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CAN Bus Protocol based Greenhouse System

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Abstract-In this paper, an Automatic Greenhouse Monitoring and Control system based on CAN Bus protocol and Mobile Web Server has been designed. The Intelligent Node in the Greenhouse measures the parameters inside it and the resulting data is monitored continuously. Any fluctuations from the set data would automatically start the control section functioning and thus, the required levels of the parameters are achieved.

Index Terms- CAN Bus, Environmental Parameters, Greenhouse, Intelligent Node, Mobile Web Server, Monitoring, Sensors

1 Introduction

THE increase in demand for a lot of agricultural products has created awareness for the farmers to increase their production by implementing the latest technology in the field [5]. Greenhouse is a peculiar kind of agricultural environment in which the rate of plant growth can be changed, by creating optimum conditions and the influence of atrocious weather can be kept out. Unlike open farming, where nature's control takes the upperhand, greenhouses present a closed environment that can be strictly controlled by humans in order to provide optimal conditions for the growth of the crops. The building is made of transparent walls and roof which allows sufficient solar energy to pass for plants to carry out photosynthesis effectively [6]. Some advantages seen in this mode of crop cultivation are that the production gets maximized and the difficulties due to the unprecedented changes in climatic conditions can be eliminated. This leads to high yield and high quality of crops, with high efficiency. Greenhouse environment parameters monitoring and control is crucial to enhance crops health, prevent diseases and thus to improve the productivity of the crops. Greenhouse monitoring and control system is quite complex with the need of automatic monitoring, information processing, real-time control and optimization of the different kinds of parameters in the greenhouse [7].

The objective is to develop a system that concentrates on providing the means for the management of the environment and crop growth information. The embedded monitoring system structure so developed will closely monitor and control the microclimatic and environmental parameters on a regular basis round the clock [3].

The proposed system would be economical, effective and easy to install. The microclimatic parameters that are generally considered for monitoring and control are temperature, humidity, light intensity, moisture content in the soil, carbon dioxide(CO2) etc. On the basis of making full use of natural resources, greenhouse monitoring system obtains the optimum condition of plant growth by changing the factors mentioned. It consists of microcontroller, sensors, field bus and web server [2]. Record of the environmental parameters is accomplished by the sensors. Each parameter being monitored and controlled has a separate sensor of its own. When any of the climatic parameters cross the set, safe threshold for the protection of the crops, the sensors sense the change and the microcontroller reads this data. The microcontroller then processes the data received and sends it to the remote web server through the high speed CAN bus transceiver, along with its display on the LCD connected to it. The set-up of microcontroller DSPIC 30F4011 and the sensors for measuring variations in the parameters of temperature, humidity, light intensity and carbon dioxide (CO2), is called the Intelligent Node. At the remote web server, a web page dedicated for the greenhouse displays the set value and the measured real-time value. The fluctuation(s) in the measured value from that o the set ones, triggers up the microcontroller to perform the needed control actions to bring back the strayed-out parameter(s) back to its optimum level. Since microcontroller acts as the heart of the system, it makes the embedded system architecture, effective, economic and user-friendly.

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2 SYSTEM ARCHITECTURE

The overall system architecture is shown in Figure 1.

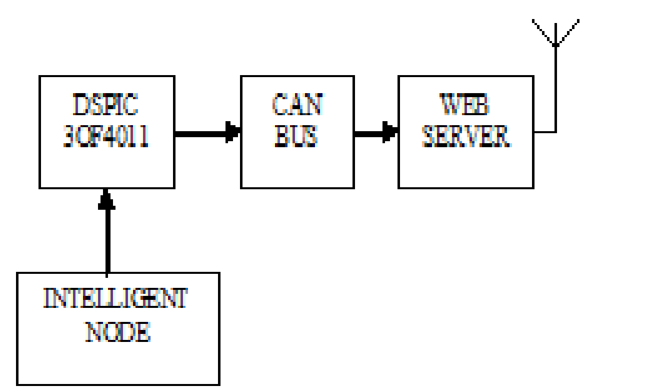

Figure 1: System Architecture.

The Intelligent Node section, includes the central controlling IC DSPIC 30F4011, the sensors for temperature, humidity, light intensity, carbon dioxide measurement and soil moisture content, the CAN bus and the LCD display. The system consists of many interconnected Intelligent Nodes to a GPS system. The data is transferred to the web server with the help of high speed CAN bus, due to its easy expansion and good real-time performance [1]. A web page consisting of the details of the considered Greenhouse's parameters is present in the web server. The control section consists of the cooling circuit and the artificial lights, with air control.

The central controlling component, DSPIC 30F4011, processes the sensed data and transfers it to the web server. The sensed data signal, which is the measured value of the environmental parameters, is analog in nature. This is converted to digital signals and is processed. Processed values are compared with the set values and any deviations found, is sent as an alert signal to the farmer's mobile. Also the controls are activated and continued until parameter values are brought back to normal levels.

3 SYSTEM DESCRIPTION

3.1 INTELLIGENT NODE

The Intelligent node, as shown in Figure 2, is the basic circuit structure placed inside the greenhouse. This structure provides the values of the parameters being measured, with the help of sensors. For healthier agro products, environmental parameters play a major role. If the environmental conditions can be properly controlled, then the quality and quantity of the cops grown improves a lot. The most critical environmental parameters being monitored and controlled are temperature, humidity, light intensity, soil moisture content and amount of carbon dioxide. There are separate sensors for each of these parameters.

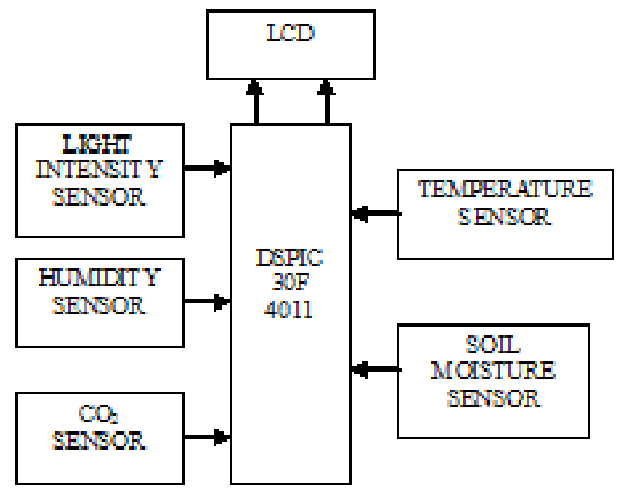

Figure 2: Block Diagram of Intelligent Node.

The sensed data is sent to the controlling component, IC DSPIC 30F4011, where it is processed and compared. The sensed values are analog in nature, but DSPIC is a Digital Signal processor IC, where input required should be digital. Hence, the input analog signals are converted to digital signals with the help of in-built 6-channel ADC (Analog to Digital Controller) pins. The DSPIC has the ability to process signals that have a very low power. Thus, in most cases, power conditioning is not required. The digital signal related to the sensed data, is compared with the optimal parameter values set by the farmer. The set values and the measured values are sent to the web server, through a flexible and robust CAN bus transceiver. At the web server, these data are shown on a web page designed for the particular greenhouse. Also, both the set of data are displayed on an LCD for helping the farmers near to the greenhouse, to detect the condition inside it. Whenever a deviation occurs in the measured value from the set value, an alert signal is generated and transmitted to the farmer's mobile using GSM service [5]. The deviation happens when the sensed data crosses the border of the set values, as decided by the farmer or the person controlling the greenhouse. As and when the alert signal is generated, the control action gets activated and this continues, until the measured values are brought back to its normal level.

3.2 DSPIC 30F4011

This IC (Integrated Circuit) is a 16-bit digital signal controller IC, which integrates the control attributes of a microcontroller with the computation and throughput capabilities of a digital signal processor. It has a modified Harvard architecture, meaning that the separation between code and data is loosened, while still supporting high performance concurrent data and instruction access. It has a wide array of digital and analog peripheral functions, full-speed real-time emulation, brown-out protection and code security.

The 16-bit digital signal controller IC is a 40 pin package with 48 KB on-chip flash program space and 2KB on-chip data RAM. Few other features include programmable code protection, self-reprogramming capability, low power consumption and wide operating voltage range, 2.5V-5.5V. There are flexible clocking options and about 40MHz extended operation clock input. The speed of operation of the IC is in the range of 30 MIPS (Millions of Instructions per Second). Selectable power management modes like Sleep, Idle and Alternate clock, make it manage its power consumption. Among the 40 pins, 4 are dedicated for supply and ground, VDD and VSS. Ports RF0 to RF6 are connected with the LCD and the sensors are connected to the pins for port B. There are in-built 6-channel ADC pins for the purpose of converting the low-power analog signals related to the measured parameter values, into digital signals, for the ease of computation of the DSPIC. Other ports used are ports C, D and E. 6 PWM (Pulse Width Modulation) pins are in port E. Pins 13 and 14 are available for clock signals, CLKIN and CLKO, respectively. The processed data is shown in the LCD screen.

3.3 Sensor System

Sensors form the heart of the greenhouse monitoring and control system, since the values measured by them determines the condition inside the greenhouse and, finally, the quality of the crops grown in them. Each of the environmental parameter being measured has a sensor of its own. The growth of a plant takes a long time and hence, there's a need to continuously monitor and modify the parameters. The most common characteristic found in these sensors is that they are simple- in terms of both construction and usage. This makes them very popular in the basic electronic circuits related to the sensing of environmental conditions. Also, the position of the sensors must be such that they can be easily reached and modified, according to the activities performed inside the greenhouses.

Temperature affects the movement of water, minerals and food in roots, stems and leaves. The ideal temperature range for the summer crops is in between 20-30°C. Temperature sensor LM35 used is a precision Integrated-circuit sensor whose output is linearly proportional to the ˚C temperature, which gives an advantage over the temperature sensors calibrated in ˚K [4]. It provides typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full -55 to +150˚C temperature range. Its low output impedance, linear output and precise inherent calibration makes the interfacing to the control or readout circuit easy. LM35 series temperature sensors have a property of low self-heating, since it has only about 60 µA current drain.

Humidity sensor SY-HS230 works on a 5V DC supply and is very simple in construction, with just 3 pins- Vs, Vout and Gnd. The operating temperature range is 0-60°C and the corresponding humidity range is 10-95% RH, where RH is Relative Humidity. For good plant growth, 30-70% RH is mandatory. Relative humidity, expressed in %, is the ratio of actual moisture in the air to the highest amount of moisture air, at that temperature, can hold [4]. Normally, a capacitive device with special material as dielectric, the electrical characteristics of which change according to the humidity in the air, is used as the sensing device. This sensor has fast response, high stability in the long-term and high reliability and is used in most of the high volume cost sensitive applications. It is also useful in all applications where humidity compensation is required.

Light intensity inside the greenhouse determines the rate of photosynthesis in plants, a process by which food is obtained by them. The visible radiations, CO2 and water are used by the plants to react and form their food, carbohydrate and oxygen. In the respiration process, the reverse of photosynthesis, energy is liberated by the reaction of carbohydrate with O2, which is used by the plant for nutrient uptake, division of cells and protein formation. Minimum light intensity of 25,000 lux is sufficient for plant growth. Light Dependent Resistor (LDR) is the light sensing device used, with the sensitivity measured as the relation between the light falling on the device and the resulting output signal. The cell resistance falls with the increasing light intensity and its operating temperature range is -60°C - +75°C. Commonly used material for LDRs is Cadmium Sulphide (CdS).

Plants grow if photosynthesis is more than respiration and stop growing if both activities are equal. So, similar to the light intensity, CO2 has also its importance in the production of food by photosynthesis. A typical range of 0.03-0.04% of CO2 is desirable in the air inside the greenhouse. The general characteristics desired in a CO2 sensor are good sensitivity and selectivity to CO2, low humidity and temperature dependency and long stability and reproducibility. The CO2 sensor used here is MQ7, which satisfies the conditions as given.

The content of water in soil is a major factor that determines the well-being of crops. Two simple copper rods act as the moisture sensor for soil. These rods are immersed in the soil inside the greenhouse and three conditions may prevail. When no conduction path exists between the rods, the soil can be termed as dry.

The LCD (Liquid Crystal Display) is used to display the measured parameters and the set parameters. Set parameters, which are the ideal values of the environmental parameters inside. For the optimally moist soil, a closed path is formed in between the rods for the current to flow. In the excessively moist soil, a steady conduction path gets established between the sensor leads and the voltage output of the sensor remains constant. A low-level amplifier, 2N222, is used to enhance the signal obtained from the rods.

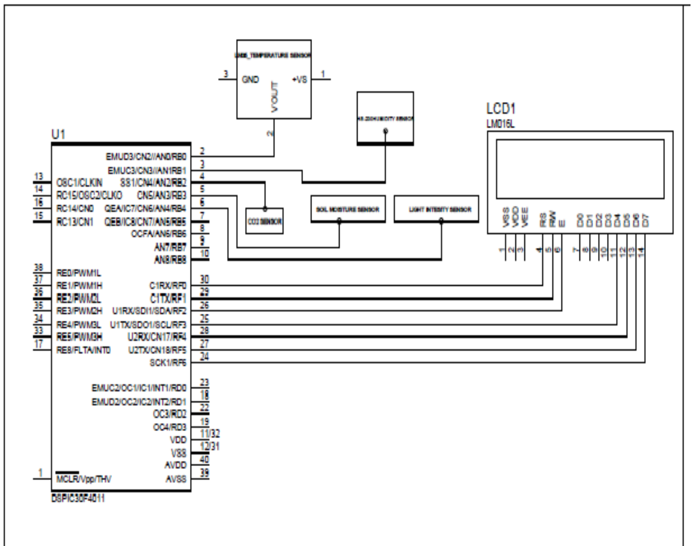

Fig. 3. Monitoring Section Circuit.

3.4 LCD Screen

The LCD (Liquid Crystal Display) is used to display the measured parameters and the set parameters. Set parameters, which are the ideal values of the environmental parameters inside the greenhouse, the greenhouse, are provided by the farmers. The 16 character X 2 lines LCD display has an in-built LSI HD 44780 controller. The small size, light weight display has 14 pins, with its interfacing done to the Port F of the DSPIC. The ideal value set for temperature is about 32°C. Likewise, for other parameters, values for the ideal crop growth are set. So on watching the LCD, the farmer can determine the situation inside the greenhouse and initiate the necessary control actions.

4 CIRCUIT DESCRIPTION

As shown in the circuit diagram in Figure 3, the central component is the DSPIC 30F4011, the 16-bit digital signal controller integrated circuit (IC). It is a 40 pin IC with 3 pins each for VSS and VDD. Clock signals are provided at pins 13 and 14. There are 5 types of ports, namely B, C, D, E and F. There are 9 pins for port B, from RB0 to RB8 and they are used as the in-built ADC unit. They convert the analog signals obtained from the sensors to DSPIC-compatible digital signals. It is to the port B pins that all the sensors are connected. This converts the analog signals from the sensors directly into digital signals, thus making it easy for the DSPIC to process the signals. For motor control purposes, there are 6 PWM (Pulse Width Modulation) pins, from RE0 to RE5. To the pins in port F, the LCD is interfaced and it is in this display, both the set and the measured values are shown. These values are also sent to the Web Server, through the high-speed CAN bus transceiver. At the Web Sever, there is a special web page for the greenhouse considered which displays the values sent from the DSPIC. Using both these displays, farmers can understand the situation inside the greenhouse and initiate the appropriate control actions. Data is measured every 2500 ms and sent to the DSPIC.

5 RESULTS

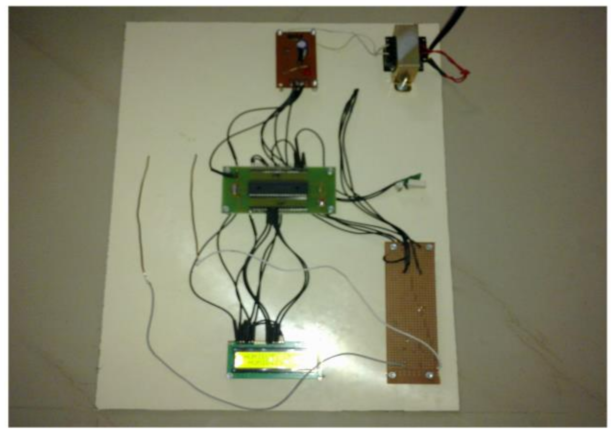

Fig. 4. Intelligent Node Hardware.

The system proposed here helps in the automatic monitor and control of the environmental conditions inside the greenhouse. This helps the farmers managing the greenhouse to know about the situation inside it and bring about the required changes, without going to its vicinity. The control of the greenhouse is possible from anywhere provided the transfer of data to the web server occurs properly with the help of the CAN bus. The hardware of the Intelligent Node is shown in Fig. 4.

The control section setup, shown in Fig. 5 operates upon finding a fluctuation in the values of the parameters of temperature, humidity and soil moisture. A provision for the use of cooling fan is also made. The control equipments help in bringing the environmental parameters monitored, back to its optimum levels. The system helps a farmer in such a manner that he is able to get a good quality, high yield crop and a well-deserved profit, which is the ultimate aim of its creation.

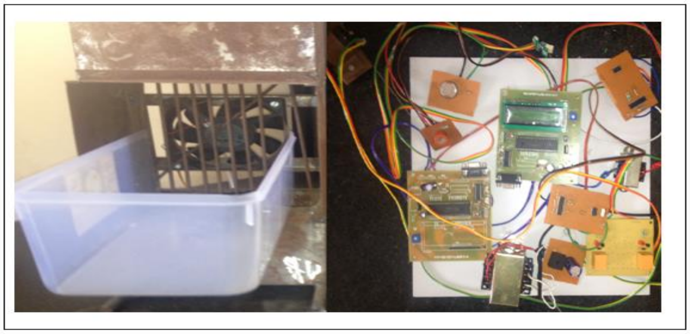

Fig. 5. Control Section Hardware.

6 CONCLUSION

The greenhouse monitor and control system can be generalized, for implementation in various other sectors like industries, where regular monitoring of the environmental conditions is of prime importance. Hence, this system can be extended to other fields and further improvements can be made. The most important among them would be the food processing industries, where the control of the parameters is of prime concern.

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REFERENCES

[1] Y. Song and J.M. He, "Design of Distributed Greenhouse Big Awning Monitoring System Based on Field-bus," Fifth International Conference on Intelligent Computation Technology and Automation, vol.7, pp. 135-138, 2012.

[2] O. Mirabella and M. Brischetto, "A Hybrid Wired/ Wireless Networking Infrastructure for Greenhouse Management", IEEE Transactions on Instrumentation and Measurement, vol.60, pp. 398-407, Feb 2011.

[3] K.Sahu and S.G.Mazumdar, "Digitally Greenhouse Monitoring and Controlling of System base on Embedded System", International Journal of Scientific & Engineering Research, vol. 3, issue 1, Jan 2012.

[4] V.R.Deore and V.M.Umale, "Wireless Monitoring of the Greenhouse System Using Embedded Controllers", International Journal of Scientific and Engineering Research, vol.3, issue 2, Feb 2012.

[5] B. Vidyasagar, "Greenhouse Monitoring and Automation using GSM", International Journal of Scientific and Research Publications, vol2, issue5, May 2012.

[6] Song Y, Ma J, Zhang X and Feng Y. (2012) 'Design of Wireless Sensor Network-based Greenhouse Environment Monitoring and Automatic Control System', J. Networks, vol 7, pp 838-844.