RESEARCH FRONT

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DEVELOPEMENT OF AUTOMATIC TEMPERATURE CONTROL SYSTEM FOR GREENHOUSE TOMATOES

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Abstract:

Tomatoes are the most important greenhouse vegetable crop in India. For the proper growth of tomato it requires proper environment. The air temperature is the main environmental component that is responsible for proper growth of tomato. The maximum growth of tomato occurs at the day and night temperature of approximately 25^{0}C. The maximum fruit production occurs with night temperature of 18^{0}C and day temperature of 20^{0}C. Therefore, an attempt has been made to design an electronic system to measure and control the temperature of greenhouse tomatoes at 25^{0}C by using microcontroller. The temperature sensor LM35 is deployed. Analog signal resulted from data acquisition system is digitised by using on chip ADC and then subjected to AVR microcontroller ATmega32 for further processing. The LCD is interfaced to ensure the digital readout. An embedded firmware is developed to control the temperature at 25^{0}C. Incandescent lamps are employed to warm the environment whereas ventilators are adopted for cooling the environment. The results regarding implementation of the systems are interpreted in this paper.

Keywords:-Temperature sensor, AVR Microcontroller, LCD display, Control unit.

1. Introduction:

In Indian agriculture, various vegetable crops are grown. The tomato is the most important crop. Generally the tomatoes are grown by using traditional methods where they do not get the required environment for their proper growth. Instead, if they are grown in greenhouse by using advanced techniques, it increases their quality and quantity. There are various parameters that are required in sufficient amount for the proper growth of tomatoes. The air temperature is the main environmental component that is responsible for proper growth of tomato. The maximum growth of tomato occurs at the day and night temperature of approximately 25^{0}C. The maximum fruit production occurs with night temperature of 18^{0}C and day temperature of 20^{0}C. Naturally the air temperature changes as per the season. The lower temperature (below 18^{0}C) can result in catfacing and higher temperature (above 25^{0}C) results in cracking of tomatoes.

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Fig(i):Extreme fluctuations in temperature   Fig(ii):Cool spring weather Can affect tomatoes

It is possible to control the temperature of greenhouse in the range 18^0C to 25^0C by using the microcontroller with suitable temperature sensor. The signal produced by the sensor is analog in nature, which is converted into digital form by Analog to Digital Converter (ADC). This signal is then processed by the microcontroller. The objective of this work was to design optimized technique by developing an electronic model to control temperature of a greenhouse in the range 18^0C to 25^0C which is suitable for proper growth of tomatoes. An electronic model is developed by using AVR microcontroller ATmega32 & temperature sensor with some circuit components to control the temperature of greenhouse tomatoes.

2. The Hardware:-

The block diagram of an electronic circuit that is developed to control the temperature of greenhouse in the range 18^0C to 25^0C is shown in following figure (1), which consists of a temperature sensor LM 35, display, control unit (relay), ventilator, incandescent lamp & AVR microcontroller ATmega32.

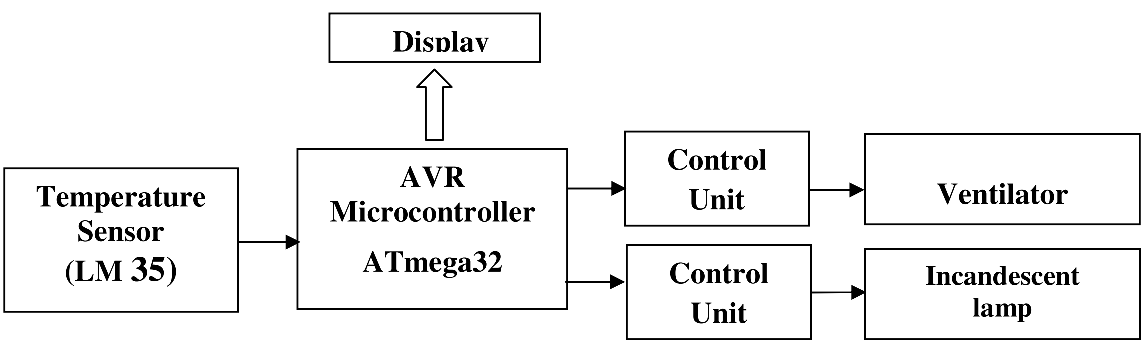

Fig (1): - Block Diagram

The temperature of greenhouse is sensed by the temperature sensor IC LM 35 which is connected to channel ‘0’ of ADC. This temperature signal is converted into digital form by on chip 10 bit ADC (000H-3FFH) and is then processed by ATmega32.

The microcontroller ATmega32 converts this temperature into real temperature by dividing it by 4 (00H-FFH) and then sends to display that is connected to Port B(Control Signals) and Port C(Data lines) after converting it to ASCII format. While sending data to

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display, first it is compared with 048H (ADC O/P for 18^0C) temperature value. If ADC output data is smaller than 048H, a logic high (1) is given to the control unit (Pin -PD0) to turn ON the lamp so as to increase the temperature, otherwise a logic low (0) is given to control unit (Pin -PD0) to keep the lamp OFF. Secondly the data is compared with 064H (ADC O/P for 25^0C) temperature value. If ADC output data is greater than 064H, a logic high (1) is given to the control unit (Pin –PD1) to turn ON the ventilator so as to decrease the temperature, otherwise a logic low (0) is given to control unit (Pin –PD1) to keep the ventilator OFF. The following figure (2) shows experimental setup of the circuit.

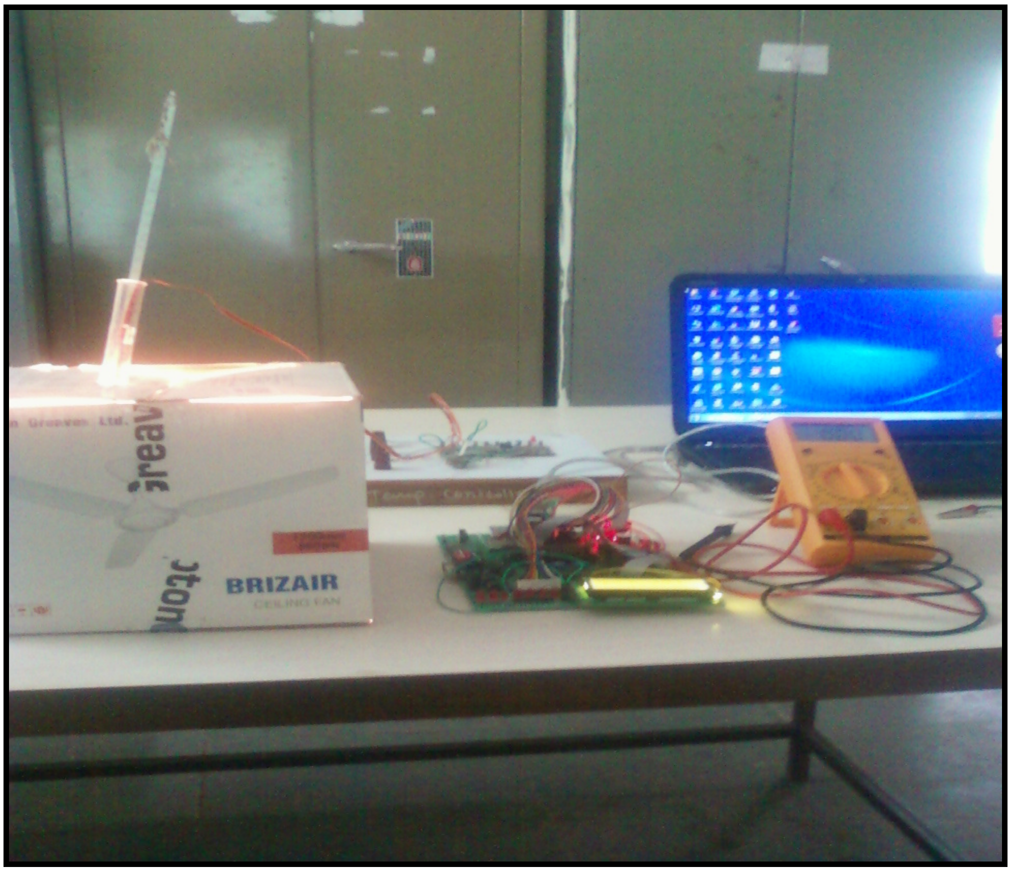

Fig (2):- experimental setup of the circuit

2.1 Temperature sensor LM 35

Temperature sensor LM 35 is an integrated temperature sensor that can be used to measure temperature with an electrical output in the form of voltage proportional to temperature in degree Celsius (^{0}C). The LM 35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature [4]. The LM 35 thus has an advantage over linear temperature sensors calibrated in Kelvin as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35's low output impedance, linear output and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating less than 0.1^0C in still air. The LM35 is rated

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to operate over a -55^0 to $+150^0$ C temperature range while the LM35 C is rated for a -40^0 to $+110^0$ C range.

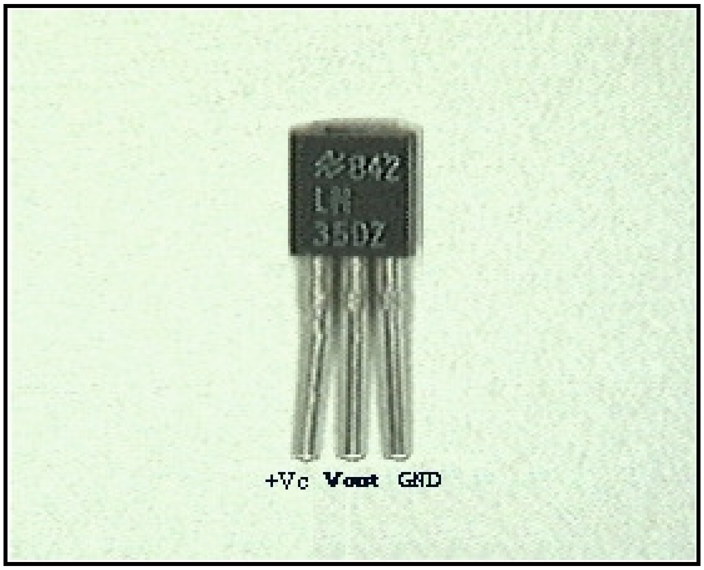

Fig (3):- IC LM 35

2.2 AVR Microcontroller ATmega32

An ATmega32 is an 8 bit AVR microcontroller which provides features as [1]: 32Kbytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 1024bytes EEPROM, 2Kbyte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary-scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, A/D Converter, SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next External Interrupt or Hardware Reset. In Power-save mode, the Asynchronous Timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the Asynchronous Timer continue to run.

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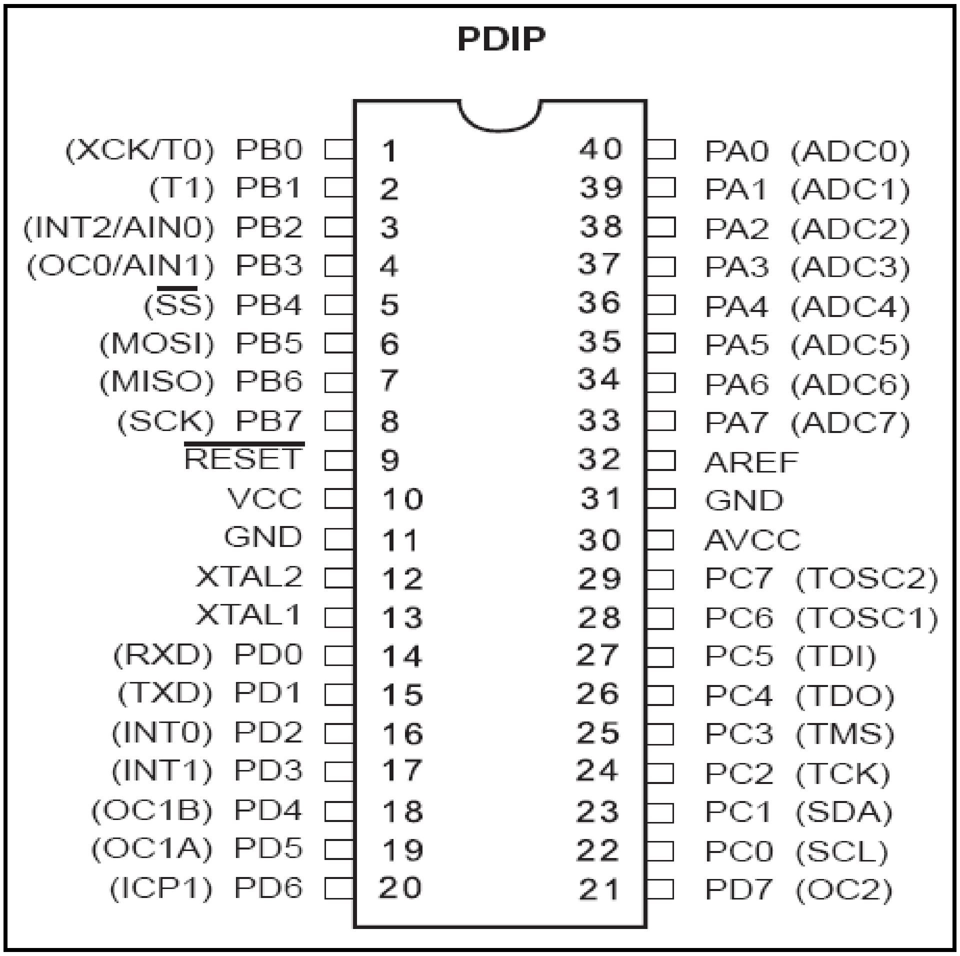

Fig (3):- Pin out of ATmega32

3. **The Software:-**

To run the above system, a program is developed in ‘C’ by using AVR studio4 in which ADC (Channel ‘0’) gets input data from temperature sensor. The digital output of ADC is then given to LCD display after conversion from hex to ASCII. In main programme various modules are developed for specific tasks. Following are the modules developed & used in programme in proper sequence.

i) Reading of analog signal
ii) Analog to digital conversion
iii) Initialization of LCD
iv) Character display
v) Hex to decimal & decimal to ASCII conversion
vi) Configuration of LCD
vii) Sending data to LCD
viii) Controlling of lamp to increase the temperature
ix) Controlling of ventilator to decrease the temperature
x) Delay function

4. Result and discussion:-

From the above model it is found that, if temperature of greenhouse decreases below 18^0C, the lamp turns ON automatically to increase the temperature. Similarly if temperature of greenhouse increases above 25^0C, the ventilator turns ON automatically to decrease the temperature. i.e. temperature of a greenhouse is controlled in the range 18^0C to 25^0C for proper growth of tomatoes by using temperature sensor IC LM35, AVR microcontroller ATmega32 with some circuit components.

5. Conclusion:-

The paper presents an electronic model based on AVR microcontroller ATmega32 to control the temperature of a greenhouse in the range 18^0C to 25^0C for proper growth of tomatoes. The circuit works properly; hence it is conclude that, temperature of a greenhouse can be controlled in the specific range for proper growth of various plants that are grown in the greenhouse. It is also conclude that the same circuit is applicable for other plants only by changing the range of temperature as per the requirement of the plant.

6. References:-

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