)	GSM	Wired	ARM7	No	Moderate	Moderate
Jonnala & Shaik (2013)	GSM	Wired	AT89S52	No	Moderate	Less
Sengunthar G. R. (2013)	Wired	Wired	PSOC-3 KIT	Yes	Less	Less
Pawar A. M. et al. (2013)	RF Module	Wireless	AVR ATmega8L	Yes	Less	Less
VidyaSagar B. (2012)	GSM	Wired	PIC16F877A	Yes	Moderate	Moderate
Gautam & Reddy (2012)	GSM + Bluetooth	Wired	PIC16F877A	Yes	More	More
Pandya & Shukla (2012)	GSM	Wired	Arduino	Yes	Less	Less

From the table 1, It is concluded that RF module alongwith GSM and Bluetooth technology is much better technique for wireless data transmission among all the technologies used. Arduino based hardware may be used due to its inbuilt ADC which provides less complex circuitry, less power consumption and easy to program.

4. CONCLUSION

In India traditional farming is popular but Polyhouse farming has come forward to replace this traditional farming. It provides better crop in a short period of time with less manual labor. It reduces reliance on rainfall & apex usage of land & water resources. Polyhouse farming help the farmers for their living by growing multiple crops. Polyhouse cultivation avoids over & under irrigation and reduces the wastage of water. The main advantage is that the system's action can be changed according to the situation for different types of crops, extreme weather conditions like floods & draught. A stand by battery or solar cell can be used for reducing the power consumption and to avoid the power failure.

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