PIC Microcontroller Based Control and Automation of a Poultry Farm

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Abstract

Poultry sector is one of the sparkling segments of Agriculture Industry in Pakistan. Its role in agriculture growth is 4.81% and 9.84% in Livestock growth. Poultry meat contributes 19% of the total meat production in the country. Broiler meat is the cheapest source of animal protein for increasing population of the world. Due to complex operation of broiler meat production, a proper climate controlled environment should be provided for better health and growth of chickens. In manually operated poultry houses there are many problems such as large number of labourers have to work, bio security risk, wastage of water and feed, maintain the internal temperature and humidity level, poisonous gases can be produced which may increase death rate of chickens. The main objective of this work is to automate the poultry farm by introducing the control system. Control system contains temperature sensor, humidity sensor and LDR (Light Dependent Resistor) sensor which send signal to PIC (Peripheral Interface Controller) microcontroller in order to maintain internal environment of poultry shed and make necessary changes automatically according to required status of poultry farm. Temperature and humidity varies with atmosphere, so certain levels of temperature and humidity should be controlled using cooling pad, electric heater and fans. LCD is used to display the current readings of all the sensors and current status of output devices (fans, heater, light etc.) inside the control shed by using PIC Microcontroller.

Keywords— PIC Microcontroller, Control and Automation, Poultry Farm, Temperature, Humidity, Sensors

I. INTRODUCTION

Poultry sector is one of the sparkling segments of Agriculture Industry in Pakistan. This zone produces employment and income for about 1.5 million people. Its role in agriculture growth is 4.81% and 9.84% in Livestock growth. Poultry meat contributes 19% of the total meat production in the country. The current investment on poultry industry is above PRs. 200 billion. Poultry sector has shown a strong growth at the rate of 8-10% annually which reflects its natural potential. The cheapest source of animal protein available in Pakistan is broiler meat. Broiler birds are raise in lesser time than any other source of animal protein. The increasing demand of white meat in market has made it a profitable business enterprise. According to Industry sources there is capacity of 5,000 Environmental Control Houses in Pakistan and currently 2,500 poultry houses are working, out of which 75% (1,875) are in Punjab and remaining 25% (625) are in other provinces .Heat tension is the major problem in poultry farming. Being a hot country the temperature reaches over 40°C during summer and is not suitable for poultry farming. Hot and humid weather conditions and poor management practices increase the death in flocks, reduce the growth and make poultry production to too costly level. In usual farming, during the summer farmers have to either continue taking flocks compromise with poor performance in feed eating, growth rate, weight gain, FCR (Feed Conversion Ratio) in broilers along with death or totally close the business to avoid all these risks that could disturb the hired labor and staff. Controlled environment poultry farms can beat this critical summer situation. These farms when equipped with highly mechanized system of automatic systems make the environment quite conducive for poultry production by getting continuous production. Poultry Farming in Controlled Environment can bring a great change in poultry industry of Pakistan and is rapidly become popular among broiler producers due to its significant advantages like we can maintain the temperature between 20°C to 24°C humidity between 50% to 70% lights on and off automatically for better growth of chickens . Open poultry houses are liable to expose high Bio-security risk as large number of labourers has to work there to perform all the functions manually in result Germination of poisonous gases like Ammonia, Carbon dioxide, Carbon monoxide etc. may increase of death rate of chickens.

II. LITERATURE REVIEW

Industrial automation and control system is discussed in [1] for minimize food spoilage .They have developed the cold storage automation and remote access system which is cost, resource and energy efficient in their work various sensors are installed. They send the data to central controller frequently central controller make decision on the basis of preset value and take necessary action. Wireless sensor aware web based poultry farm monitoring system is developed in [2]. This monitoring system measures the temperature and humidity and uploads the gathered data from sensors to data base which is online using agent program and then data is accessed via web application temperature and humidity sensors measures the temperature accuracy +-0.3 and +-

2% respectively they claim that it is first ever approach used in Pakistan with respect to WSN based poultry farm system. Chicken farms in Taiwan for automation Integration and management Using Field Server is highlighted in [3]. Field Server particularly wireless technology on the basis of multimedia sensors is used in [3] to elaborate automation integration system for farm this process converts all the equipment of farm to electronic from manual system it also have sensing device like temperature sensor humidity sensor and for getting internet based access of integrated automation a system software is also proposed. Microcontroller based smart farm is discussed in [4] in which whole the inner environment of farm house is automatic. It includes temperature sensor humidity sensor moisture light switching system smoke detection and security for all this. They also suggest that sensors detects and also claims about reduction of labor cost as compare to manual system and achieved 100% efficiency.

III. Problem Defination

The significant objective of this research is to make an efficient Poultry Farm by using automation techniques. Automation of poultry sheds increases the growth of poultry industry and minimizes the external exposure which is harmful for chickens. Following are the problems which will be highlighted in the paper.

1. Reduce the human work
2. Provide clean and safe environment
3. Lower the energy requirement (Power Management)
4. Increase efficiency
5. Reduce cost.

IV. Design Procedure

In this section, design is comprises on three following portions as shown in figure 1.

A. Hardware Design
B. Software Design
C. Mechanical Design.

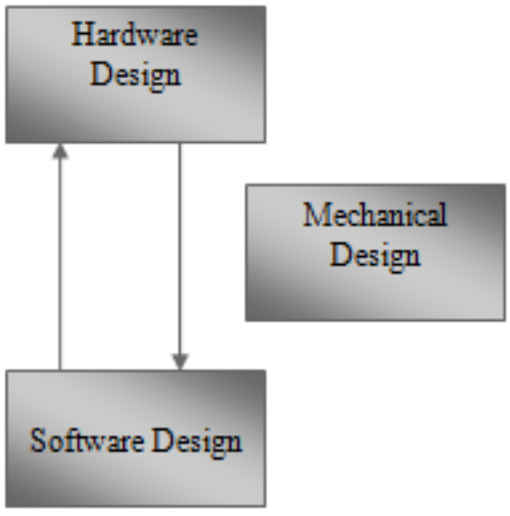

Figure 1: Components of Design Procedure

A. Hardware Design

We prepared our electronic design in different stages. After collaboration of different parts; such as power supply, keypad & LCD interfacing with microcontroller (PIC16F877A), temperature, humidity & LDR sensors interconnection with PIC, and an output section in which four different circuits are used including heater circuit, fans circuit, water pump circuit & light bulb circuit. Figure 2 is a self-explanatory block diagram of electronic circuit is given.

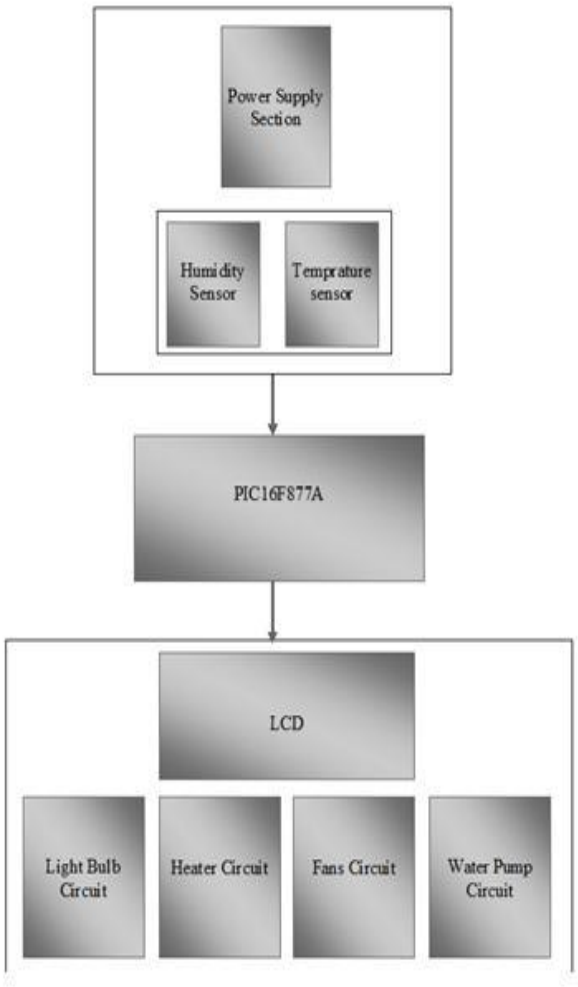

Figure 2: Block Diagram of Hardware Design

B. Software Design

In second stage as shown in figure 3, we completed our software design. Our software design comprises of a C language program. We made the program to calibrate the controller that how it has to perform like. When the controller has to switch to the ON/OFF states of output relays to which the output devices like electric heater, electric fans, light bulb and water pump are connected with. In this way, the overall system will be purely automated and controlled to achieve the required situations. These decisions will be made by the controller using the instructions set in the software program.

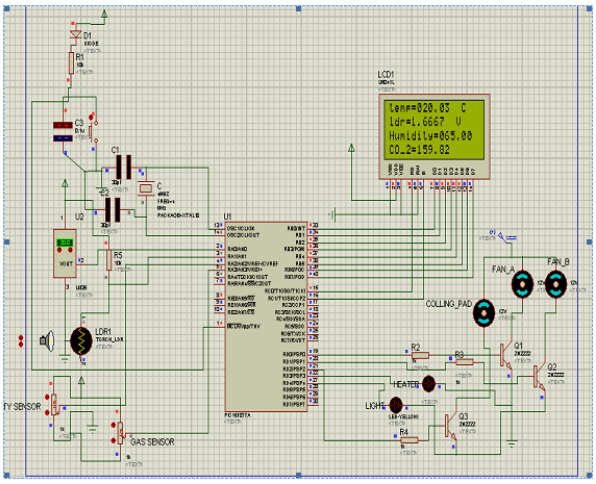

Figure 3: Software Simulation Design

C. *Mechanical Design*

In third stage; we completed our mechanical design. Our mechanical design comprises of a small level control shed prototype model including installed electrical components. We started construction of the control shed by defining the dimensions of prototype model. Prototype model has an area of 12 square feet (length = 4 feet, width = 3 feet) and height of 4.5 feet. We have implemented three electric fans, one electric heater, one light bulb, one cooling pad, one water pump, one temperature sensor, one LDR (Light Dependent Resistor) sensor, and one humidity sensor. Capacity of control shed varies with the age of chickens, so this control shed has the capacity to fill up to 24 chickens of age 3 to 4 weeks. Electric heater is located at the centre within the control shed and location of cooling pad and electric fans is opposite to each other for the easy passage of air as shown in the figures below. We also used single sided glass in our prototype model in order to make internal environment visible to outsiders. We placed a small water tank in order to provide water to cooling pad by the help of water pump. We also hanged a light bulb at the centre of control shed for lighting purpose. This control shed has become user friendly because of the portability.

Figure 5: Side view of control shed mechanical design

V. METHODOLOGY

Temperature sensor sense the environment temperature and send information to the PIC microcontroller, LDR sensor senses the intensity of light and sends the information to the PIC microcontroller. Humidity sensor senses the relative humidity and sends its value to PIC microcontroller. The carbon dioxide sensor, which senses the level of CO2 in environment and sends its value to PIC microcontroller as shown in figure 4.

PIC16F877A microcontroller receives the information from different sensors and take decisions according to the programming and sends the signals to the required electronic device (fans, heater, light bulb, water pump etc). If the temperature, humidity or CO_2 level of the environment is high electric fan will be turned on. If the temperature is low, the electric heater will be switched on. If light intensity is low in the control shed, the light bulb will be turned on. If there is sunlight falling on the control shed, light bulb will switched off.

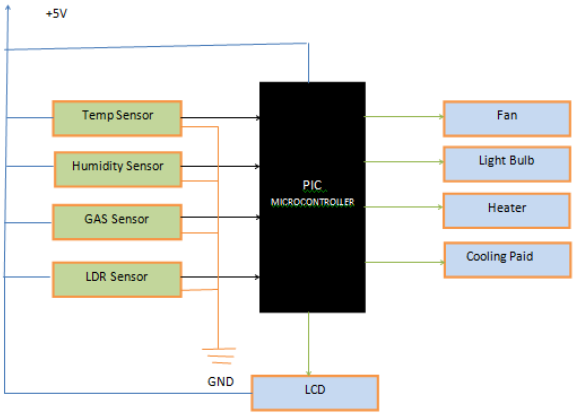

Figure 4: Block Diagram of Proposed Method

Major Components Involved:

Following are the major components involved in our methodology in order to implement efficient poultry farm design on PIC microcontroller.

PIC16F877A Microcontroller: A microcontroller that makes the whole behavior of system automated. It makes our system user friendly and eliminates manual operations.

Temperature Sensor (LM35): An electronic temperature sensor that senses and measures the atmospheric temperature of the control shed and provides the results to the microcontroller to control the temperature as required. As we need constant temperature (22 to 24) for internal environment of control shed; temperature sensor made it possible by the traits it has; to sense the current temperature and provide the sensed results to microcontroller.

Humidity Sensor (HSU-04): An electronic humidity sensor that senses and measures the atmospheric

humidity of the control shed and provides the results to the microcontroller to control the humidity up to the desired level. As we need constant humidity for internal environment of control shed; humidity sensor made it possible by the traits it has; to sense the current humidity and provide the sensed results to microcontroller.

Light Dependent Resistor (LDR): LDR sensor is used to control the lighting system inside the control shed. It senses the intensity of light; if light outside the control shed is low, light bulb will be turned on and if light outside the control shed is high, light bulb will be turned off.

Electric Heater: Electric heater is used to increase the temperature when needed.

Electric Fans: Electric fans are used to control the humidity requirements of the control shed. These are also used for ventilation purpose as well as for air circulation..

Cooling Pad: When temperature inside the control shed is increased, cooling pad is to be wet by using water pump in order to pass the fresh & cool air inside the control shed.

Water Pump: When temperature inside the control shed is increased, water pump is used to provide the water to cooling pad in order to maintain the temperature level.

Light Bulb: When sunlight outside the control shed is low, light bulb will be turned on and if sunlight outside the control shed is high, light bulb will be turned off.

LCD: LCD displays the current readings of temperature, humidity and light voltages of the control shed to the user/operator. It also displays the current status of all output devices (fans, cooling pad, heater, light bulb etc) i-e whether they are turned on or turned off. In this way; it keeps the user posted with the current atmosphere of the control shed.

VI. RESULTS AND DISCUSSION

A. Power Section:

The intention of design power section to sustain constant input signal of 5 volts that is required to derive PIC microcontroller. Power section circuitry entail of the main component like Step Down Transformer and Voltage Regulator. To Convert Ac source from (220 to 240V / 110 to 120V) to 12V step down transformer utilize, PIC operated at 5 volt to get requirement, voltage regulator exploit to switch 12 volt to 5 volt. Core object is to ensure constant steady 5 volt must be supply to PIC microcontroller. This procedure is done by connecting DC Voltmeter with the output of the power circuit as shown in table 1.

Table1: Analysis of Power Section

Component Name	Test 1	Final Result	Details
12 volts supply	OK	OK	Input Supply of 12 Volts given to power circuit
Voltage regulator (7805)	OK	OK	To regulate the voltage signal to 5 Volts
DC Bridge	OK	OK	To rectify the voltage signal of 5 Volts
Resistors and Capacitors	OK	OK	To reduce fluctuations of the signals
Volt Meter	OK	OK	To measure the output signal of power circuit
Transformer	OK	OK	To step down from (220 to 240V /110 to 120V) to 12V

B. Temperature Control Section:

This Part contains interfacing of Temperature sensor (LM35) with PIC 16f877A microcontroller. To maintain certain level of atmospheric temperature in poultry shed ventilation fan, cooling pad and heater are exploit. At beginning level PROTEUS tool employ to get result than implement to hardware. The testing procedure include testing of output voltage of temperature sensor, testing of data interpret from sensor and display to LCD .To maintain specific temperature in poultry shed microcontroller switch the status of ventilation fan, cooling pad and heater are on and off, light emitting diode (LED) hook up with each relay of ventilation fan, cooling pad and heater as mentioned in table 2.

Table 2: Analysis of Power Control Section

Component Name	Test 1	Final Result	Details
PIC 16F877A	OK	OK	Voltage and frequency level of each pin of microcontroller
Voltage Source	OK	OK	Output of power section circuit is 5 volt 12 volt signal to each relay of ventilation fan, cooling pad (220 to 240V) volt signal to relay of heater
Cooling pad	OK	OK	Cooling purpose
Temperature Sensor (LM35)	OK	OK	Data read from sensor and send signal to PIC microcontroller
LCD & LED	OK	OK	LCD to display temperature LED use to check status of relay
Resistors and Capacitors	OK	OK	To reduce fluctuation of the output signal of sensor and control the intensity of light of LCD
Relay	OK	OK	For switching purpose
Volt Meter	OK	OK	To measure the output signal of temperature sensor
DC Fan	OK	OK	Ventilation purpose
Heater	OK	OK	For heating purpose

C. Humidity Control Sensor:

Our next stage is to control humidity of the internal environment of the poultry farm. For this purpose; we interface a humidity sensor with the PIC microcontroller and use the LCD to display the humidity. To ensure that whether the humidity that was displaying on LCD is accurate or not, we compare the output voltage and displayed humidity with the output graph of the sensor that was available in the data sheet of the sensor. In Cycle 1; our results were not same as the desired results. First we ensured that sensor is working properly .For this purpose, we compared the output voltage of the sensor and take a corresponding value of humidity and compare with the humidity meter's output. The results were satisfactory .Then we check the code again and a problem found in it. We troubleshoot the problem and solved it by changing our code. After doing this; we compared our results displayed on LCD with the humidity meter, now the results are satisfactory.

Table 3: Analysis on Humidity Control Section

Component Name	Test 1	Final Result	Details
PIC 16F877A	OK	OK	To receive the signal from sensor and control the humidity by switching water pump and fan
Water pump And shower	OK	OK	To spray the water drops in air to increase the humidity
DC fan	OK	OK	For equally distribution of water particles at internal surface of incubator
Relay	OK	OK	For switching purpose
Voltage supply	OK	OK	Voltage supply of 220 voltages to make water pump ON.
LCD and LED	OK	OK	To show the measured humidity LED to check that which relay is On or OFF

D. Light Control Sensor:

Light control in poultry shed is most important step to avoid needless use of light and provide comfortable environment for chicken. Energy crisis is already big issue in Pakistan, Light dependent resistor use to control light. Resistance of an LDR is very high, occasionally as high as 1000 000 ohms, but when they are illuminated with light resistance drops. PROTEUS tool use to get satisfactory result at initial level, than implemented to hardware. In hardware Light Dependent Resistor (LDR) interface with peripheral interface controller (PIC microcontroller) and value of voltage level display on liquid crystal display (LCD). LDR send input signal to PIC microcontroller, PIC microcontroller process the value and send to relay to control the output device, in this case output device is light bulb. In light control section we face problem of variable resistor that is also use to get stability of circuit, setting of accurate value of variable resistance is issue during testing and debugging.

Table 4: Analysis on Light Control Section

Component Name	Test 1	Final Result	Details
PIC 16F877A	OK	OK	Voltage and frequency level of each pin of microcontroller
Voltage supply	OK	OK	Voltage supply of 220 voltage to bulb
Relay	OK	OK	For switching purpose
Variable resistor	OK	OK	Provide stability for LDR
LCD	OK	OK	LCD shows that light is on or off

VII. CONCLUSION

In this work, we have achieved our targeted goals by installing a Microcontroller based control system in which internal environment of control shed is automated according to the variations in temperature, humidity and light voltage levels in order to reduce the human work and increase the efficiency (less power consumption) and decrease the death ratio of chickens (i-e growth of chicken is increase). Due to automation, total cost of overall system is decreased b/c of less power consumption and less number of labourers is required. We have performed software simulation for carbon dioxide sensor. In future it can be implemented using practical carbon dioxide sensor.

VIII. FUTURE SCOPE

This design is implemented using PIC Microcontroller. In future, there is wide scope to implement the same design using ARM processor or FPGAs.

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