DESIGN AND CONSTRUCTION OF MICROCONTROLLER BASED TEMPERATURE CONTROL SYSTEM FOR AN INCUBATOR

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DEDICATION

This project work is dedicated to the almighty God for loving me this much and for seeing me through this academic programme.

DECLARATION

I Adewumi Grace Funmilayo declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

This design deals with the design and construction of a microcontroller based temperature control system for an egg incubator. The purpose is to cause fertile eggs to hatch by the application of heat. Heating of the chamber is achieved by the use of a 200watts electric bulb installed inside the incubator.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 Overview

All birds lay eggs, but there is one peculiar group of birds called the "mounted builders" found in some countries like Australia and some neighboring islands, which like many reptiles, lay their eggs in heaps of soil or decaying vegetation and pay no more attention to them, the young after hatching are able to fly almost at once. All other birds incubate their eggs by supplying heat from their bodies and giving the young devoted care. That heat may be considerable, since the temperature of a bird varies from 37.8 to 44.4 degree Celsius according to the species.

Ordinarily, incubation does not start until the "set" or clutch is completed. As the time approaches, the birds become more secretive and stealthy. Once incubation begins the bird (hen) seldom leaves the nest. The length of the incubation period variss for birds but for domestic hen or chicken which is my main concern it is 21days. This seems to depend on the size of the egg, the kind of young and perhaps on the body temperature of the parent. During incubation the eggs have to be turned once or twice a day so that they will be heated evenly, and the membranes of the embryo will not adhere to the shell. This is achieved with beak when hatching the egg is "pipped" from the inside and to do this, the young hen has a hard sharp "egg tooth" on its soft upper bill/beak. Later, this disappears. It's interesting to watch a mother hen return to her nest, carefully straddle the eggs, arrange them, wriggle around until she gets them all to her "brood patch", and then contentedly huddle down, there she will squat, motionless until the next day.

But before I proceed I will like to give the definition and the different options/types of incubation.

Incubation is the term used to describe the process of applying heat to an egg so that the embryo contained within develops in to a chick. Aviculturists of today have three options regarding the incubation of eggs and the procedure accordingly differs somewhat in each case. Each option has some advantages and some disadvantages. These options are as follows:

- Incubation and hatching by the hen/bird (natural incubation)
- Incubation and hatching by a brooding domestic hen (natural incubation by a surrogate mother)
- Incubation and hatching by artificial means (incubation with electronic incubators).

1.1.1 Natural Incubation

Natural incubation is the incubation performed by a hen be it pheasant (i.e the one that laid the eggs or surrogate pheasant parent). The hen pheasant can be left with the job of incubation and hatchung the egg and subsequently brood them also. The main advantage of this procedure is that one does not have to worry about the correct temperature and relative humidity, turning of the eggs and the preservation of the instincts in the succeeding generations. Also, there is less contact with man and the chances of being adversely imprinted are reduced.

1.1.2 Artificial Incubation

Artificial incubation is a type of incubation made by humans (not occurring naturally). It is a process whereby the mother hen is not allowed to incubate the egg due to the fact that the numbers of eggs to be incubated are large. An external supply of heat and relative humidity are needed for the incubation to be performed and it is convenient when there is a constant supply of steady voltage. Artificial incubation is far more practical than natural incubation, but low and very high voltages affect the electronic instrument which can lead to poor incubation results. Also experiment had shown that artificial /electronic incubators are far more practical than natural incubation because of the convenience of the operation and the more precise regulation of the temperature and humidity.

1.2 Aim And Objective

The aim of this project is to design, construct and test a microcontroller based temperature control system for an egg incubator. It is designed in such a way that accurate temperature condition is met.

1.3 Methodology

The microcontroller based device is made up of six modules which include the power supply unit, the sensing unit, the conversion unit, the control unit, and the display unit.

In the circuit, the power unit provides system with DC voltage for operations. This is the voltage used in driving the various components without causing any damage to the system.

The LM 35 senses the ambient temperature from the environment i.e (the incubator) and then convert it to analogue output voltage.

The analogue digital converter (ADC 0804) converts the output from the sensor to its digital equivalent by pulsing WR low, then high.

The microcontroller (AT89C51) is a low power, high performance CMOS 8-bit microcomputer. It uses a user program /codes to make logical decisions on data sent to it from the ADC to control devices that are interfaced to it. The microcontroller has a 12MHz crystal oscillator which makes it to count up to 1,000,000 times per second. The seven segment displays now display the outputs of the chip for visual observations.

1.4 Scope.

The major concern of this project is heat / temperature control in an egg incubator (using an LM35, ADC and Microcontroller) Many of the principles/ ideas discussed are of basic value and also find application in most heating systems.

1.5 Limitation

In the course of the project, setbacks and constraints encountered were mainly due to unavailability of required components. These were within containable limits as necessary remedies were sought for and implemented leading to the final completion of the desired project.

1.6 Project Layout

This project report comprises of five chapters for easy grasp of knowledge governing the design and construction of the microcontroller based incubator control system. Chapter one is the general introduction, which includes the brief history of the design, the aims and objectives, methodology, scope and limitation of the project were highlighted.

Chapter two contains the literature review. And it focuses on the general design description design methodology and the function of the modules.

Chapter three contains detailed system design and analysis. It comprises the general circuit diagram and its operation. General principles governing the design were also discussed.

Chapter four covers construction and testing. It contains the test results.

Finally, chapter five contains recommendations for further improvement. Constrains encountered during the project are also highlighted.

CHAPTER TWO

GENERAL DESIGN DESCRIPTION

2.1 Literature Review

Most poultry species have an optimum incubation temperature of 37 c to 38 c and small deviations from this optimum can have a major impact on hatching success and embryo development. The vast majority of poultry hatching eggs are artificially incubated in incubators that must be designed to accurately control the temperature inside the machine to ensure that the temperature of the developing embryo does not deviate from this optimum.

Research shows that the success of small incubators lies in their being located in a small room where temperature and humidity do not change that much, also there should be good ventilation with fresh air providing the right environment for artificial incubation.

Experiment has also shown that artificial incubators are more practical than the natural incubation because of the convenience of the operation and the more precise regulation of the temperature and humidity. Also no doubt that an electronically based incubator will not break the egg nor trample a chick and also the control of disease is very much easier than the natural incubation.

2.2 Understanding the egg meant for artificial incubation:

The two most critical factors in incubating an egg artificially are temperature and proper egg weight loss from the time it is laid until it hatches. Egg weight loss can be in part controlled by regulating the incubator humidity. Eggs from all species of birds should lose 18% of the fresh egg weight by the time they hatch.

2.3 Successful Operation of the Incubator:

The success of incubation depends on the proper operation of the incubator. The important factors are location of the incubator, placing of the egg, temperature, hygiene, humidity, turning of the eggs, candling and ventilation.

2.3.1 Location of the Incubator:

The incubator should be located in the draft-free area out of the direct sunlight and should be operated for at least 24 hours prior to the beginning of incubation to insure proper adjustment.

2.3.2 Placing egg in incubator:

The eggs should be placed on the wire rack, in the center and close to the heat shield, with the large end tilted slightly up. Inside the shell the chick grows with its head at the large end of the egg where the air pocket is located. Standing the delicate little chick on its head will cause the chick to die. Egg should always be lay one side with the LARGE END SLIGHTLY UP.

2.3.3 Temperature:

Proper incubation temperature is critical for ensuring the maximum hatchability of the eggs as well as the best condition of the chicks that hatch. Variation from the optimum temperature affects growth rate and incidence of embryonic mortality and deformity. The use of sub optimal condition is evidenced by poor hatching success which is the major reason that brought about these project (i.e micro processor based incubator) it is designed in such a way that accurate temperature condition is met. The optimum temperature seems to be 37.7degree Celsius. Research shows that developing eggs are very vulnerable to overheating but are somewhat less affected by short periods of cooling.

2.3.4 Humidity:

Proper control of the incubator humidity is also critical for successful hatching of artificially incubated eggs to reach the correct weight loss. For the eggs of most pheasant, 48 – 50% relative humidity inside the incubator will be alright

2.3.5 Hygiene:

Strict hygiene is a vital part and successful incubation. This is done by cleaning the incubators before the beginning and at the end of each breeding season using a good disinfectant; also the eggs are also disinfected before putting them in the incubators, so they cannot easily transmit pathogen organisms to the incubation room.

2.3.6 Turning of the eggs:

Egg-turning during incubation is important as it prevents the developing embryo from sticking to the shell membranes, a problem which develops if the egg lies too long in the same position. The turning should be done at least two to three times daily for optimum hatchability. Regardless of the number of times an egg is turned each day, the interval between turnings should be evenly spaced throughout the 24 hour period. Each egg should be marked so turning all eggs is insured. A simple method to use is to place an "X" on one side of each egg and an "O" on the opposite side, then when the eggs are turned all the "X"s or "O"s are visible at the same time.

2.3.7 Candling:

Candling is a technique which facilitates observation of the inner contents of an egg without opening the shell. It provides information about the condition of the egg shell as well as the condition and position of the embryo. It is necessary to perform candling on regular basis (at least 2 times per week) to keep track of the change air-cell and ultimately on the egg weight loss.

2.3.8 Ventilation:

Getting fresh air into the incubator is necessary because the developing embryos require oxygen. The ventilation openings at the back of the unit allow the amount of fresh air entering the unit to be regulated. It is particularly important that these openings be at least partially open during the final stages of incubation when the embryos are large and when more oxygen is needed

The advent of modern day's egg incubator has provided productivity, safety and time reduction technological advancement to poultry industry. Thus chapter gives the complete description of the various elements or modules used in the design of the microprocessor based incubator for the control of heat in an egg incubator

The temperature experienced by the developing embryo is dependent on three factors:

1. The incubator temperature.
2. The ability of heat to pass between the incubator and the embryo itself.
3. The metabolic heat production of the embryo itself.

2.4 Optimum Incubation Temperature

Optimum incubation temperature is normally defined as that temperature required to achieve maximum hatchability. Incubation temperature has been found to affect the hatchlings thermoregulatory ability, hormone levels, post hatching growth rate and also temperature may be able to alter the sex ratio by altering he phenotypic sex of a proportion of chick embryos. Several conclusions were drawn:

1. Optimum contiouous incubation temperature for poultry species is between 37°c to 38°c, although hatchability is possible between 35 to 40.5 c°;
2. Embryos are more sensitive to high temperature than low temperature;
3. The effect of a suboptimal temperature will depend on both the degree of deviation from optimum temperature and the length of time applied;
4. Embryos appear to be more sensitive to suboptimal temperatures at the beginning of incubation than at the end of incubation.

2.5 Theory Of Heat Exchange

The thermal energy of incubation has been modeled by Kashkin (1961), Sotherland *et al.* (1987), Turner (1991, 1994), Meijerhof and van Beek (1993). A simple form of the model can be given as: Tegg= Tinc + (Hemb - Hwater loss)/K................................ [1] Where

Tegg = temperature of egg (Celsius);

Tinc = temperature of incubator (Celsius);

Hemb = heat production of embryo at a given moment of incubation (watts),

Hwater loss = heat loss from evaporative cooling (watts); and K = thermal conduction of egg and surrounding boundary air around the egg (watts per degree Celsius). The heat balance of an animal is described by (Schmidt-Nelson, 1975).

Hemb - Hwater loss = Hrad + Hconv.......... [2] Where, Hrad and Hconv are the heat lost or gained by radiation and convection respectively (watts). Equation 1 uses the terms Hemb-Hwater loss to describe the loss or gain from an egg because they are easier to measure than either Hrad or Hconv. Heat transfer through radiation is assumed to be small because all the surfaces within the machine will be at temperatures close to (within approximately 1 c to 2 c of) the surface temperature of the egg. Kashkin (1961) estimated that 40 to 45% of the total heat loss from a hen's eggs was by radiation; however, this estimate has assumed that the total egg would be able to radiate heat to the surface of the incubator. In a commercial incubator an egg would be surrounded by other eggs at the same temperature, thereby reducing the effective radiative surface of the egg. It is therefore assumed that the main transfer of heat occurs through convention. Equation 1 contains the term H water loss because egg continually lose water through the incubation, typically amounting to 12% of the fresh egg weight between the onset of incubation and the start of piping (Ar, 1991). The phase change from liquid water to water vapor requires heat and at incubation temperature this equates to approximately 580cal/g of water lost (Schmidt- Nelson 1975). For example, a 60-g chicken egg loses approximately 0.4g of water/d, which equates to a heat loss of 232cal/d or 11.2mW. Embryo heat production can be measured directly but research showed that it can be estimated by measuring O2 consumption. Every liter of O2 consumed by the embryo is equivalent to the production of 4.69kcal of heat. At the onset of incubation, Hemb is negligible and therefore Tegg< Tinc because Hemb<Hwater loss however, at the end of incubation, Hemb>>Hwater loss and Tegg>Tinc. The result is that during the first half of incubation egg gains heat from the surrounding air, whereas during the second half of incubation, egg will lose heat. The thermal conductivity term, K, used in Equation 1 combines the thermal the conductivity of the egg (Kegg) and the boundary layer of air around the egg (Kair). Sotherland *et al.* (1987) determined values for Kegg and Kair and showed that the air boundary layer around the egg was approximately 100x greater a barrier to heat loss than the egg itself. Research also showed that the value of Kair is dependent on the air speed over the eggs and the relationship could be estimated as follows:

K= (0.97 U 0.6) M0.53, where U= air speed from 0 to either 100 or 400 m/s increased thermal conductance by approximately 2.5x and 6x, respectively.

An important consequence of the relationship between Kair and air speed is that the differential between Tegg and Tinc during the second half of incubation will become greater at slower air speeds. Meijerhof and Van Beek (1993) estimated the increase in Tegg over Tinc for eggs of different weights and Hemb at two air speeds.

2.5 Temperature In Incubators

The use of thermal conductance, K, in Equation [1] has assumed a simple incubator, which is an egg surrounded by air. However, in commercial incubators the situation is much more complicated, as each egg will be surrounded by many other eggs that may (in a single stage incubator) or may not (in a multi-stage incubator) be at the same developmental stage. Clearly the design of the incubator will have an effect on the transfer of heat between the egg and the incubator air.

Incubators require an air conditioning unit to provide heat or cooling and humidification and a fan to circulate the conditioned air through the eggs before being returned to the conditioning unit. The volume of air that passes the eggs to transfer heat can be estimated using:

(Toff – Ton) =F. Heggs/Veggs… … ………………….. [3]

Where (Toff – Ton) = the temperature rise in air flowing over the eggs (Celsius); F = factor, approximately 3.25 for incubator air at 37.5 c and 50% relative humidity; Heggs= heat production of eggs in flow paths (watts); Veggs= flow rate of air over eggs. The rise in temperature as it passes over the egg is inversely proportional to air volume flow and therefore uniform control of egg temperature within the incubator depends on uniform air movement around the eggs. The uniformity of air flow within an incubator will depend on how easy it is for the air to pass between the trays of the eggs. This may be the path of greatest resistance to air movement and air may pass around the mass of eggs, through spaces next to machine walls or between egg trolleys.

Eggs must be turned through 90°C for normal embryo development to take place and this is achieved in an incubator by tilting the egg trays at 45 c from horizontal. The effect of the turning is to reduce the space between the trays significantly from the spacing when the trays are horizontal. Also the incubator fan speeds were changed to give different air speeds over the eggs. Increasing the incubator fan speed resulted in faster air speeds over the eggs and lower air temperatures, supporting the predictions of Southerland *et al.*(1987) and Meijerhof and van Beek (1993) that air speed has a major influence on thermal conductivity. Air speed is also varied between tray locations within the machine, although only at the lowest fan speed did this result in a temperature difference between the trays. The increase in temperature at the lowest fan speed was also sufficient to depress hatchability.

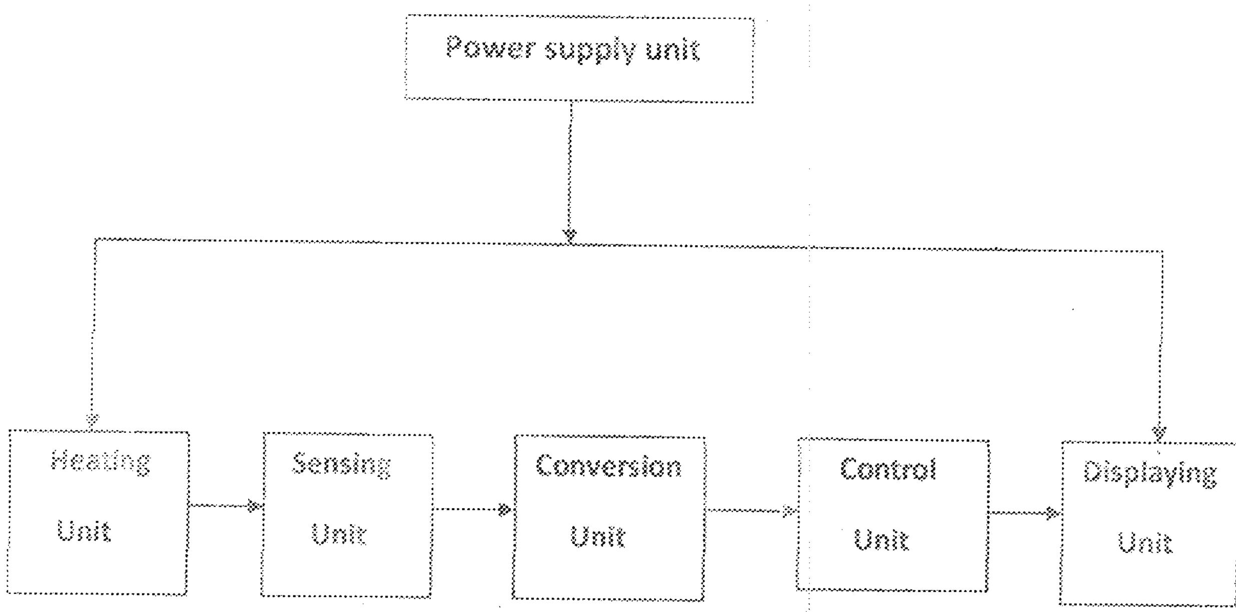
Mauldin and Buhr (1995) measured temperatures on top of eggs in a multi-stage chicken incubator and observed that temperature was on average 1 °c warmer on the trays than at the temperature controller of the incubator. Temperature on the trays also changed with time depending on the age of the eggs within the incubator. The initial effect of the movement of eggs was to lower the temperature just after transfer. An increase of approximately 0.5 c was observed, until temperature fell again at the next transfer. Which illustrate the effect that the presence and management of other eggs within the incubator can have on the temperature experienced by an individual egg. The observation of Mauldin and Buhr (1995) that temperatures recorded among the eggs can differ markedly from the operating temperature of the incubator has also been observed in a wide range of hen incubators. Maximum temperatures were recorded normally on eggs at the end of incubation and were between 0.4c to 3.1 c above the machine operation temperature. It is clear from this research that many commercial incubators were not able to maintain a uniform temperature surrounding the incubating egg, principally due to uneven air flow within the machine. This then brought about the idea of this project i.e a micro-controller based incubator which will help to a reasonable extent in combating this challenges confronting the incubator manufacturers.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

The design and construction of a microcontroller based temperature control system for egg incubator is guided by certain factors, which include temperature, humidity, ventilation, sanitation, and egg turning. It is designed to sense temperature (Heat) above a preset input value and automatically cut –off any device connected to it. This device is made up of five units consisting of different components performing certain specified tasks. It comprises of the power supply unit, the heating unit, the sensing unit (LM 35), the analog digital converter (ADC), the control unit and the display unit. Each of the models is discussed sequentially.

The block diagram of the entire circuit system is shown below.



Block Diagram Representation Of The Modules

3.1 Power Supply Unit

A 240/12v step-down transformer is connected between the bridge rectifier and the 240v AC utility supply. The 12v AC voltage was converted into a DC voltage by a bridge rectifier.

3.1.1 The Transformer

The transformer used for this project is 240/12v 500mA 50Hz step-down transformer having lesser windings on the secondary side. The output of the transformer is connected as inputs to the bridge rectifier except for the heating element that takes ac supply of 220v from the mains

3.1.2 The Rectifier

The rectifying unit is a circuit that consists of four diodes which convert the ac supply voltage to dc. This process is called rectification, it could either be a half wave or full wave rectification although the full wave is more efficient because it converts both polarities of the input to dc. The 12v is now rectified into a dc voltage.

3.1.3 The Capacitor

The capacitor connected across the circuit is meant to filter the ac ripples of the supply unit since the diode may not give a pure dc due to some impurity in the diode. For this design a 2200uf (25v) and 1000uf (16v) were used for further filtering of the dc wave.

3.1.4 The Regulator

The regulator is designed to maintain its output voltage despite any variable or fluctuation of the load. For this project 7805 type is used to produce 5v output. It helps in regulating /keeping the voltage constant (at 5v) with little variation in the supply system.

3.2 The Temperature Sensing Unit

This is the input signal to the components. It is made up of the LM35 an integrated circuit. It senses the heat from the environment i.e from the incubator and then convert it to analogue output voltage signal. It's a precision semiconductor sensor giving an output of 10mV per degree centigrade. It has a sensitivity range from zero to a hundred degree centigrade with an accuracy of about +2 c.

The time constant was chosen such that the DC output of the sensor is maintained steadily as any rapid changes in the output would produce a hard to read information.

This time constant is low enough to track the sensor output as it reduces, and to prevent an incorrect reflection of the sensed temperature. The sensor is supplied with 5v from a 7805 regulator. The output voltage could be in the range of -1.0v to 6v. Based on the above relationship, the output terminals could produce voltage from 0 – 1000mV.

In a situation where the sensor is subjected to a temperature of about 30 c, the output voltage from the sensor would be 300mV. This relationship applies to the entire temperature range with little or no accuracy of +2 c.

3.3 The Conversion Unit (Adc 0804)

The usual method of converting analogue signals into digital ones is to use an analogue to digital converter (ADC) in which this design incorporates such an idea. The presence of ADC 0804 is to convert the analogue signals generated from the sensor (LM 35) to a digital 8-bits signal that can be understood by a microcontroller. An ADC 0804 is an 8-bit successive approximation register analogue to digital converter. It has typical conversion time of 100ms and a 60 KHz clock.

The device was interfaced with the microcontroller via port 1, with two control lines,"WR and INTR" connected to P3.0 and P3.1 respectively.

The analog voltage is applied to pin 6 and the result is available at pins 11 through 18.pin 1 and 2 (chip select and read) is connected to the ground so that the chip is always enabled. Pin 7 (Vin -) is connected to the ground. The ADC 0804 includes an internal oscillator which requires an external capacitor and resistor to operate. 150pf capacitor from pin 4 (CLOCK IN) is also connected to the ground and the 10kohm resistor from pin 4 to pin 19(CLOCK R).

The pin 9 that is $V_{ref}/2$ terminal is used to achieve the desired calibration since it adjusts the sensitivity of the device. The reference voltage is usually half the expected full analogue input. In this design, the sensitivity of the sensor is 10mv/ ^oc. Therefore for an accurate calibration, the reference voltage must be in – line with the input sensor's sensitivity. When the reference voltage is at 2.5v, the analogue input coverage is 5v. The sensitivity of the adjustment is shown below:

Vin/Vref = D_{out}/256

D_{out} = 256 x Vin/Vref

BCD = (256x 0.3)/2.56

ADC Data Sheet

Pin NO	input/output or power	DESCRIPTION
1	input	Chip select line from microcontroller control
2	input	Read line from microcontroller control
3	input	Write line from microcontroller control
4	Input	Clock
5	Output	Interrupt line goes to the microcontroller
6	Input	Analog voltage (+ve input)
7	input	Analog voltage (-ve input)
8	Power	Analog ground
9	Input	Voltage reference
10	power	Digital ground
11	Output	Data output
12	Output	Data output
13	Output	Data output
14	Output	Data output
15	Output	Data output
16	Output	Data output
17	Output	Data output
18	Output	Data output
19	Input	Connect external resistor for clock
20	Power	+5v power supply to Vcc

The device was configured to run off a clock source of frequency given by the relation

$F = (1/1.1RC)Hz$

R = Resistance connected between pin 19 and pin 4

C = Capacitance connected from pin 4 to ground

Where R = 10kohm, and Capacitor = 150pf

$$F = \left(1 \Big/ 1.1 \times 10{,}000 \times 150 \right) = 606KHz$$

3.4 The Control Unit

This is achieved by using the Microcontroller. A microcontroller is a single-chip microcomputer. One chip includes the CPU, a RAM, and an I/O chip, an EPROM or EEPROM. Microcontrollers are widely use today in many areas, particularly in sophisticated machines and embedded systems. No modern electrical system will be complete without a microcontroller or microprocessor. In the scope of this project, a microcontroller is used to capture, save and display data i.e the ambient temperature in an egg incubator.

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4k-b of FLASH programmable and Erasable Read Only Memory (PEROM). The On-chip flash allows the program memory to be reprogrammed in-system or by a conventional Nonvolatile memory programmer.

By combining a versatile 8-bit CPU with flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications. The Microcontroller has four ports which are port 0, port 1, port 2, and port 3 which are explained below:

PORT 1

Port 1 consists of pins 1- 8. They are used for input output. They are bi-directional and can be address at once or bitwise. For this design they are the digital output from the ADC, (i.e P1.0 – P1.7)

PORT 2

These pins are referred to as port 2 of the microcontroller. They are bi-directional and can be used when working with functional memory. All functions of port 1 are also applicable to port 2. They are the output to the seven segment display (i.e P2.0 – P2.7).

PORT 3

They are pins (10- 17 with port number P3.0 – P3.7). they are also bi-directional and can be address bitwise. Pin (10-11) i.e p3.0 and p3.1 are the WR and INTR (start conversion and end conversion pins)

PORT 0

This pins (32 – 39) form port 0 of the microcontroller. They are bi-directional and can be address bitwise. For these design, pin 38(p0.0) and pin 39(p0.1) were connected to 2.2kohm resistor which is the base of the transistor that switches the display unit, while pin 37(p0.2) goes to the relay.

Pins 9 is the reset pin

Pins 18 and 19 are used to connect to an external crystal oscillator which determines the rate of frequency at which it processes the data.

Pin 20 is connected to the ground

Pin 40 is connected to the Vcc

Pin 31 is called external access (EA)

3.4.5 The Device Port Pin Function

Port 0 = Data Bus

Port 1 = ADC Bus

Port 2 = Control Bus

Port 3 = Push Button Bus

Port 2.0 – port 2.7 = Display for the seven segment LED

Port 1.0 – port 1.7 = Data transfer from ADC to Microcontroller

Port 0.0 – Control TX0, port 0.1 – TX1, port 0.7 – Relay switching

Port 3.0 – Read Data, port 3.1 – Interrupt

Below, in fig 3.5 is the orientation of the circuit pin configuration of the Microcontroller as used in the design of this project.

The Relay

A relay is an electromechanical device for switching on and off devices with a relatively low electrical signal compared to the arising voltages. It requires maximum current than many IC's can provide so a low power transistor is needed to switch the current for the relay coil. When an input is introduced in the coil, a magnetic field is produced in the core of the electromagnet this action causes the switch to slide. Relays are either normally open or normally closed and are available for ac or dc excitation with a coil voltage range from 5v to 230v. The primary uses of relays are for remote switching. When an over current is detected as a result of increase in temperature variation around the sensor, the relay opens under software control by a time determined by the systems software.

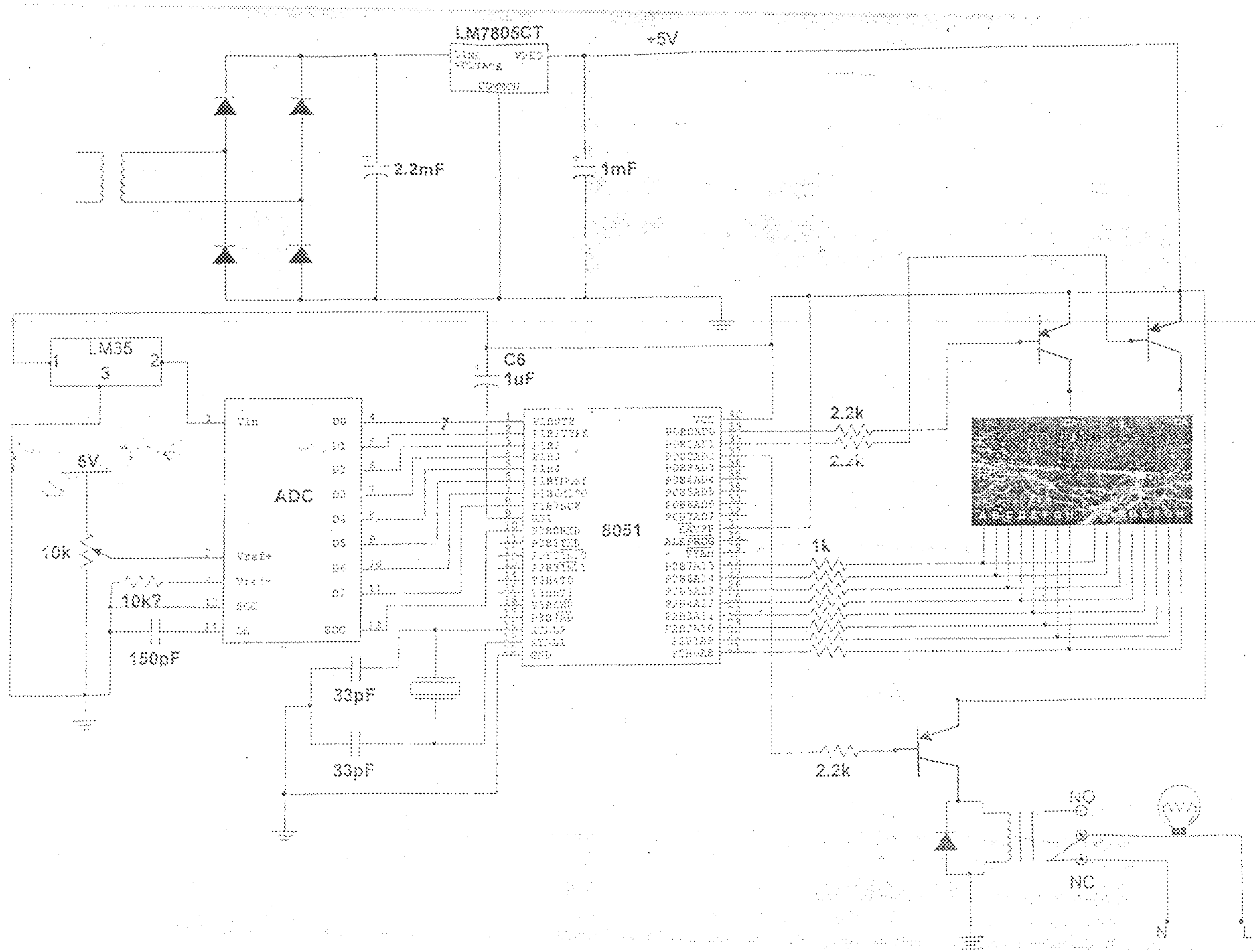
To protect against inductive kick- back, generated by relay turn-off, freewheeling diodes is placed in parallel with the relay to absorb inductive kickback generated by relay turn-off, thereby protecting the control device in the circuit as to provide a reliable guaranteed smoothing and overdrive at all possible system operating states.

3.5 The Display Unit

This unit is made up of the seven segment display. The result is shown on a seven segment LED. Common anode display LED is used for this design because of its sharp luminance. A 2-digit seven segment display of this sort is used and it was interfaced directly with the microcontroller for a visible display using the port 0 interface line from the microcontroller.

3.6 Basic Operation Of The Circuit Design

The combination of all sub-circuits yields the desired design of the microprocessor based incubator. Temperature sensor (LM35) senses temperature and convert it to analogue voltage signal. This analogue output voltage measured is proportional to the temperature it sensed (i.e for every1 degree Celsius is 10mV). This output voltage was fed to the ADC 0804 which converts the analogue voltage signal to binary equivalent in an 8-bit resolution. The output of the ADC is then fed in to the microcontroller, which decodes the binary digit and allows it to be display on a seven-segment digit display unit. The entire circuit is connected to power supply that powers the circuit. The main circuit diagram is as shown below:


LM7805CT
+5V
2.2mF
1mF
LM35
C6
1uF
5V
10k
10k?
150pF
ADC
8051
33pF
33pF
2.2k
2.2k
1k
2.2k
NO
NC
N
L

CHAPTER FOUR

TESTING, RESULTS AND DISCUSSION

4.1 Project Construction

The circuit construction of the microcontroller based temperature control system for an egg incubator was carried out in sections. On inspection of the required components, the components were first tested and subsequently simulated on the system following systematically the circuit diagram. After the simulation, the circuit was tested and transferred to the Vero board. Modular approach is used and each of the modules is soldered separately on the Vero board.

The construction was quite challenging involving care and reasoning. Both the software and the hardware implementation were also handled with care, soldering on the Vero board involves the technique of disallowing the IC's pin to bridge (a line type of Vero board is used). Therefore, the entire circuit was powered and tested accordingly.

4.2 Building The Incubator:

The following materials are needed to construct a plywood incubator

- Plywood
- Formuca
- Glass
- 200watts bulb and lamp holder
- Fan
- Water basin

4.3 Testing

Tests were performed on the completed construction so as to check its response and performance with the aim of the project. The testing basically depends on the temperature regulation/control in an egg incubator

First and foremost, it involved the plugging in of the device to the ac mains power supply and powering it "ON". This operation initiates the active part of the device. The preset temperature was initialized with the increment and decrement switch push buttons to a desired temperature value which corresponds to the display on the seven-segment display LED. The relationship is that of the LM 35 temperature sensor which 10 C to 10mV. The digital display provides an accurate and precise temperature readout that is displayed by the seven-segment LEDs. The preset buttons are well labeled for easy visual access to the temperature ranges and are used to monitor the temperature reading and preset of the device.

4.4 Discussion Of Result

The results obtained at the end of repeated tests were found to consist and matched up expected results. Thus the aim of the project was met. From the result, it was observed that the operation of the device centers on switching "ON" and "OFF" at a preset temperature while displaying the ambient temperature.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This project is a prototype of a microcontroller based temperature control for an egg incubator that displays the values of the preset ambient temperature of an egg incubator on a seven segment display as well as activating the relay i.e the heater relay. The operation is successfully designed.

5.2 Problem Encountered

1. Damage of certain IC's due to excessive heat while soldering
2. Problem of shunt circuit on the board due to bridge of wires.

5.3 Recommendations

For more sensitive and efficient system the following recommendation are made based on various aspect of the design

1. A modification in the user program to control various devices could be modified on.
2. A provision for wider temperature readout could be incorporated using both a sensor of a higher temperature rating and several multiplexed digital visual display.
3. A provision for automatic egg turner should be incorporated.

REFERENCES

1. Introduction for temperature controller, (2006 copyright) online available. http//www.omega.com/prodinfo/temperature controllers.html [2008,sept16].

2. M W. Anyakoha. New School physics for the experiment,[2008,july 12] pp44-49.

3. Temperature sensitive swtich (2002-2004-copyright).

4. www.atmel.com/at89c51/datasheet.pdf

5. www.google.com/converters/ADC8004; "About ADC Converter".

6. Robert Boylestad Lows Nashkey,[2008], Electronic device and circuit theory edition eight pp 55-58

APPENDIX

PROJECT SOURCE CODE

```
INCLUDE 89c51.inc

RB0         EQU   00H
RB1         EQU   08H
display     EQU   P2
dis_1       EQU   P0.0
dis_2       EQU   P0.1
light_pin   EQU   P0.2
adc_port    EQU   P1
adc_control EQU   P3
adc_sc      EQU   P3.0
adc_eoc     EQU   P3.1
stack       EQU   3FH
count       EQU   20H
speed       EQU   21H
value_1     EQU 22H
value_2     EQU   23H
;****************************************

            ORG 0000H
```

```
        JMP main
        ORG 000BH
        JMP refresh
main:
        CALL one_sec
        MOV PSW, #RB0
        MOV SP, #stack
        MOV speed, #00H
        MOV count, #00H
        MOV TMOD, #01H
        MOV TL0, #00H
        MOV TH0, #0FDH
        MOV IE, #82H
        CLR TF0
        SETB TR0
        MOV value_1, #00H
        MOV value_2, #00H
;****************************************
main_loop:
        CALL read_temp
        CALL show_temp
```

```
        SJMP main_loop
;****************************************
read_temp:
        MOV adc_port, #0FFH
        MOV adc_control, #0FFH
        CLR adc_sc
        NOP
        NOP
        NOP
        SETB adc_sc
        JB adc_eoc, $
        MOV R0, adc_port
        RET
;****************************************
show_temp:
        CJNE R0, #40, on_light_1
        CLR light_pin
        SJMP continue
on_light_1:
        CJNE R0, #41, on_light_2
        CLR light_pin
```

```
        SJMP continue
on_light_2:
        SETB light_pin
continue:
        CALL hex_to_bcd
        MOV value_1, R3
        MOV value_2, R4
        RET
;****************************************
hex_to_bcd:
        MOV B, #10
        MOV A, R0
        DIV AB
        MOV R4, B
        MOV B, #10
        DIV AB
        MOV R3, B
        RET
;****************************************
refresh:
        PUSH PSW
```

```
    MOV PSW, #RB1
    PUSH ACC
    INC count
    MOV R7, count
QA_1:
    CJNE R7, #01H, QA_2
    MOV speed, value_1
    CLR dis_1
    SETB dis_2
    CALL DISP
    AJMP down
QA_2:
    CJNE R7, #02H, QA_3
    MOV speed, value_2
    SETB dis_1
    CLR dis_2
    CALL DISP
    AJMP down
QA_3:
    MOV count, #01H
    MOV R7, count
```

```
        AJMP QA_1
down:
        MOV TL0, #00H
        MOV TH0, #0FDH
        POP ACC
        POP PSW
        RETI
;******************************************
DISP:
        MOV R6, speed
        CJNE R6, #00H, aas_1
        MOV display, #0C0H
        RET
aas_1:
        CJNE R6, #01H, aas_2
        MOV display, #0F9H
        RET
aas_2:
        CJNE R6, #02H, aas_3
        MOV display, #0A4H
        RET
```

```
aas_3:
        CJNE R6, #03H, aas_4
        MOV display, #0B0H
        RET
aas_4:
        CJNE R6, #04H, aas_5
        MOV display, #99H
        RET
aas_5:
        CJNE R6, #05H, aas_6
        MOV display, #92H
        RET
aas_6:
        CJNE R6, #06H, aas_7
        MOV display, #82H
        RET
aas_7:
        CJNE R6, #07H, aas_8
        MOV display, #0D8H
        RET
aas_8:
```

```
        CJNE R6, #08H, aas_9
        MOV display, #80H
        RET
aas_9:
        CJNE R6, #09H, aas_10
        MOV display, #90H
        RET
aas_10:
        MOV speed, #00H
        AJMP DISP
;***************************************
one_sec:
        MOV R2, #0FAH
loop_sec:
        LCALL one_milli_sub
        LCALL one_milli_sub
        LCALL one_milli_sub
        LCALL one_milli_sub
        DJNZ R2, loop_sec
        RET
one_milli_sub:
```

```
        MOV R1, #0FAH
loop_milli:
        NOP
        NOP
        DJNZ R1, loop_milli
        RET
        END
```

```
:02000000800B73
:10000B000806211F575D00075813F75210075200058
:10001B00758901758A00758CFD75A882C28DD28C8D
:10002B007522007523001137114A80FA7590FF7500
:10003B00B0FFC2B000000002B020B1FDA89022B032
:10004B002804C28C8009B82904C2828002D282119C
:10005B00610B228C232275F00AE884ACF075F00AD0
:10006B0084ABF022C0D075D008C0E00520AF20BF14
:10007B00010B852221C280D28111A8019D8F020BE9
:10008B00852321DC80C28111A8019D752001AFC04B
:10009B00017A758A00758CFDD0E0D0D032AE21BECE
:1000AB00000475A0C022BE010475A0F922BE020493
:1000BB0075A0A422BE030475A0B022BE040475A0D3
:1000CB009922BE050475A09222BE060475A0822259
:1000DB00BE070475A0D822BE080475A08022BE09F5
:1000EB000475A0902275210001A07AFA120106105C
:1000FB000106120106120106DAF22279FA0000D982
:02010B00FC22D4
:00000001FF
```