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FPGA Based Real Time Monitoring System for Agricultural Field

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Abstract — **The most important factors for the quality and productivity of plant growth are temperature, humidity, light and the level of the carbon dioxide. Continuous monitoring of these environmental variables gives information to the grower to better understand, how each factor affects growth and how to manage maximal crop productiveness .The optimal greenhouse climate adjustment can enable us to improve productivity and to achieve remarkable energy savings - especially during the winter in northern countries. The system itself was usually simple without opportunities to control locally heating, lights, ventilation or some other activity, which was affecting the greenhouse interior climate. This all has changed in the modern greenhouses. The typical size of the greenhouse itself is much bigger what it was before, and the greenhouse facilities provide several options to make local adjustments to the lights, ventilation, heating and other greenhouse support systems. However, more measurement data is also needed to make this kind of automation system work properly. Increased number of measurement points should not dramatically increase the automation system cost. It should also be possible to easily change the location of the measurement points according to the particular needs, which depend on the specific plant, on the possible changes in the external weather or greenhouse structure and on the plant placement in the greenhouse.**

For the implementation of agricultural technologies, low cost and real time remote monitoring are needed, in this sense, programmable Logic Devices (PLDs) present as a good option for the technology development and implementation, because PLDs allow fast development of prototypes and the design of complex hardware systems using FPGAs (Field Programmable Gate Arrays) and Complex Programmable Logic Devices.

I. Introduction

Crop growth is mainly influenced by the surrounding environmental climatic variables and by the amount of water and fertilizers supplied by irrigation. This is the main reason why a greenhouse is ideal for cultivation, since it constitutes a closed environment in which climatic and fertirigation variables can be controlled to allow an optimal growth and development of the crop. The climate and the fertirrigation are two independent systems with different control problems. Empirically, the requirements of water and nutrients of different crop species are known and, in fact, the first automated systems were those that controlled these variables. As the problem of greenhouse crop production is a complex issue, an extended simplification consists of supposing that plants receive the amount of water and fertilizers that they require at every moment. In this way, the problem is reduced to the control of crop growth as a function of climate environmental conditions.

II. Relevance of Working Methodology

The proposed system is an embedded system which will closely monitor and control the microclimatic parameters of a greenhouse on a regular basis round the clock for cultivation of crops or specific plant species which could maximize their production over the whole crop growth season and to eliminate the difficulties involved in the system by reducing human intervention to the best possible extent.

The system comprises of

- Sensors
- Analog to Digital Converter
- FPGA

When any of the above mentioned climatic parameters cross a safety threshold which has to be maintained to protect the crops, the sensors sense the change and the FPGA reads this from the data at its input ports after being converted to a digital form by the ADC. The FPGA then performs the needed actions by employing relays until the strayed-out parameter has been brought back to its optimum level. Since a FPGA is used as the heart of the system, it makes the set-up low-cost and effective nevertheless. As the system also employs an LCD display for continuously alerting the user about the condition inside the greenhouse, the entire set-up becomes user friendly.

III. Methodology

To implement a real time monitoring system for agricultural field low cost is a significant factor. In that sense programmable logic device(PLD) is a good option for the technology development and implementation, because PLD's allow fast development of prototype and the design of complex hardware system using FPGA'S and commercial PLD's.

1. *Green House Technology*

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Greenhouse Environmental degradation is a serious problem with many sources and causes. One of the biggest causes is farming. Moving agriculture into greenhouses can recover most of the water used, by dehumidifying the exhaust air and treating and re-using runoff. Greenhouse agriculture requires less labor and far less land area than open-field agriculture, and provides greater independence from weather conditions including seasonal variations. A large-scale move to greenhouse agriculture would reduce water use, land use, and weather-related food shortages. Greenhouse by definition is a framed structure, covered with a transparent material for the purpose of admitting natural light for plant growth, under partly or fully controlled environmental conditions.

2. Environmental parameters:

a. Light Intensity

For proper growth of plants in greenhouse required light intensity should be around 50,000 to 60,000 LUX is needed. Light intensity in India is around 40,000 to 1, 40,000 LUX. Thus using shade nets we have to reduce this light intensity.

b. Temperature:

Temperature for plant (flowers or vegetables) growth required is Day temperature around 26degreeC to 30degreeC Night temperature around 15degree C to 18 degree C This temperature can be controlled using ventilation or fan pad cooling systems.

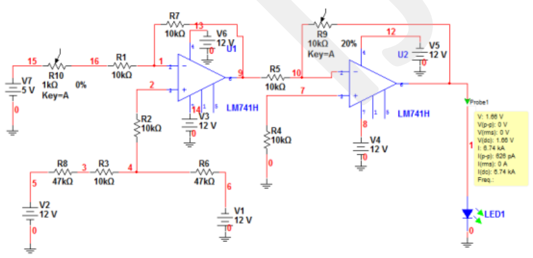

Figure 1

c. *Humidity:*

For floriculture 70% to 80% humidity should be maintained and for vegetables 60% to 70% humidity is required. Humidifiers or foggers are used to maintain this humidity range.

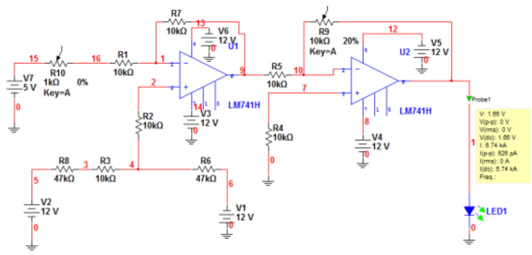

Figure 2

This project is divided into three phases: -

1. Identifying the appropriate sensor for measuring temperature and relative humidity. Temperature sensor to be used is RTD so that low cost aim can be successful with best stability.
2. Design of controller using FPGA, sensor interface card, isolation circuit for input and output, output relay card.
3. Development of a user interface and the controlling software.

3. Signal conditioning circuit:

Sensing temperature and humidity requires two measurement of:

1 Surrounding of air temperature (Tdry)

2 Rate of evaporation

For measuring temperatures RTD is the best option due to its linearity with temperature. Thus one RTD is used to measure the air temperature and other is used to measure the wet temperature.

4. System Architecture:

The system mainly consists of two units namely (system board, control center) .The Control center consists of pc and mobile phone connected together through the serial communication port RS232.

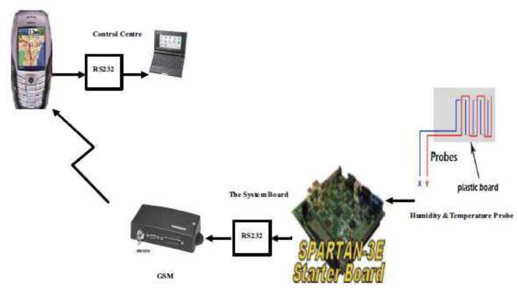

Figure 3

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The system board consists of two units:

a) System board:
The system board is located in the remote land, where humidity, Light intensity and temperature are measured. The main function of system board is continuously measure the temperature and humidity and compares the measured values with a threshold level, and sends message through GSM network to the control center in case of high temperature or humidity exceeds the threshold level.
The controller has many components namely:
Control unit (CU), the ROM memory, the HMU (Humidity measurements unit), TMU (Temperature measurement unit) and LTU (Light Intensity Unit).

b) Control unit:
The control unit will be implemented in Spartan 3E FPGA. The HMU, LTU and TMU send control signals to CU in case of low humidity or high temperature. The main function of CU is to send message to mobile according to the given signals coming from the HMU, LTU and TMU units.

5. Controller Design
The selected FPGA is SPARTAN 3 , XC3S 400 – 4PQ208 . FPGA provides the user with two dimensional arrays of configurable resources that can implement a wide range of arithmetic and logic function. These sources include dedicated DSP block, multipliers, dual port memories, lookup table (LUTs) , resisters , tri-states buffers , multiplexers and digital clock managers. In addition Xilinx FPGAs contain sophisticated I/O mechanisms that can handle a wide range of bandwidth and voltage requirements. Programming tool which is Xilinx 8.1 web pack is easily available from the internet. The program can be downloaded in device through parallel port thus less development time required

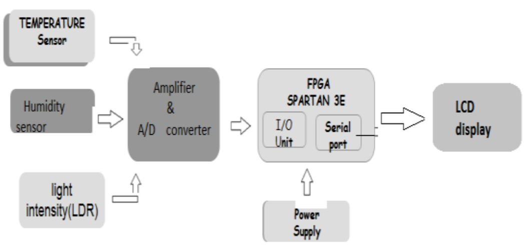
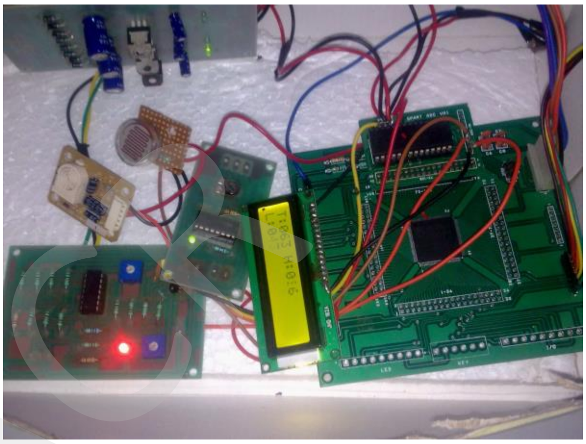


Figure 4

IV. OUTCOME

Daily monitoring of agricultural field condition by humans in day to day life is not possible today's world. In order to improve the efficiency of the data collection procedure, and to improve the precision with which agricultural operations are managed, it is necessary that we have an automated system that collects environmental data, especially to record long-term and up-to-the-minute environmental fluctuations



V. CONCLUSION

The greenhouse automation at commercial level is experiencing attention. Also, to achieve competitiveness in the market, the production costs must be kept as low as possible. Low cost automation can be achieved by using VLSI systems so that all category farmers can afford it.
The objective of this project was to develop a system to provide autonomous control for temperature and humidity in a closed environment of Greenhouse, which is fulfilled.
Future Scope
The programming can be extended for n - greenhouse climate control.
• Parameter data can be saved and record can be generated.
• Other control parameters can be added.
• Facilities for user can be increased such as one can set the offset of the temperature and humidity.
• System can be programmed to indicate if fault is generated.

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