CHAPTER ONE

1. INTRODUCTION

1.1 The Need for Automation in Lighting Control System

Lighting is an essential component of successful commercial poultry production. Providing light for chickens has become a little more complex than just screwing in a bulb and flicking on a switch. Light is very important in poultry production, most especially during the night because it facilitates sight, stimulates internal cycles due to day-length changes, and initiates hormone release. Artificial lighting of poultry is as old as poultry farming; man has been devising means of providing light for the birds from the primitive method of using the lantern, candle, stick, gas burner and eventually to electricity today (Classen and Riddell, 1989).

As demand for poultry products increase, there is need to move from manual methods to automation. Lighting being an important factor in poultry growth, development and reproduction, needs to be automated to bring about effectiveness and proper monitoring of the system. A well designed automatic lighting system in a poultry house has beneficial effects on birds' health, its appetite, age of puberty and also allows controlling physiological growth processes, providing the best maintenance conditions and gaining the growth of all flock productivity indices (Bob, 2014). The automatic light controller has provided a means of switching ON or OFF the poultry house lamps at the correct time as decided by the farmer. The decision which depends on: stage of birds/age, period of the year, natural daylight pattern and feeding system adopted.

1.2 Economic Importance of Light in a Poultry House

Living organisms are accustomed with light-dark cycle. Any physiological variations in the light-dark regimen are known to influence several physiological parameters. Photoperiod affects productivity, health issues, immunity and sexual maturity in birds. Photoperiods govern the feeding behavior where birds eat majority of food during daytime. In most housing systems, artificial light is utilized to maximize production in pullets, layers and breeders. Light controls many vital processes in poultry. It is required for vision, rhythmicity and hormonal stimulation to control growth, maturation and reproduction. It determines the time for rest and sleep in poultry birds. The aim of any lighting program is therefore to supplement the varying natural daylight so that an even pattern of total light is received throughout the year (Abhijit and Pradhan, 2012)

1.3 Problem Statement

In Nigeria today, the agricultural sector which could have otherwise being the central of the economy, has been the most vulnerable. One of the major problems is the manual operations involved in the farming practices. Poultry farming being an essential part suffers a major effect. Manual farming practices are boring, monotonous, drudgery, time consuming, stressful, and health-costing. Because of these, people run away from the agricultural sector.

Inadequate lighting period is as bad as too much of lighting because both will result in reduction in productivity. Because human is not 100% efficient, the farmer may likely forget to either turn ON/OFF the light which can affect the productivity of the birds. Having the light ON for more than the required period as a result of humans' imperfect nature can lead to wastage of power which is not desirable in any system.

1.4 Aim and Objectives of the Study

The aim of this project is to design, fabricate and test an automatic lighting control system for a 2.0m by 1.0m by 1.0m deep liter poultry pen housing 10 broiler birds.
The specific objectives are to:

i. design and construct a 2.0m by 1.0m by 1.0m deep liter poultry pen housing 10 broiler birds;
ii. design and fabricate an automatic lighting control system for the pen house; and
iii. conduct the performance evaluation of the system in the poultry pen.

1.5 Justification

The goal of Agricultural engineering in ensuring that farmers have a fulfilling farming experience brings about the incorporation of automation into farming processes. Lighting is an important aspect in breeding of birds under intensive production and care. Manual operation of lighting in the poultry house is one of the challenges being faced by poultry farmers. This project seeks to overcome the hurdles being faced by farmers in controlling the lights in poultry houses.

The major source of growth for broiler birds is feeding; this means birds need to feed constantly to acquire some minimum weight requirement that is marketable so that the farmer can make profit. When there is no light during the night, the birds find it difficult to feed. To facilitate sight, however, there is need for an efficient lighting system. The project wants to address this important issue by constructing a system that automatically controls the lighting of the poultry house as determined by the farmer.

Electricity is one of the most important resources in this century that should be conserved because it is not enough especially in this part of the world. Wastage of power is not desirable in any system, so it is very much economical to have this arrangement so that power is not wasted during day time where manual operation is not possible or the farmer forgets to turn it OFF as it happens on several occasions resulting in electricity wastage and an increased billing.

There are several significance of the project to the birds, the farmer, farming profession and the Nigerian economy. Among which are:

i. Poultry birds enjoy constant lightning supply as needed which enhances feed intake and bring about proper growth
ii. It saves the farmer of the stress of having to wake up in the night to ON/OFF the light as may be required
iii. It requires less labour to operate since it works automatically therefore the running and opportunity cost is encouraging
iv. The principle saves energy as the system automatically turns OFF the light when not needed

v. The design is cheap and economical, thereby, it can be established as one main business since it requires less capital to organize

vi. It makes farming practices more fun, enjoyable and interesting for the farmer. This will renew the interest in agriculture.

1.6 Scope of the Project

The study is limited to the following scopes:

Different bird types have different lighting requirement. Hence, the design shall be made solely for broiler birds. The scope is limited to lighting control and does not have to do with any other electrical facilities like temperature control, water supply, ventilation, etc of the poultry house. This is necessary to ensure focus and to avoid unnecessary complexity of the project. The construction of a backup system shall not be included in this project because of the cost and technicalities involved.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Poultry Farming and the Nigerian Economy

Poultry farming is the raising of domesticated birds such as chickens, ducks, turkeys and geese for the purpose of farming meat or eggs for food. Poultry are farmed in great numbers with chickens being the most numerous. Comparison in World Farming (CIWF, 2011) estimated that more than 50 billion chickens are raised annually as a source of food, for both their meat and their eggs. In Nigeria, the poultry industry plays a major role in contributing towards addressing key national development goals and improving the standard of living of people through poverty alleviation and creating employment opportunities (Heinke *et al.*, 2015).

According to the Food and Agricultural Organization of the United Nations FAO (2011), “growing populations, economies and incomes are fueling an ongoing trend towards higher consumption of animal protein in developing countries.” In 2013, United States Agency for International Development (USAID) asserted that this trend is very likely to continue over the next few years. Therefore, the consumption of poultry and eggs will increase by 200% between 2010 and 2020 for at least some countries in sub-Saharan Africa. One African country where this trend can clearly be seen is Nigeria (Heise, *et al.*, 2015)

The popularity of poultry production can be explained by the fact that poultry has many advantages over other livestock. Poultry birds are good converters of feed into useable protein in meat and eggs. The production costs per unit remain relatively low, and the return on investment is high. Therefore, farmers need a relatively small amount of capital to start a poultry farm. Poultry meat is also very tender and acceptability to consumers is high, regardless of their religious beliefs. Also, the production cycle is quite short, so capital is not tied up over a long period. Finally, eggs, one of the major products of poultry production, are more affordable for the common person than other sources of animal protein (Ojo, 2003; Aboki *et al.*, 2013).

Rothschild (2002) explained that despite these positive aspects, poultry production has not been keeping pace with rapidly increasing domestic consumption. This lagging increase in domestic production can be explained by the fact that most producers in Nigeria still employ traditional rural poultry farming systems which is boring, monotonous, drudgery, time consuming, stressful and health-costing making people run away from the agricultural sector.

2.2 Broiler Feeding Pattern

The objective of broiler management is to achieve heavy birds with uniform weights. Broiler chicks require broiler starter feed for the first four weeks of their life. The broiler starter feed should be at least 20 percent protein, preferably 23 percent protein. After four weeks, a 19 percent protein should be fed to the birds (broiler developer or finisher) because as they mature, the rate of growth slows down and their protein needs are lower (Khare, 2008).

2.2.1 Types of Feed and Conversion Ratio

Khare (2008) described the two types of broiler feeds as below:

i. Broiler Starters

Broiler starter is in the small granule size which makes easy for the chicks to pick up the feed faster. Starter feed is designed in a very precise manner for healthy growth of the chick which carries high immunity to face the possible stresses like diseases, climate variation, vaccinations, handling etc. A bird requires 1 Kg. of starter feed to shift to finisher feed rational balance of all required nutrients is maintained in this feed so as to get faster & maximum weight gain. Most starter feeds contain medication to prevent coccidian infections

ii. Broiler Finishers

This Feed is advised after consuming 1 Kg. of starter feed till the point of disposal of the birds. This feed is designed at a very high energy level with well-balanced protein, energy ratio to get faster, & maximum weight gain with lowest ratio feed conversion.

2.2.2 Feed Conversion Ratio

Feed conversion ratio (FCR) is a measure of how well a flock converts feed intake (feed usage) into live weight. Also known as the feed to meat ratio, this number is simply the kilograms of feed given to a chicken divided by the weight of the cleaned carcass. Typical figures for growth and feed conversion ratio (FCR, kg feed per kg gain) in good commercial production are shown in table 2.1

Table 2.1 Typical Figures for Growth and Feed Conversion Ratio

Days	Weight	Feed Conversion Ratio (FCR)
0-21	900 g	1.42
21-43	2.3 kg	1.85

(Source: PoultryHub, 2017)

The implications are that there is a requirement for a very high-quality feed if maximum growth rate is to be achieved (this may not be possible or desirable in some countries due to high temperature or feed ingredients are very costly).

2.3 Disease Control in Broiler Production

Various types of poultry diseases can cause serious loss in the poultry farming business. Diseases occur due to lack of proper care and management, inadequate nutritious feeding and some other factors. Generally, diseases can be defined as 'changes of general or usual physical condition'. Almost all types of animal can be affected by different types of disease in their lifetime. Poultry birds are not exception; they also get affected by numerous diseases. These types of disease can suffer the poultry health seriously (Roys, 2017). Through vaccination, the various diseases can be prevented.

The vaccination schedule of broiler birds as given by FAO (2009) is as shown in table 2.2

Table 2.2 Broiler Vaccination Schedule

Days	Vaccine	Route
6-7	Ranikhet disease	Eye drop or nasal drop
10-12	Gomboro	Drinking water
18-21	Lasota	Drinking water
24-30	Gomboro	Drinking water

(Source: FAO, 2009)

2.4 Broiler Housing

Chickens reared for meat are called broilers. CIWF (2011) reported that commercial broiler chickens are bred to be very fast growing in order to gain weight quickly. A good housing system provides the needed facilities for optimum growth and development. Protecting the birds from predators, passersby and reduce their exposure to environmental hazards. Poultry can be reared on a free range where the birds are allowed to move from place to place. The rearing system can also be either intensive or semi intensive. In which case, the birds are kept in a housing system (FAO, 2009).

Poultry house can be open sided structure which depends largely on the prevailing climate of the area or environmentally controlled in which the birds are kept in a totally enclosed structure and subjected to optimum environmental needs. During the past twenty-five years, there has been a gradual evolution in the construction of poultry houses. This evolution has brought the poultry house from the roost in the trees, the hog and cattle pens, cast-off farm buildings, up to the individual poultry houses of all shapes, sizes and capacity. The houses have been constructed with straw, logs, stones, cement and wood of all kinds. They have been built permanent and movable (Elford, 1920).

2.4.1 Features of a Good Housing System for Broilers

FAO (2009) asserted that a good housing system for broilers must be able to satisfy the following features:

i. protect birds from adverse climatic conditions
ii. ensure easy and economic operation
iii. ensure scientific feeding in a controlled manner
iv. facilitate proper micro-climatic conditions in a near vicinity of bird
v. effective disease control measures
vi. ensure proper supervision

2.4.2 Considerations of a well Ventilated Poultry Pen

Dhia (2013) opined that the economical growing of chickens starts from the correct and adequate design of the building for the appropriate breed and the environment of the location. He stated that the designs of the poultry house for hens or broilers in some countries are not always based on engineering and scientific foundation, but on some incorrect information, and practices or lack of accurate information. For these reasons and others there is a high mortality rate. Not using scientific rules in poultry building design could create production problems, high production cost, lower returns, and wastage of different types of energy. FAO (2009) affirmed that poultry housing can be crude or elaborate as long as the factors in section 2.4.2.1 to 2.4.2.9 are considered in the design and construction:

i. Protection

A good poultry house protects the birds from the elements (weather), predators, injury and theft. Poultry require a dry, draft-free house. This can be accomplished by building a relatively draft free house with windows and/or doors which can be opened for ventilation when necessary.

ii. **Adequate Space**

Birds need adequate space for movement and exercise as well as areas to nest and roost. Space requirements vary with bed type.

iii. **Easy Access to Feed and Water**

Feeders and drinkers should be placed conveniently throughout the pen for birds' access. Place the bottom of the waterers and top lip of the feeders at the birds' back height. This will keep the feed and water clean and prevent wastage.

iv. Source of Light

There must be provision for electric light. One electric light every 40 feet at ceiling height is appropriate. Windows placed on the Southside of the coop will also be a good source of light and warmth in raining season and a good source of ventilation in dry season.

v. Ventilation

Ample air movement without a draft is essential. Fresh air brings in oxygen while excess moisture, ammonia or carbon dioxide is removed as the air moves out of the house. Well-ventilated houses must also have plenty of insulation and a good vapour barrier. Ventilation in the poultry house is necessary to provide the birds with fresh air and to carry off moisture. Since the fowl is a small animal with a rapid metabolism, its air requirements per unit of the body are high in comparison with that of other animals. A building with open sides is ideal, otherwise cross-ventilation at bird level should be allowed for in the form of floor level inlets, open in a direction to allow the prevailing wind to blow across the width of the building. Shade should be provided, especially if there is little air movement or if humidity is high. With no shade, or when confined in higher temperatures, poultry become heat stressed and irritable, and may begin to peck at one another.

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vi. **Appearance**

The appearance of any poultry house or outside run that is visible to the neighborhood should never detract from the over-all appearance of the surroundings. Weeds and trash should be removed from around all facilities. Proper landscaping can provide screening and also help muffle sounds from the birds.

vii. **Orientation**

Houses must be oriented in a direction to take advantage of prevailing airflow patterns. Orientation must also be considered relative to solar heat transfer into the building from exposed roofs or sidewalls. The broiler houses should be oriented with their long axis in an east-west direction to avoid direct sunlight falling into the building. The rule of thumb is that the long axis of the houses should be parallel to the shadow of a vertically erected pole during the hottest period (Dhia, 2013).

viii. Size

Each broiler requires one square foot of floor space in deep-litter system of rearing. So the size of the house depends on the number of birds to be reared.

ix. Length

The length of the house can be of any extent. The number of birds reared and availability of the land determines the length of poultry house.

x. **Width**

The open sided poultry houses in tropical countries should have a width not more than 22 to 25 feet in order to allow ample ventilation and aeration at the mid-portion. Sheds wider than this will not provide adequate ventilation during the hot weather.

xi. Height

The height of the sides from foundation to the roof line should be 6 to 7 feet (eaves height) and at the center 10 to 12 feet. With this size, the pen house can conveniently house 5 broiler birds from day old to maturity according to the FAO standard specifications of the spacing required as shown in the data in table 2.3

Table 2.3 Recommended Minimum Floor Space Requirement for Broiler Birds

Chicken types	Floor space (birds/$\boldsymbol{m^2}$)	Floor space ($\boldsymbol{ft^2/bird}$)
Layer	3	3.6
Dual purpose	4	2.7
Meat	4-5	2.1-2.7

(Source: FAO, 2009)

xii. **Location of Poultry House:**

Location is a very important parameter to consider in the design and construction of a well-ventilated pen house. A good location should:

i. be easily accessible.
ii. have a reliable water supply.
iii. be well drained.
iv. be at a sufficient distance from residential areas (far enough to protect human health and close enough to provide security for the birds).
v. be far away from woodland.

2.5 Description of different Parts of the Poultry Pen

The various components of a poultry pen are as given by FAO (2009). Those related to this project are described in sections 2.5.1 to 2.5.7

2.5.1 The Doors

This is the main entry/exit point of the structure. The door of a pen depends on the size of the structure. This project made use of a 2 by 2 plank frame covered with net. Both the main compartment and the control sections have a door of size 0.25m by 0.25m so that the biggest bird can conveniently be moved in and out of the structure. A padlock is provided to ensure safety of the birds.

2.5.2 The Sidewalls

The wall of the pen is made of net. The net will ensue that the needed ventilation and sunlight enters the building while the plywood at the base will provide safety for the birds from predators and passersby. This side wall prevents the birds from escaping from the pen. It also protects against theft and provides sufficient ventilation.

2.5.3 The Roof

The roof of the poultry house may be thatched, tiled, asbestos or concrete depending upon the cost involvement. Different types of roofs are Shed, Gable, half-monitor, full-monitor (Monitor), Flat concrete, Gambrel, Gothic etc. In this project, the shed roof type covered with plywood is used because it is the simplest type of poultry roof and by far the most useful and practical type of roof that can be used under different climatic conditions and for different systems of poultry keeping. The angle of inclination of the roof is 15° from the horizontal, which helps the roof to withstand stormy winds. Plywood is used for the roofing because it is generally cheap and prevents excess heating of the pen.

2.5.4 The Floor

A solid and adequate foundation is provided to support the building. The floor is made of plywood and braced under to provide adequate support. Plywood is used as the base because it is light and it can conveniently support the weight of the birds from day old to 6 weeks (maturity). On top of the plywood is sawdust to serve as litter. The floor is raised 0.35m from the surrounding level using planks.

2.5.5 The Litter

Broiler litter is the material used as bedding in poultry houses to absorb faecal waste from birds and to make the floor of the house easy to manage. Common litter materials are wood shavings, chopped straw, sawdust, shredded paper and rice hulls, and a wide range of other materials are used in different regions around the world. Saw dust is selected as the litter material because it is light, friable, non-compressible, absorbent, quick to dry, of low thermal conductivity, readily available and cheap. The FAO recommended depth for litter is between 10 to 20 cm. 10cm will be used because of the small scale of the project.

2.5.6 Water Pots and Drinkers

Neat water is required for growth and digestion in poultry birds just like in humans. The drinkers are equipment used for supplying water to the birds. This study will utilize two plastic bowls of 2.0 litres capacity each as drinkers. Plastic material is selected to ensure that the temperature of the water is not too high for the birds. It is also relatively cheaper compare to those made of iron or steel and it is readily available. They are located at a distance of 0.5 m apart to ensure that all the birds have access to the water. The 2.0 litres water pot capacity is sufficient for 5 broiler birds from day old to maturity according to the FAO standard specifications of the water need of the birds as shown in the data in table 3.2. Vaccination of the birds is also achieved by adding the vaccines to their water.

Table 2.4: Water Requirement for Pullets and Broilers Relative to Their Age

Chickens (Age)	Water Requirement ($\frac{l}{day}/bird$)
1-4 weeks of age	0.05-0.15
5-8 weeks of age	0.06-0.25
9-12 weeks of age	0.20-0.35
13-20 weeks of age	0.25-0.40

(Source: FAO, 2009)

2.5.7 Feeding Trough

Feeding Troughs are equipment used in feeding poultry birds. The food is deposited in the feeder and the birds feed from it. The amount of feeders provided for a poultry farm is based on the amount of birds available. Two feeding troughs are provided for each compartment of the house. They are made of wood and hanged at a distance of 0.8m apart with an adjustable rope to ensure that the birds can easily have access to the feed at different stages of growth and also to protect the feed from faeces. FAO (2009) suggested that a good feeder should be:

i. durable enough to withstand frequent cleaning;
ii. stable enough not to be knocked over;
iii. of the correct height and depth;
iv. bird proof (such that birds cannot get into it or roost in it);
v. equipped with a lip to prevent birds from spooning feed out onto the floor with their beaks.

vi. the height of the feed inside the feeder, which should never be more than one-third full, should be level with the back of the birds, to prevent them from scratching contaminated litter into the feeders and to limit feed wastage.

2.6 Light and Lighting

Light is an important aspect of an animal's environment. Avian species as well as mammalian species respond to light energy in a variety of ways, including growth and reproductive performance. Light is important for poultry as they are day-active species. Most of their behaviour is mediated by vision and they have a better vision in bright than in dim light (Prescott *et al*., 2003). The value of regulating the photoperiod of poultry and livestock to stimulate reproduction has been recognized for many years and is used regularly by commercial poultry and livestock farmers. Lewis and Morris (1998) noted that broiler birds require up to 23 hours of light during their first five days and up to 19 hours after then. This suggests that the natural light from the sun is not enough for the optimum production of the birds and this necessitates the use of artificial lighting.

2.7 Common Terms used in poultry Lighting

The University of Connecticut Department of animal science (2009) reported that the common terms used in poultry lighting are as described:

i. Photoperiod: Duration of light in a 24-hour period.
ii. Luminous flux: Total perceived power of light produced by the light source. The unit is Lumen (lm).
iii. Luminous intensity: Power emitted by a light source into directional solid angle. The unit is Candela (cd).
iv. Illuminance: Total luminous flux on a surface. The unit is lux (lx) and the non-metric unit is footcandle (fc).
v. Clux or galliux: Total radiant flux incident on a surface adjusted by color (measured in nanometer [nm]).
vi. Visible light spectrum: Portion of the electromagnetic spectrum that is visible to the human eye or animal eye.

vii. Photopic spectral sensitivity: Color sensitivity or sensitivity to light under bright conditions.

viii. Chromaticity: The objective measurement of the color of a light source independent of the illuminance.

2.8 Sources of Light in Poultry House

Many different types of light sources are utilized in the poultry industry, ranging from open houses under the influence of the sun to the most technologically advanced layer houses with the newest equipment without exterior light influence. Generally, the sources of light can be broadly grouped into:

i. Natural Daylight

ii. Artificial Lighting

2.8.1 Natural daylight

Natural daylight varies from place to place and also with weather. The major advantage of sunlight is that it subjects the birds to natural environmental condition and Poultry houses designed to utilize natural daylight may require little or no artificial light, saving on energy costs (Hyline, 2015).

According to researches made by Hyline (2015), sunlight is not an efficient lightning source in a poultry house because:

i. the spectral composition and intensity of sunlight changes from dawn to noon to dusk, from season to season, sunrise to sunset, and with cloud cover

ii. light intensity of changes throughout the day as light will come in from different areas of the house.

iii. light intensity is much higher from the sun than an artificial bulb, and overcoming seasonal changes in day length can be difficult. A bright sunny day can be 60,000 to 100,000 lux which is not desirable for the birds.

iv. high light intensity may cause aberrant behaviors such as nervousness, feather pulling, pecking and cannibalism.

2.8.2 Artificial Lighting

In most housing systems, artificial light is utilized to maximize production in pullets, layers and breeders. Because of this, supplementary artificial light is a commercial necessity in order to maximize production (Pradhan, 2012). Artificial lighting is a tool used in poultry production and it aims to improve food and water intake and consequent growth, and hence flock economic feasibility (Mendes *et al.*, 2010).

According to Andrews and Zimmerman (1990), the various lighting sources used in poultry production facilities for laying hens, breeder flocks and growing broiler birds are: Incandescent, Fluorescent, Metal Halide, Cold Cathode Fluorescent Light, High-Pressure Sodium lamps and Light Emitting Diodes.

i. Incandescent Bulbs

This produces light by passing an electric current through a tungsten filament, heating it to incandescence. These lamps provide light energy over the entire visible spectrum, however much of the electrical energy is converted to heat energy as infrared. They have a light efficiency of about 8 - 24 lumens per watt and a rated life of about 750-2000 hours. A tungsten-halogen incandescent lamp will last about 3000 hours with an efficiency of about 20 lumens per watt.

ii. Fluorescent Lamps

It produces light by the passage of an electric current through a low-pressure vapor or gas contained within a glass tube. The wavelengths emitted depend upon the phosphors used in coating the tube.

iii. Cold Cathode Fluorescent Light (CCFL)

This is a tubular light that works by passing an electrical current through a gas or vapor, much like neon lighting. Cold cathode lights can come in many sizes and colors, and there are many advantages over neon and fluorescent lighting. The first advantage is that cold cathode lights do not get hot. Another is that a cold cathode light is up to five times brighter than neon lighting, and it has one of the longest lives of any lighting fixture at about 50,000 hours. Unlike incandescent bulbs, the longevity of one of these lights is not shortened by the repeated action of turning it on and off.

iv. High Pressure Sodium (HPS) lamps

They discharge an electric arc through a concentrated sodium vapor producing energy across the entire visible spectrum, but with the highest intensity in the yellow, orange and red regions. These lamps have been used successfully in poultry facilities, mostly in breeder houses and turkey facilities, with peaked roofs so that light distribution is more easily controlled (Andrews and Zimmerman, 1990).

v. Metal Halide (MH) lamps

These have ratings from 32 to 1500 watts and come in three different outer bulb finishes, clear, phosphor coated and diffuse. The MH lamps emit light across the entire visible spectrum, but are considered a cool light, having a lot of blue. They have efficiencies of about 80 to 100 lumens per watt and are rated at about 10,000 to 20,000 hours of life.

vi. Light Emitting Diodes (LED)

They have been used for many applications where long life and reliability are required. Most run on low voltage (3.6 – 24 volts) and when put into an array, they can produce high light output in either a focused or wide angle beam. They come in many different colors. The LED arrays are relatively expensive, but are getting less expensive all the time. They are illuminated solely by the movement of electrons in a semiconductor material, and they last just as long as a standard transistor. Currently, LED use in broiler production has demonstrated high luminous efficiency, less power consumption, and longer service life when compared to incandescent and fluorescent lamps.

2.8.3 Blackout Training

A publication by New South Wales Department of Primary Industries (2008) presented that all young poultry are given blackout training from day old in order to accustom birds to sudden darkness. This is achieved by turning light off for between 5 and 60 minutes daily to simulate blackout conditions. If this is not done there is a very real danger of birds dying in ‘pile-ups’ on the litter if a blackout occurs anytime in the future.

Andrews and Zimmerman (1990) asserted that darkness is just as important to the health and growth of birds as is light. During the dark phase, melatonin, a hormone is released by the pineal gland. Birds provided with sufficient dark periods have fewer health related problems, including sudden death, spiking mortality and leg problems

2.8.4 Lighting for Broilers

Broilers benefit from having a defined pattern of light and dark (day and night) (Karen and Hank, 2010) creating distinct periods for rest and activity. A number of important physiological and behavioral processes follow normal diurnal rhythms. Therefore, defined cycles of light and dark allow broilers to experience natural patterns of growth, development, and behavior.

Broiler chicks can be exposed to 20-23 hours of continuous light at one and two days of age and then reduced to 18 - 20 hours of light until processed (Gerry, 2007).

2.9 Automation

Automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery of services. Present farming practices require a lot of redundant manual labour, which is tedious as well as strenuous. It is time consuming to manually look after the whole farm and livestock. Because of this, automation is the answer to Nigeria's pursuit for being a world-class industrial competitor especially in the agricultural industry. Automation is a single solution to achieve quality as well as the environmental balance required on the farm.

Frank (2013), said automation can bring about:

i. increased productivity.
ii. improved quality or increased predictability of quality.
iii. improved robustness of processes or product.
iv. increased consistency of output.
v. reduced direct human labour costs and expenses.
vi. replaced hard physical or monotonous work

2.9.1 Automatic Lighting Control

As the demand for poultry products increases, there is need to move from manual methods to automation. Lightning being an important factor in poultry growth, development and reproduction needs to be automated to bring about effectiveness and proper monitoring of the system. The major components of the automatic light control as presented by Mustafa, *et al*. (2008) are:

i. The Light Dependent Resistor Circuit
ii. Comparators

iii. Microcontroller Unit
iv. Display Unit
v. The Switching Unit
vi. The Power Supply Unit

i. Light Dependent Resistor Circuit

The LDR is the sensor that detects illumination. It is easily interfaced with a microcontroller by connecting it to the analogue inputs of the microcontroller (Mustapha *et al*, 2009). One of the pins of the LDR is connected to the ground while the other is connected to pin 30 of the microcontroller. A light dependent resistor (LDR) is a resistor whose resistance increases or decreases depending on the amount of light intensity. LDRs (Light Dependent Resistors) are a very useful tool in a light/dark circuits. When the LDR detect light, its resistance will get decreased, thus if it detects darkness its resistance will increase.

ii. Op-amp Comparators

An LM741 Op-amp comparator is selected to convert the continuous voltage obtained from the LDR to a digital form that can be read by the digital PORTbit or pin of the microcontroller. It does this by comparing the sample from the LDR network with the reference voltage purposely set to control sensitivity of the circuit to a small change in illumination. The Op-amp which already has an infinite open loop gain takes the difference and amplifies it. The output level now depends on which of the inputs is greater. If the Inverting input (LDR) is greater, the output is logically low and if it is the Non-Inverting input (reference) that is high, then the output is logically high (alldatasheets, 2008).

iii. Switching Unit

This consists of a transistor, relay, diode and a resistor. Relays are remote control electrical switches that are controlled by another switch, such as a horn switch or a computer as in a power train control module. Relays are components which allow a low-power circuit to switch a relatively high current on and off or to control signals that must be electrically isolated from the controlling circuit itself. The relay functions as a switch that turns on or turns off the light depending on the selected mode and the illumination from sunlight. To make a relay operate, a suitable pull-in and holding current (DC) has to be passed through its energizing coil. The coil has a resistance which will draw the right pull-in and holding currents when it is connected to a supply voltage. A suitable relay driver circuit with a low-power circuitry that can control the current through the relay's coil is needed and this relay driver is an NPN transistor which is used to control the coil current (Jaycar, 2009).

iv. The Display Unit

The display unit is made up of the Liquid Crystal Display(LCD) which displays the selected lighting mode and the additional number of hours the light will ON when the LDR detects darkness. It accepts binary coded hexadecimal data from the microcontroller and displays it on a 16 x2 Liquid crystal display. The 16x2 LCD has 8 data lines, 3 instruction/ Command lines, the brightness adjust pin, 2 backlight pins, a power and a ground pin, which makes a total of 16 pins on it (EngineersGarage, 2009).

v. The Microcontroller Unit

The microcontroller is a digital device that has a central processing unit (CPU), input and output peripherals all embedded on a single chip. It has many electronic circuits built into it, which can decode written instructions and convert them to electrical signals. The microcontroller will then step through these instructions and execute them one by one. As an example of this a microcontroller we can use it to controller the lighting of a street or a house by using the exact procedures. Microcontrollers are now changing electronic designs. Instead of hard wiring a number of logic gates together to perform some function we now use instructions to wire the gates electronically. The list of these instructions given to the microcontroller is called a program. There are different types of microcontroller, this project focus only on the PIC16F877A Microcontroller. This is the control unit of the project. The microcontroller reads data from a comparator and sends it to the LCD. It also performs the function of switching the relays connected to it as the case may be. The PIC16f877A is a low- power, high-performance 40 pins microcontroller. It consists of two 8 bit and one 16 bit timer. One of the main advantages is that it can be write-erase as many times as possible because it uses FLASH memory technology known as programmable and erasable read only memory (PEROM). It is also cheap, has wide range of applications, high quality and easily available (Microchip, 2003 ; alldatasheets, 2008). The microcontroller however does the functions aforementioned by following a set of instructions written by a programmer. The instruction for the automatic lighting device will be coded in C programming language.

vi. Power Supply Unit

The project will utilize a resistive power supply (transformer) which produces DC voltages at two specified levels: +5V to supply the microcontroller, LDR, Op-amp comparator, LCD and +12V to power the relay. The power supply unit (PSU) consists of a transformer, rectifier, smoothing capacitor and regulator. Before designing a PSU, a current requirement evaluation is needed to determine the specification of the power supply unit. This is done to determine the current requirement of the load (CircuitDigest, 2016). The block diagram of the power supply unit is as shown in figure 2.1

A resistive power supply typically incorporates:

i. Transformer
ii. Rectification
iii. Filtering
iv. Voltage Regulation

i. Transformer

This is an electronic device that transfers electrical energy between two or more circuits through electromagnetic induction. A 1000 Amps transformer will be used based on specification.

ii. Rectification

Diodes used for rectification should have sufficient Peak inverse voltage (PIV). The peak inverse voltage is the maximum voltage a diode can withstand when it is reverse biased. 1N4001 diode can withstand up to 50 Volts and 1N4007 has a toleration of 1000 Volts. The 1N4007 is thereby selected for rectification.

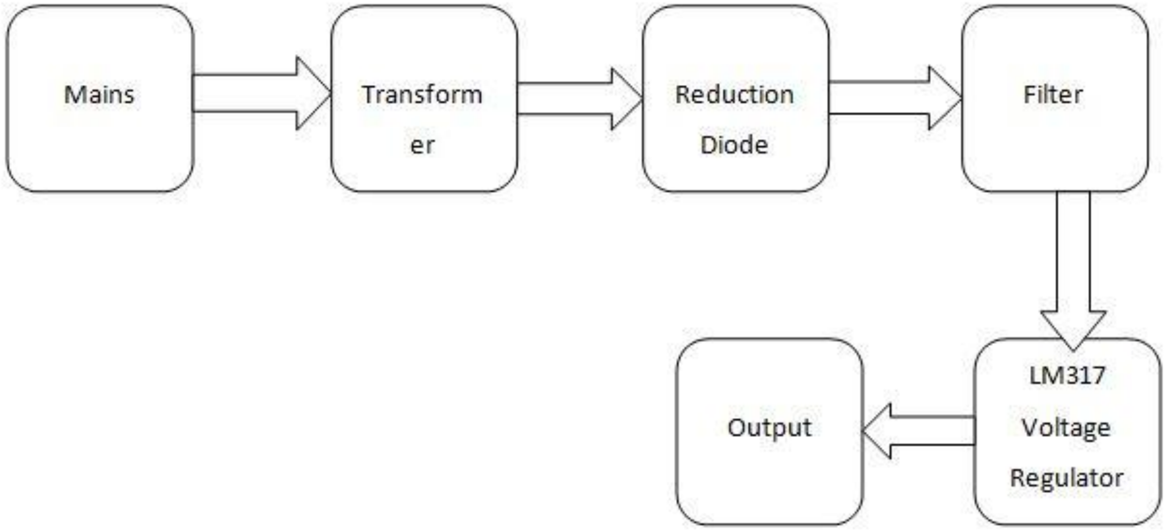

Fig. 2.1: Power Supply Unit

iii. Filtering

An electrolyte capacitor known as Smoothing Capacitor is used to generate ripple free DC. Smoothing capacitor is also called Filter capacitor and its function is to convert half wave / full wave output of the rectifier into smooth DC. The power rating and the capacitance are two important aspects to be considered while selecting the smoothing capacitor. The capacity of the capacitor selected is 1000microFarad.

iv. Voltage Regulation

The main function of a voltage regulator is to keep the output voltage at a constant value. A voltage regulator is necessary to maintain the output at a constant level so that the components do not get damaged. In the design of this project voltage regulators 7812 and 7805 were used to regulate to 12V and 5V respectively.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Description of the Poultry Pen and the Lighting Control Unit

The pen was a two halved open sided structure made of wood and covered with net to allow proper ventilation and sunlight in the structure. The need to create a control for the performance evaluation of the system necessitated the two-halved structure. Wood is selected as the material of construction because it is relatively cheaper and offers a far greater level of flexibility and modification.

The base of the pen was raised with a plank and covered with ply wood at a distance of 0.35m from the ground to reduce the activities of pests. The roof of the pen was shed type and it was covered with galvanized zinc so that it could reflect the sun.

It had two feeding troughs made of wood with volumetric capacity of 0.09 cubic meter and two waterers of 2.0 litres capacity at each sections. The door of the structure was made of wood and covered with net. The dimension of the door was 0.25-meter square making it fit to conveniently feed the birds and clean the pen.

The automatic lighting control system was designed and constructed for only one section of the structure. It had only one lighting point located at the center of the section. Because of the small size of the pen, the lighting control unit was located at the upper right corner outside the pen. This was where all the necessary lighting selections were being done by the farmer. There was also a switch in case there is need for the farmer to manually control the light. Figure 3.1 shows the schematic illustration of the pen house and the lighting control unit.

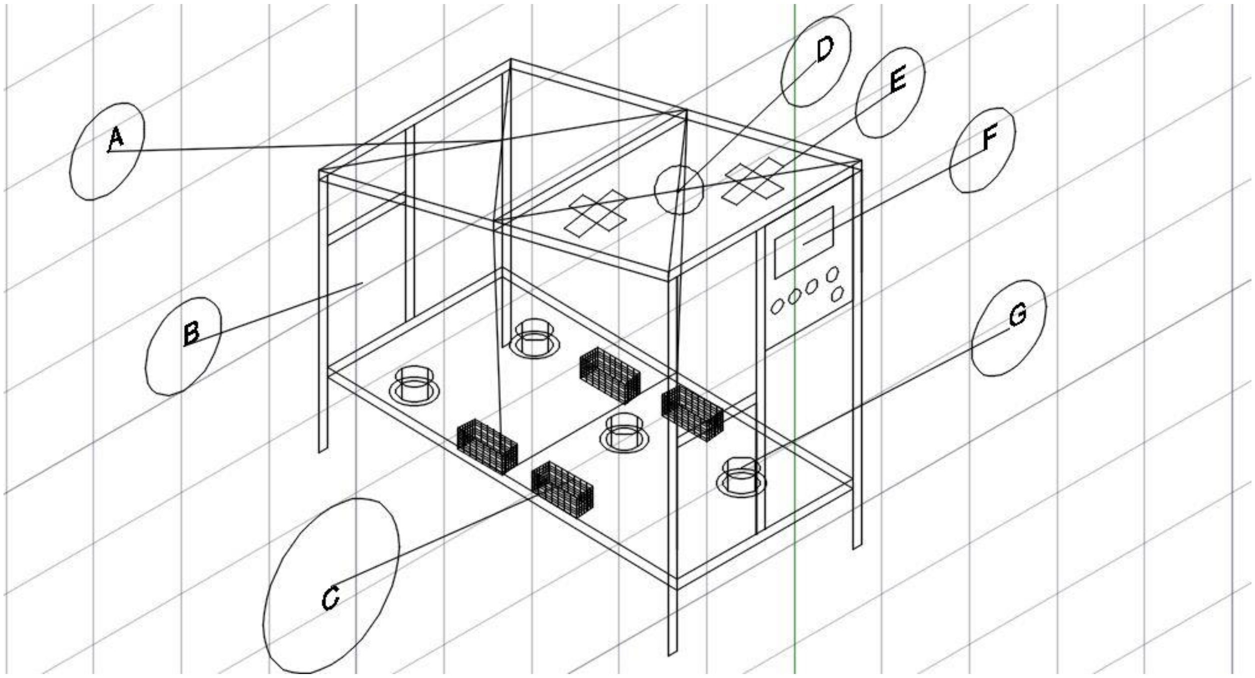

Fig. 3.1 Schematic Illustration of the Pen and the Lighting Control Unit
A: Roof , B: Door , C: Feeding Trough , D: Lighting Point , E: Fan , F: Light control system, G:Waterer

3.2 Design Considerations of the Poultry Pen

The poultry pen to be constructed followed design considerations based on standards from Food and Agricultural Organization of the United Nations (FAO) and the environmental condition of the project site as stated in sections 2.4 and 2.5 of this report.

3.3 Design Considerations of the Lighting System in the Pen House

The Lighting system considered the design considerations based on standards from Food and Agricultural Organization of the United Nations (FAO), Institution of Electrical and Electronics Engineering (IEEE), datasheets of the various components and the environmental conditions of the project site. The various considerations were as stated in section 2.9.1 of this report. In the design of the lighting control system, the following assumptions were made:

i. The LDR senses darkness same time everyday
ii. There is no blackout throughout
iii. There is no external interference with the system in terms of noise
iv. Light is the only factor affecting feeding rate
v. There is no incidence of darkness before twilight

3.3.1 The Working Principle of the Automatic Lighting Control System

The system is a user interactive microcontroller based automatic light control. It is switched ON by pressing the power button which prompts the LCD to display a welcome message followed by the lighting schedules. The light requirements of the birds have been grouped into four different schedules from day old to maturity as shown in Table 3.1. The microcontroller was programmed using C-programming language to accommodate the different schedules. A lighting program can be selected based on the need of the birds by pressing any of the four push buttons each representing different light requirement. When a button is pressed, the Light Dependent Resistor senses sunlight and sends signal to the comparator which converts the voltage value to a digital form that is then fed to the microcontroller. The microcontroller converts the comparator output to a format compatible with the LCD and the LCD displays the lighting values. The switching circuit which includes relays is operating as a switch and controls the light automatically. The Reset circuit is used to put the microcontroller into known state. The complete block diagram of the automatic light control is as shown in Figure 3.2.

Table 3.1: Lighting schedules for broiler birds

Age(week)	Expected Natural lighting hour(Approximate)	Artificial lighting hour
One	10	13
Two	10	8
Three	10	4
Four	10	6

(Source: Bolla, 2007)

3.3.2 Circuit Design

The Lighting system is divided into two parts namely hardware and software with each of the sections analyzed extensively. Figure 3.2 is a block diagram showing the different components that make up the project and appendix 4 shows the schematic view of the circuit diagram. The paragraphs below give detailed design calculations for the system.

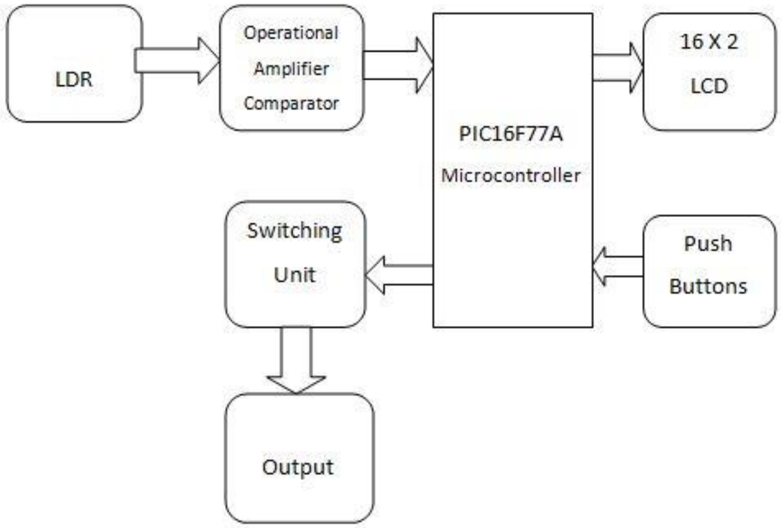

Fig. 3.2 Block Diagram of the Light Control System

3.4 Design Calculations for the Pen House Construction

3.4.1 Design of the Roof

The roof of the structure is a shred type having a right angle triangle cross section and inclined at an angle of 15° to the horizontal. Fig 3.2 shows the free body diagram of the roof.

The length of the structure= 2.0m

To find the height of the Shed roof (h)

Using,

Tan15= $\frac{h}{2}$

h=tan15$\times$ 2

h=0.2679$\times$ 2

h=0.54m

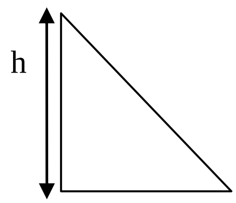

Fig. 3.3 Free Body Diagram of the Shed Roof

3.4.2 Volumetric Capacity of the Pen

Height of pen= 1.0m

Length of pen = 2.0m

Breadth of pen= 1.0m

Volumetric capacity= $l \times b \ \times h$

=2.0m^3

3.4.3 Floor Space Area Calculation

Area of the pen =$l \times b$

$= 2.0 \times 1.0$

=2.0m^2

5 birds can be conveniently housed in $1.0m^2$(from Table 3.1)

3.4.4 The Volumetric Capacity of the Water Pots

Number of water pot: 2

Size of each pot: 2.0 Litres

Total capacity= 2$\times$ $\mathbf{2}$

=4.0 Litre

Maximum water requirement of one bird per day= 0.4 litre (Table 3.2)

For 5 birds= $\mathbf{5 \times 0.4}$

=2.0 Litres

The calculated value corresponds with the FAO recommendation

3.5 Design Calculations and Selection of Components for the Lighting Control System

3.5.1 Determination of Number of Lighting Points and Illumination Required

Table 3.2: Broiler Lighting Program

Days	Light	Dark	Intensity
0	23	1	20
1-2	20	4	20
3-4	18	6	20
5-14	6	18	5
15-21	10	14	5
22-28	14	10	5

(Source: Gerry,2007)

From Table 3.2,

Average Intensity required= $\frac{\mathbf{20+5}}{\mathbf{2}}$

=12.5 Lux

Area of Pen= 1.0×1.0

=1.0$\boldsymbol{m^2}$

Illuminance= Area $\times$ Intensity

=1.0×12.5

= 12.5 Lumens

From Bulb ratings

4w= < 20 lumens (powersure,2017)

Number of Lighting Point= One 4 watts LED bulb

Therefore, just one 4w bulb is required in the pen.

3.5.2 Selection of Components

Mustapha *et al*. (2008) suggested that the following should be considered in selecting components for the lighting control system:

i. **Selection of Relay**

The type of load determines the type of relay to be used:

Rated power of the load=60W

Output Voltage=220V a.c

Therefore,

$$P = IV$$

$$I = \frac{60}{220}$$

$$I = 0.273A$$

A relay of capacity 0.273A is selected and resistor of 1 KΩ is sufficient to draw the right pull-in and holding currents calculated.

ii. **Selection of the Transformer**

100Amps, 220V transformer was selected based on specification from Datasheets of the components.

iii. **Selection of Microcontroller**

A PIC16F877A microcontroller is selected for the system based on its specifications and requirements stated below (Microchip, 2003):

Operates on a 5V supply ± 10% of the supply voltage i.e. 5V ± 10% of 5V = (5 ± 0.5) V

It is an 8-bit microcontroller with a total of 40pins. 33 pins are for input/output.

From the datasheet of the PIC16F877A, the current demand of the microcontroller is:

Icc = (0.9 × F + 25) mA where F is the frequency of the crystal oscillator.

The typical value of this Frequency as given in the datasheet of the microcontroller is 4MHz.

Icc = (0.9 × 4 + 25) mA = 28.6mA

The pins used on the microcontroller are described below.

P.12 (GND): this is the ground pin, the 0V reference.

P.11: the supply voltage pin.

P.1 (RESET): this resets the device.

P.13: this is the crystal 1 pin. It is the input to the inverting oscillator amplifier and the output to the internal clock generator circuit.

P.14: this is the crystal 2 pin. Output from the inverting oscillator amplifier

P.15– P18: Data input pins for the push buttons

P.19-to the switching circuit

P.30-to the LDR circuit

P.33- start button

P.35– P.36: Command pins to the LCD.

P.37 – P.40: Data output pins for the LCD

iv. Selection of Display Component

The 16× 2 liquid crystal display is preferred to the conventional multiplexed 7 segment display because of its ease of connection, very low power consumption and the ability to adjust its brightness.

v. Selection of Op-amp Comparator

An LM741 Op-amp comparator is selected because it is a general purpose operational amplifier and usable for a wide range of analog applications. It has a high gain and wide range of operating voltage which provide superior performance in integrator, summing amplifier, and general feedback applications.

3.6 Methods of Performance Evaluation

One of the objectives of this study is to evaluate the effect of automatic artificial lighting system on the broiler birds. Ten day-old broilers of the same source will be divided into two. One group will be subjected to natural day light condition to serve as a control for the project while the other will be exposed to automatic artificial lighting. To justify the effectiveness of this study, the following methods shall be used to evaluate the automatic artificial light performance on the broiler birds:

3.6.1 Weight Gain

The initial weight of all the birds shall be taken and recorded. The birds in either category will be subjected to the same feed and wate-700g of feed per day and 3 litres of water. Every two days, the weights of all the birds shall continually be taken and recorded for a period of 30 days using weighing balance and thereafter compared to know under which condition the fastest growth was achieved.

3.6.2 Mortality Rate

This will compare the rate of death of the birds exposed to artificial lighting and those subjected to natural day light.

3.6.3 Other Physiological Developments

Behaviours like activeness, aggressiveness, locomotive activities, scratching, fetcher picking, cannibalism, etc . This however does not have a standard of measurement and may not be included in the performance evaluation

At the end of the study, the result derived from the performance evaluation shall be discussed and represented on a bar chart.

3.7. Construction of the Poultry Pen

3.7.1 Material Survey

A market survey was carried out after the necessary design has been done. All the materials for the pen house construction are locally available and relatively cheap. The materials are as listed:

i. 2 by 4 woods
ii. 4 by 8 Ply wood
iii. Net
iv. Nails
v. Tie Rod
vi. Waterer
vii. Feeding Troug

3.7.2 Construction of the Pen House

After all the materials needed have been purchased, the design specifications and diagrams as stated in chapter three (3.2) were carefully followed to assemble the materials together. The process of construction is as explained:

i. The frame: the soil was dug at the required spacing and six 2 by 4 woods were fixed in them to form the frame of the structure. Also, eight 2 by 2 lumbers were used to hold the 2 by 4 woods firmly.
ii. Separation of the compartments: Plywood was used to divide the compartments into two equal half of dimension 1m by 1m by 1m each. The separation is done in such a way that there is no interference between the two compartments. The reason for the division has been explained in chapter three (3.1)
iii. The Base: The base of the structure was covered with the required size of plywood. The plywood is braced under with 2 by 2 woods so that it can support the weight of the birds.
iv. The doors: There are two doors, one in each compartment of the structure. The doors were made of 2 by 2 lumbers and covered with net.
v. Covering the sides: The sides of the structure are covered with the net to ensure free flow of ventilation in and out of the structure.
vi. The Roof: The roof of the structure was thereafter covered with plywood to ensure safety from environmental hazard and security of the birds.
vii. Others: This involves painting and disinfecting the pen

Once the construction was completed, the structure was moved to its permanent location i.e. under the combined harvester shed of the department. This is because, the place is relatively save, covered, close to source of electricity and possess all the attributes of a good poultry house location as listed in chapter two (2.4.1 and 2.4.2). Some pictures of the construction stages are shown in appendix 2.

3.8 Programming the microcontroller

The microcontroller (PIC16F77A) was programmed using C- programming language. The PIC16f877A is a low- power, high-performance 40 pins microcontroller. It consists of two 8 bit and one 16 bit timer. One of the main advantages is that it can be write-erase as many times as possible because it uses FLASH memory technology known as programmable and erasable read only memory (PEROM). The code is as shown in appendix 3

3.9 Construction of the Lighting Control System

The components that make up this system include a transformer, a rectifier, a voltage regulator (LM317), a light sensor (LDR), a microcontroller (PIC16F877A), one relay, a 16 by 2 LCD, 6 push buttons, capacitors, resistors, transistors, crystal oscillator and a LED indicator. After calculation of all values of the components required for the project has been done, the first operation for the commencement of the construction was to simulate the design on a computer application (Proteus) to ensure that it works well. This was then followed by testing the individual components before they were assembled on the bread board following the design specifications and circuit diagrams. After the circuit has performed satisfactorily on the breadboard, it was then carefully transferred to the Printed circuit board (pcb). The process of constructing the printed circuit board is as described below:

i. Converting the circuit diagram to a pcb design
ii. Printing out the design on a pcb paper
iii. Transferring the toner from the paper to the pcb using hot iron
iv. Etching the pcb to prevent short circuit
v. Cleaning the surface of the pcb with a nail polish to ensure that all the conducting coppers are on display
vi. Drilling the required points on the pcb
vii. Fixing and soldering the components on the pcb via the drilled holes

The following precautions were taken while soldering the components:

i. Dry joints were avoided.
ii. Application of excess heat to the circuit board was avoided.
iii. Etching was done to the portion where continuity wasn't desirable.
iv. The soldering iron bit was thinned properly before use to ensure a good job.
v. Also, the terminals of the components to be soldered were kept clean to ensure effective soldering.

After the construction of the hardware part, the microcontroller was inserted into its socket to carry out the control functions required for the project.

3.10 Construction of Casing

The choice of casing was an important part of the whole construction process as using the wrong case would affect the final temperature reading of the system. A metal casing would not be appropriate because metal is a good conductor of heat.. Hence, a plastic casing was used. Its dimensions are 155mm X 155mm X 60mm height, breadth and width respectively. The needed slots of push buttons (6), LED indicator, Liquid Crystal Display (LCD), power in and output cable were drilled to their required size. The casing of the project is made up of Polyvinyl chloride (PVC). The sides of the casing were perforated for effective cooling of the transformer. The casing was also designed in such a way that there could be easy access to the components inside.

3.11 Installing the System on the Pen

This involved bolting the device on the pen at the left upper side. The image is as shown in the appendix 2

3.12 Testing the Component

The components were first placed on a breadboard and tested. It was able to control the lighting as false darkness and lighting were done and the LDR sensing it. However, when it was soldered on the printed circuit board, it didn't work. The system was not controlling the lighting as it should. After troubleshooting was done some errors were discovered:

i. Offset error of the operational amplifier (op-amp): the output of the op-amp is a function off the comparison of the readings obtained from the instrumented environment and a set point which is expected to be a discrete value (either 5 or 0, no halfway). Unfortunately, it was not perfectly so. A 0.47v and 4.83v representing the OFF and ON state respectively was gotten. The ON state is seen by the microcontroller as ON (which is good) while thee OFF state is also seen as ON (not good, defecting the purpose of the occasion) thereby preventing the system from responding accordingly.

   Remedy: The output of the op-amp was connected in series with a 3.3Ω zener diode before given to the GPIO pin of the microcontroller. The zener diode is a pull down resistor which removes the susceptibility to noise thereby preventing false triggering.

ii. During the circuit testing, the base of the container was not properly rid of dirt, this caused a failure to occur as part of the dirt were found to be a potential conductor which bridged (short circuited) the circuit and resulted in a spark.

   Remedy:

   i. the circuit was fixed
   ii. the base was properly rid of dirt

3.13 Performance Evaluation of the System on the Birds

This is the last objective of the project. It is meant to test the effectiveness of the lighting control system on the poultry birds.

The performance evaluation (on weight basis) encompasses the under-listed stages:

i. Getting the birds
ii. Getting and quantifying the feed
iii. Putting them in the cage for adaptation
iv. Labeling them as specimen
v. Taking the initial weight of the specimens
vi. Continuous measurement of the weight

i. **Getting the Birds**

Ten broiler birds of two weeks old were gotten from a farm in Ilorin and transported to the site in a perforated carton.

ii. **Buying and Quantifying the Feed**

Feeds (starter and finisher) of half bag each (12.5kg) making a total of 25kg were bought and transported to the site. 700g of the feed was put in the feeding trough in each compartment on a daily basis.

iii. **Putting the birds in the pen for adaptation**

In order to familiarize the birds with the new environment and also to allow them recover from the transportation stress, they were kept in the compartments for four days without disturbance.

iv. **Labeling the birds as specimen**

Each of the birds was labeled. The birds in the instrumented compartment were labeled A1 to A5 while those in the controlled compartment were labeled B1 to B5. This is to ensure that the increase in weight can easily be determined.

v. **Taking the initial weights of the specimens**

The weight of all the specimens were taken and recorded in a data book.

vi. **Continuous measurement of the weight**

Every two days, the weights of all the specimens were taken for a period of 23 days. The increase in weight was noticed. The two days interval was selected to avoid over stressing the specimens (this will happen if it would have been daily).

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Discussion of Results

4.1.1 Based on Weight Gain

The results of the weight gotten from the readings are as shown in appendix 1. From the table, charts can be plotted for better comparison of the instrumented compartment and the control environment.

i. Specimen A1 and Specimen B1

Table 4.1: Comparison of Specimen A1 and Specimen B1

	Specimen A1(g)	Specimen B1(g)	Percentage Difference (%)
Initial weight	550	540	1.82
Final weight	1435	1397	2.65

From the table, it can be seen that the percentage difference between the initial weights of the two specimens was 1.82%. After 23 days of the experiment, the percentage difference rose to 2.65% indicating a positive influence of the lighting system on the birds. The chart in Figure 4.1 shows a clear view of the difference in rate of growth.

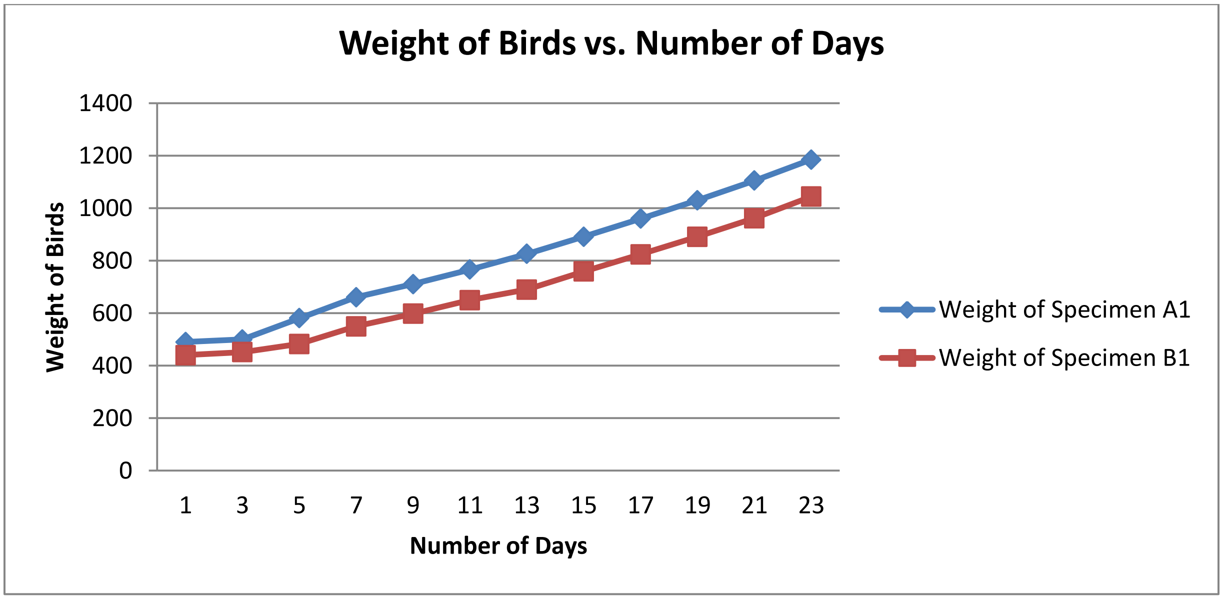

Fig. 4.1: Weights of Specimen A1 and B1 vs. Number of Days

ii. Specimen A2 and Specimen B2

Table 4.2: Comparison of Specimen A2 and Specimen B2

	Specimen A2(g)	Specimen B2(g)	Percentage Difference (%)
Initial weight	540	490	9.26
Final weight	1382	1135	17.87

From the table, it can be seen that the percentage difference between the initial weights of the two specimens was 9.26%. After 23 days of the experiment, the percentage difference rose to 17.87% indicating a positive influence of the lighting system on the birds. The chart in Figure 4.2 shows a clear view of the difference in rate of growth.

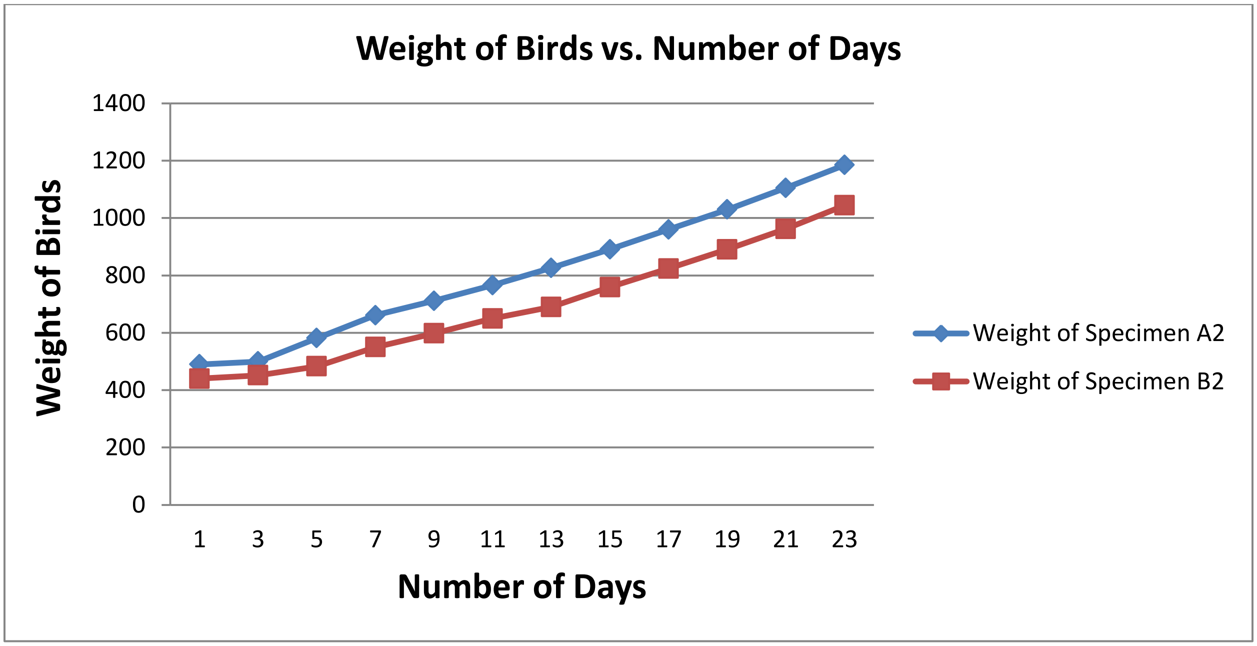

Fig. 4.2: Weights of Specimen A2 and B2 vs. Number of Days

iii. Specimen A3 and Specimen B3

Table 4.3: Comparison of Specimen A3 and Specimen B3

	Specimen A3(g)	Specimen B3(g)	Percentage Difference (%)
Initial weight	490	440	10.20
Final weight	1185	1044	11.90

From the table, it can be seen than the percentage difference between the initial weights of the two specimens was 10.20%. After 23 days of the experiment, the percentage difference rose to 11.90% indicating a positive influence of the lighting system on the birds. The chart in Figure 4.3 shows a clear view of the difference in rate of growth.

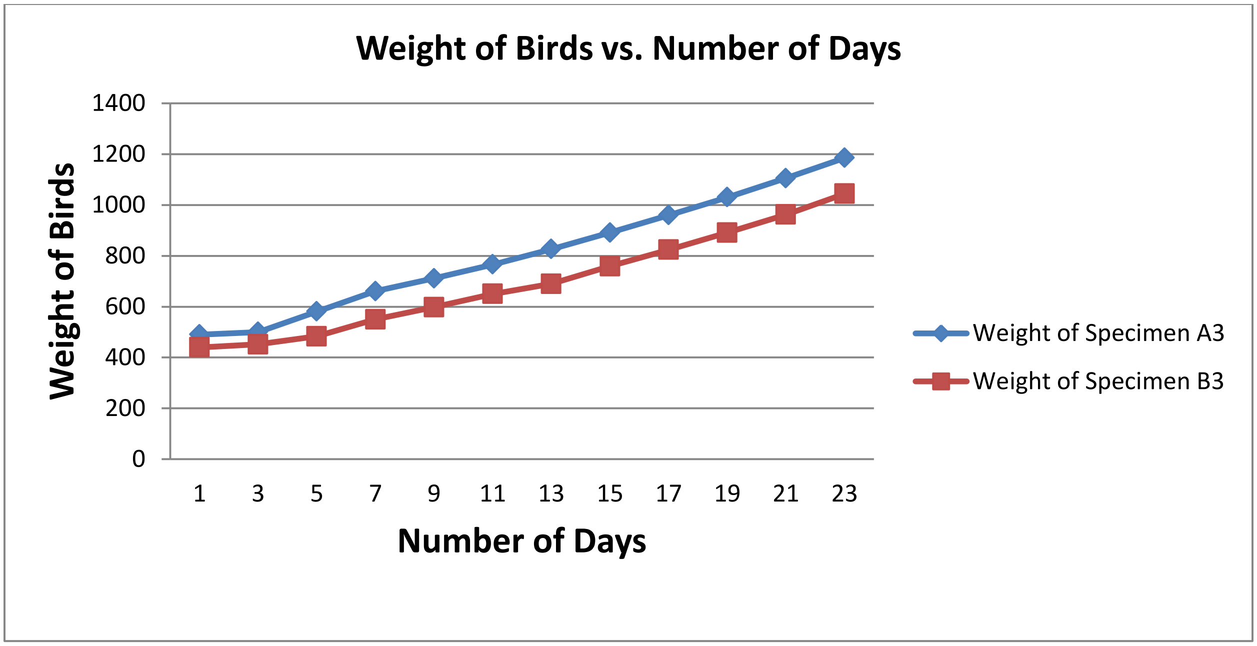

Fig. 4.3: Weights of Specimen A3 and B3 vs. Number of Days

iv. Specimen A4 and Specimen B4

Table 4.4: Comparison of Specimen A1 and Specimen B1

	Specimen A4(g)	Specimen B4(g)	Percentage Difference (%)
Initial weight	370	440	15.9
Final weight	1093	1208	9.52

From the table, it can be seen that the percentage difference between the initial weights of the two specimens was 15.9%. After 23 days of the experiment, the percentage difference reduced to 9.52% indicating a positive influence of the lighting system on the birds. This was done specifically to show that, even though the control has a higher weight initially than the instrumented compartments, with the device, the birds can still catch up. The chart in Figure 4.4 shows a clear view of how well the instrumented compartment grew to meet up with the control section despite the large difference in initial weight.

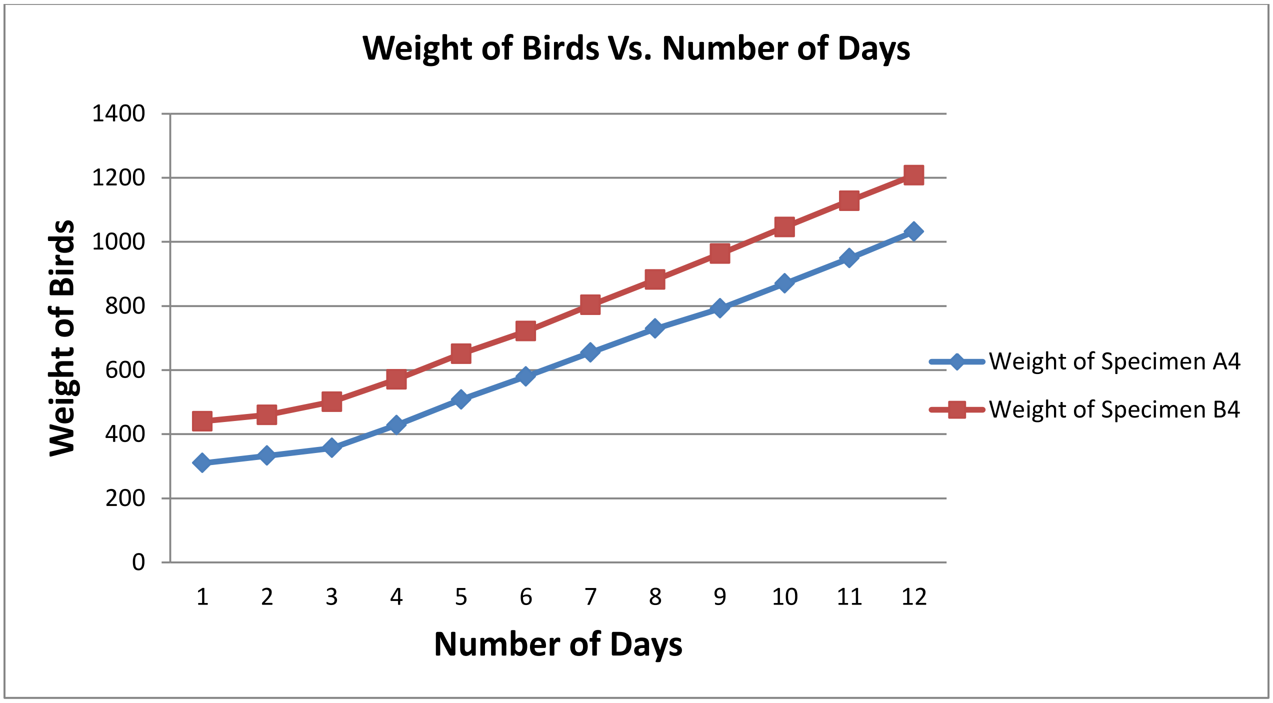

Fig. 4.4: Weights of Specimen A4 and B4 vs. Number of Days

v. Specimen A5 and Specimen B5

Table 4.5: Comparison of Specimen A5 and Specimen B5

	Specimen A1(g)	Specimen B1(g)	Percentage Difference (%)
Initial weight	350	310	11.43
Final weight	1167	1032	11.57

From the table, it can be seen that the percentage difference between the initial weights of the two specimens was 11.43%. After 23 days of the experiment, the percentage difference rose to 11.57% indicating a positive influence of the lighting system on the birds. The chart in Figure 4.5 shows a clear view of the difference in rate of growth.

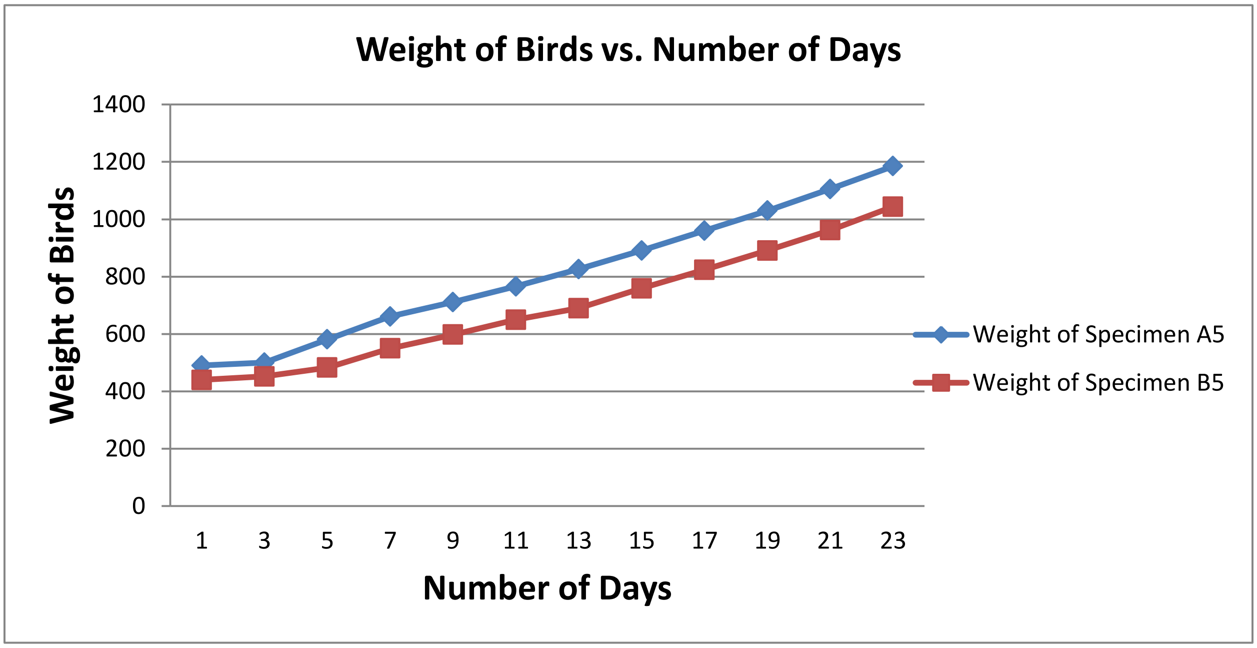

Fig. 4.5: Weights of Specimen A5 and B5 vs. Number of Days

4.1.2 Based on Mortality Rate

At the end of the project, all the ten birds were still alive. This means that zero mortality was recorded in both the control and the instrumented sections. It can therefore be said that other factors are responsible for birds' health outside the automatic lighting control.

4.1.3 Based on Activeness and other Physiological Developments

It was observed that the birds in the instrumented compartment were more active especially during the night. Automatic lighting control is therefore a good means of enhancing the activeness of broiler birds. This has an effect on their production rate.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Problems Encountered

A number of problems were encountered during the course of the design and construction of this project. The major problem encountered was getting the main components required for the project: the microcontroller, the crystal oscillator, LM714 and the LCD. Some of these had to be ordered for and this added to the cost of the project. Getting constant power supply to carry out the construction was also a challenge. Quite a few times the soldering work had to be abandoned and postponed till a later time when there will be power supply. The problem of power supply was especially encountered during the performance evaluation because the production of a backup system is outside the scope of the project.

5.2 Conclusion

The lighting control system has been designed, constructed and tested to be working perfectly and efficiently. It has also been proven to have a positive influence on birds' weight and thereby increasing farmers' income while reducing the time it takes for birds to grow from day old to maturity (market size).

The lighting control also has a very huge impact on activeness and other physiological behavious of the broilers. However, the automatic lighting control however has a very little effect on birds' mortality prevention as zero mortality was recorded in both the instrumented and control sections.

This device has combined portability, flexibility of design and low cost of production which is desirable for any consumer oriented product. This project has helped me to gain exposure on the various applications of electrical components, their characteristics and principles of operation to solve real life problems through careful design and implementation especially as it relates to Agricultural and Biological systems. It has also enabled me to appreciate the use of the data sheet, the C programming language, sensors and the evergreen world of embedded systems as they apply to Agricultural Engineering. With the project, the following beneficial effects have been derived:

i. Optimum utilization of available energy as the light only ON when needed
ii. Reduction in drudgery in operation and stress of the farmer
iii. Increase in weight and market value of the birds resulting in increased income for the farmer

Areas where this project can also be utilized aside the poultry pen are:

i. Other Livestock housing
ii. Security light in a farmstead
iii. Street lighting and farmstead lighting

5.3 Recommendations

It would be appreciated that the project be modified or improved as deemed fit by the next person who will undertake it. Some of the suggested ways to improve the system are:

i. The production of power backup system to take care of blackouts
ii. A faster and cheaper microcontroller may be used to enhance performance and reduce the production cost.
ii. Inclusion of noise removal to prevent the device from picking noise from the surroundings
iii. The use of capacitive power supply instead of the transformer power supply to release the overall weight
iv. A fully enclosed system to prevent interference from the surrounding
v. Using a bigger LCD (possibly 16 by 4) to enhance better user interaction
vi. Additional features such as being able to monitor and control the system from a remote location by utilizing the Internet of Things (IoT) could also be incorporated.

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APPENDIX 1

Data for Performance Evaluation

Table 1: Weight Gain of Specimen A1

S/N	DAY	WEIGHT (g)	WEIGHTGAIN (g)
1	1	550	-
2	3	580	30
3	5	620	40
4	7	723	103
5	9	805	82
6	11	889	84
7	13	984	95
8	15	1100	116
9	17	1194	94
10	19	1275	81
11	21	1350	75
12	23	1435	85

Table 2: Weight Gain of Specimen A2

S/N	DAY	WEIGHT (g)	WEIGHT GAIN (g)
1	1	540	
2	3	570	30
3	5	615	45
4	7	700	85
5	9	780	80
6	11	840	60
7	13	943	103
8	15	1052	109
9	17	1132	80
10	19	1214	82
11	21	1299	85
12	23	1382	83

Table 3: Weight Gain of Specimen A3

S/N	DAY	WEIGHT (g)	WEIGHT GAIN(g)
1	1	490	
2	3	500	10
3	5	581	81
4	7	661	80
5	9	711	50
6	11	766	55
7	13	826	60
8	15	891	65
9	17	960	69
10	19	1030	70
11	21	1105	75
12	23	1185	80

Table 4: Weight Gain of Specimen A4

S/N	DAY	WEIGHT (g)	WEIGHT GAIN (g)
1	1	440	
2	3	460	20
3	5	501	41
4	7	571	70
5	9	651	80
6	11	721	70
7	13	803	82
8	15	882	79
9	17	963	81
10	19	1046	83
11	21	1128	82
12	23	1208	80

Table 5: Weight Gain of Specimen A5

S/N	DAY	WEIGHT (g)	WEIGHT GAIN (g)
1	1	350	-
2	3	370	20
3	5	435	65
4	7	510	75
5	9	593	83
6	11	674	81
7	13	760	86
8	15	843	83
9	17	923	80
10	19	1004	81
11	21	1086	82
12	23	1167	81

Table 6: Weight Gain of Specimen B1

S/N	DAY	WEIGHT (g)	WEIGHT GAIN (g)
1	1	540	-
2	3	570	30
3	5	605	35
4	7	710	105
5	9	765	55
6	11	846	81
7	13	945	99
8	15	1055	110
9	17	1153	98
10	19	1232	79
11	21	1306	74
12	23	1397	91

Table 7: Weight Gain of Specimen B2

S/N	DAY	WEIGHT (g)	WEIGHT GAIN (g)
1	1	490	-
2	3	510	20
3	5	545	35
4	7	594	49
5	9	656	62
6	11	696	40
7	13	756	60
8	15	835	79
9	17	905	70
10	19	1004	99
11	21	1082	78
12	23	1135	53

Table 8: Weight Gain of Specimen B3

S/N	DAY	WEIGHT (g)	WEIGHT GAIN (g)
1	1	440	-
2	3	452	12
3	5	483	31
4	7	550	67
5	9	598	48
6	11	650	52
7	13	690	40
8	15	759	69
9	17	824	65
10	19	891	67
11	21	962	71
12	23	1044	82

Table 9: Weight Gain of Specimen B4

S/N	DAY	WEIGHT (g)	WEIGHT GAIN (g)
1	1	370	-
2	3	391	21
3	5	411	20
4	7	486	75
5	9	557	71
6	11	625	68
7	13	701	76
8	15	777	76
9	17	857	80
10	19	932	75
11	21	1012	80
12	23	1093	81

Table 10: Weight Gain of Specimen B5

S/N	DAY	WEIGHT (g)	WEIGHT GAIN (g)
1	1	310	
2	3	333	23
3	5	357	24
4	7	428	71
5	9	508	80
6	11	580	72
7	13	655	75
8	15	729	74
9	17	792	63
10	19	870	78
11	21	949	79
12	23	1032	83

APPENDIX 2

Images from Construction Processes

Plate 1: Process of Measurement and Cutting

Plate 2: Process of Fitting Components together

Plate 3: Process of Painting the Pen

Plate 4: Process of disinfecting the Pen against vectors

Plate 5: Inside view of the pen showing the liter, the waterer and the feeding trough

Plate 6: Printed Circuit Board (PCB) Making Process

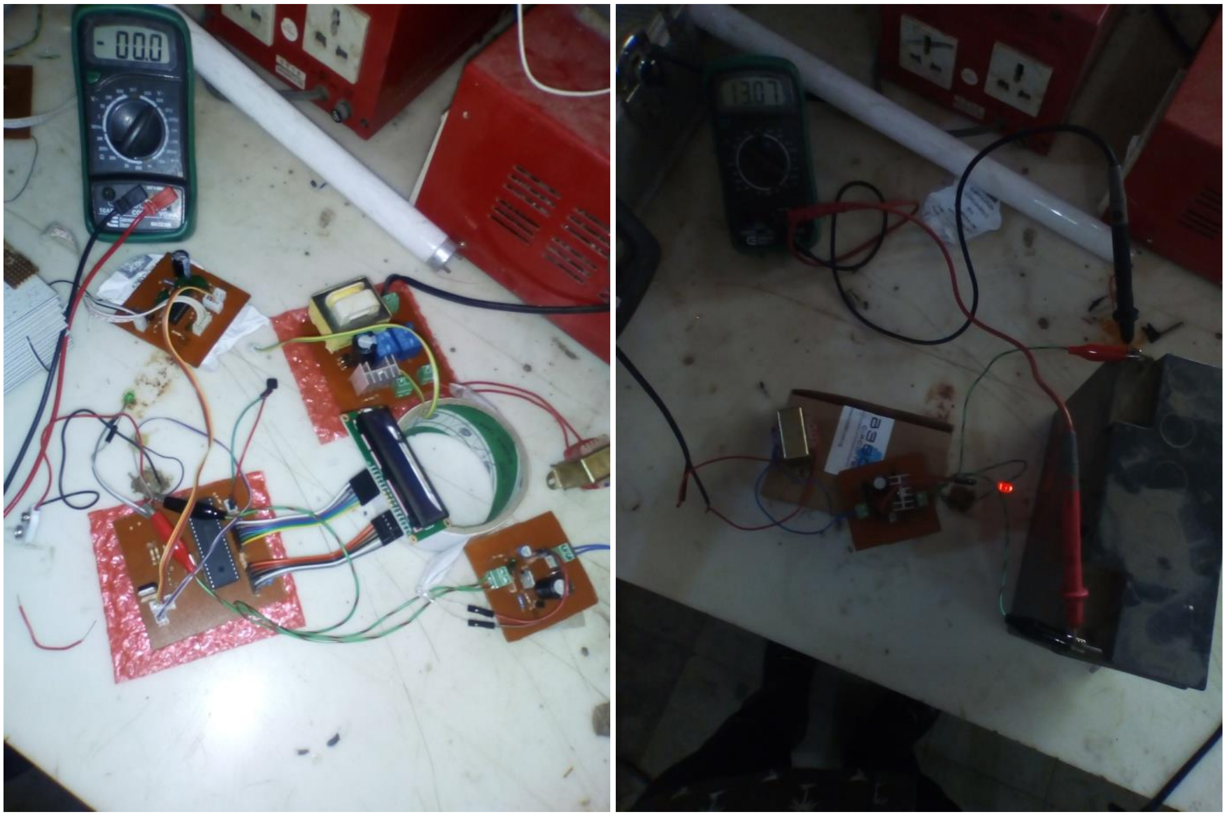


Plate 7: Fitting the components and Testing

Plate 8: Installed Lighting control system

APPENDIX 3

Programming Code

```
//lcd module interface

// Lcd pinout settings

sbit LCD_RS at RD1_bit;

sbit LCD_EN at RD2_bit;

sbit LCD_D7 at RD6_bit;

sbit LCD_D6 at RD5_bit;

sbit LCD_D5 at RD4_bit;

sbit LCD_D4 at RC7_bit;


// Pin direction

sbit LCD_RS_Direction at TRISD1_bit;

sbit LCD_EN_Direction at TRISD2_bit;

sbit LCD_D7_Direction at TRISD6_bit;

sbit LCD_D6_Direction at TRISD5_bit;

sbit LCD_D5_Direction at TRISD4_bit;

sbit LCD_D4_Direction at TRISC7_bit;

#define aux portb.f5

#define button_1 portb.f1

#define button_2 portb.f2

#define button_3 portb.f3
```

```
#define button_4 portb.f4

#define power_button portb.f0

#define load portb.f6

#define LDR portB.f7

#define light portc.f2

#define fan portc.f3

#define backlight portd.f7

void routine_1(void);

void routine_2(void);

void routine_3(void);

void routine_4(void);

void shut_down(void);

int i,t,counter;//int variables

char j,k;

const char character[] = {31,31,31,31,31,31,31,31};

const char character_2[] = {10,21,10,21,17,10,21,10};

void CustomChar(char pos_row, char pos_char);

void CustomChar_2(char pos_row, char pos_char);

void main(void)

{

mas_ref:

lcd_init();//initializes the lcd with default 16x2 settings

lcd_cmd(_lcd_cursor_off);
```

```
lcd_cmd(_lcd_clear);

load=0;

//data direction assignment

TRISD.F7=0;

TRISB=0X3F;

backlight=0;

TRISB.f7=1;

for(;;)

{

if(power_button)

{

delay_ms(100);

if(power_button)

{

backlight=1;

lcd_cmd(_lcd_clear);

lcd_out(1,6,"Hello!");

delay_ms(1000);

lcd_cmd(_lcd_clear);

lcd_out(1,2,"Please Select");

delay_ms(1000);

ref_k:

lcd_cmd(_lcd_clear);
```

```
load=0;
lcd_out(1,1,"1:Week1 2:Week2");
lcd_out(2,1,"3:Week3 4:Week4");
ref_q:
for(;;)
{
 if(button_1)//1st week
 {
lcd_cmd(_lcd_clear);
  delay_ms(50);
  routine_1();
  delay_ms(50);
  load=0;
  goto ref_q;
 }
 if(button_2)//2nd week
 {
  lcd_cmd(_lcd_clear);


  delay_ms(50);
  routine_2();
  delay_ms(50);
   load=0;
```

```
 goto ref_q;
}
if(button_3)//3rd week
{
 lcd_cmd(_lcd_clear);
 delay_ms(50);
 routine_3();
 delay_ms(50);
 load=0;
  goto ref_q;
}
if(button_4)//4th week
{
 lcd_cmd(_lcd_clear);
 delay_ms(50);
 routine_4();
 delay_ms(50);

  load=0;
  goto ref_q;
}
if(aux)
{
```

```
 goto ref_k;
 }
 if(power_button)
{
delay_ms(50);
shut_down();
goto
mas_ref;
}
}
}
if(power_button)
{
delay_ms(50);
shut_down();
goto
mas_ref;
}
}
}
}
//functions
void routine_1(void)//1st week
```

```
{
lcd_cmd(_lcd_return_home);
ref_1: lcd_out(1,1,"WEEK 1");
lcd_out(2,1,"TIME : +9 Hours");
CustomChar_2(1,16);
delay_ms(1000);
for(;;)
 {
 if(LDR==0)
 {
delay_ms(100);
load=1;
for(t=0;t<3240000;t++)
{
delay_ms(1);
 if(t==3239999)
 {
 goto ref_1;
 }
   if(button_1||button_2||button_3||button_4||aux||power_button)
 {
 goto loop;
 }
```

```
}
 if(LDR==0)
 {
 delay_ms(1800000);
 }
}
else
 {
 delay_ms(100);
 load=0;
 }
  if(button_1||button_2||button_3||button_4||aux||power_button)
 {
 goto loop;
 }
   if(power_button)
 {
 goto loop;
 }
}
loop:{}
 }
void routine_2(void)//2nd week
```

```
{
ref_2:
lcd_cmd(_lcd_return_home);
lcd_out(1,1,"WEEK 2");
lcd_out(2,1,"TIME : +7 Hours");
CustomChar_2(1,15);
delay_ms(50);
CustomChar_2(1,16);
delay_ms(1000);
for(;;)
 {
 if(LDR==0)
 {
delay_ms(100);
load=1;
for(t=0;t<2520000;t++)
{
delay_ms(1);
 if(t==2519999)
 {
 goto ref_2;
 }
  if(button_1||button_2||button_3||button_4||aux||power_button)
```

```
{
goto loop;
}
}
if(LDR==0)
{
delay_ms(2520000);
}
}
else
{
delay_ms(100);
load=0;
}
 if(button_1||button_2||button_3||button_4||aux||power_button)
{
goto loop;
}
  if(power_button)
{
goto
loop;
}
```

```
}

loop:{}

}

void routine_3(void)//3rd week

{

ref_4:

lcd_cmd(_lcd_return_home);

lcd_out(1,1,"WEEK 3");

lcd_out(2,1,"TIME : +6 Hours");

CustomChar_2(1,14);

delay_ms(50);

CustomChar_2(1,15);

delay_ms(50);

CustomChar_2(1,16);

delay_ms(1000);

for(;;)

{

 if(LDR==0)

 {

 delay_ms(100);

load=1;


for(t=0;t<2160000;t++)
```

```
{
delay_ms(1);
 if(t==2159999)
 {
 goto ref_4;
 }
   if(button_1||button_2||button_3||button_4||aux||power_button)
 {
 goto loop;
 }
}
 if(LDR==0)
 {
 delay_ms(2880000);
 }
}
else
 {
 delay_ms(100);
 load=0;
 }
  if(button_1||button_2||button_3||button_4||aux||power_button)
 {
```

```
goto loop;
}
  if(power_button)
{
goto
loop;
}
}
loop:{}
}
void routine_4(void)//4th week
{
ref_3:
lcd_cmd(_lcd_return_home);
lcd_out(1,1,"WEEK 4");
lcd_out(2,1,"TIME : +5 Hours");
CustomChar_2(1,13);
delay_ms(50);
CustomChar_2(1,14);
delay_ms(50);
CustomChar_2(1,15);
delay_ms(50);
CustomChar_2(1,16);
```

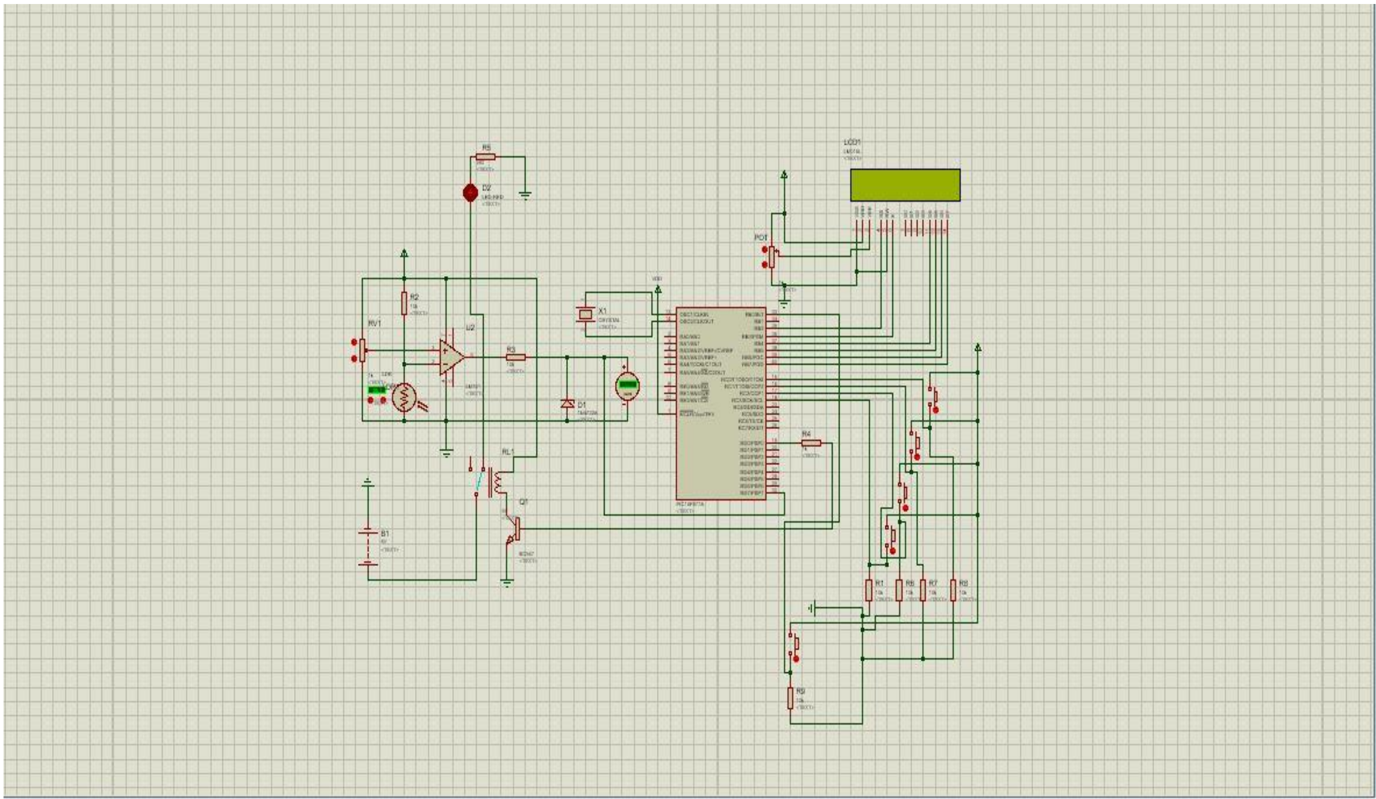
```
delay_ms(1000);
for(;;)
 {
 if(LDR==0)
 {
delay_ms(100);
load=1;
for(t=0;t<1800000;t++)
{
delay_ms(1);
 if(t==1799999)
 {
 goto ref_3;
 }
   if(button_1||button_2||button_3||button_4||aux||power_button)
 {
 goto loop;
 }
}
 if(LDR==0)
 {
 delay_ms(3240000);
 }
```

```
}
else
 {
 delay_ms(100);
 load=0;
 }
  if(button_1||button_2||button_3||button_4||aux||power_button)
 {
 goto loop;
 }
   if(power_button)
 {
 goto
 loop;
 }
}
loop:{}
}
void CustomChar(char pos_row, char pos_char) {
    Lcd_Cmd(120);
    for (j = 0; j<=7; j++) Lcd_Chr_CP(character[j]);
    Lcd_Cmd(_LCD_RETURN_HOME);
    Lcd_Chr(pos_row, pos_char, 7);
```

```
}
void CustomChar_2(char pos_row, char pos_char) {
  Lcd_Cmd(120);
  for (k = 0; k<=7; k++) Lcd_Chr_CP(character_2[k]);
  Lcd_Cmd(_LCD_RETURN_HOME);
  Lcd_Chr(pos_row, pos_char, 7);
}
 void shut_down(void)
 {
 lcd_cmd(_lcd_clear);
 delay_ms(100);
 lcd_out(1,4,"Goodbye...");
 delay_ms(500);
 lcd_cmd(_lcd_clear);
 load=0;
 delay_ms(1000);
 backlight=0;
 }
```

APPENDIX 4

Circuit Diagram of the Lighting Control System



Appendix 5

Bill of Engineering Measurement and Evaluation (BEME)

S/NO	ITEM	UNIT PRICE (Naira)	QUANTITY	AMOUNT
1	Plywood (4 by 8)	3000	2	6000.00
2	Net	250	5 yards	2500.00
3	Nail (1.5 inches)	200	2	400.00
4	Nail (2.5 inches)	200	2	400.00
4	PIC16F877A	850	1	850
5	Capacitor (1,000µF)	150.00	2	300.00
6	Capacitor (10µF)	50.00	2	100.00
7	Resistor ($^1/_4\,W$)	5.00	20	200.00
8	Relay(12V, 10A)	100.00	1	100.00
9	Casing	1,000.00	1	1,000.00
10	Indicator(LED)	20.00	1	20.00
12	PCB	500	1	500.00
13	Soldering lead	240	1	240
14	Connecting wires	70.00	2	140.00
15	Buttons	30.00	6	180.00
16	IC socket	40.00	2	80.00
17	Ribbon cable	250.00	1	250.00
18	Adhesives	100.00	2	200.00
19	LDR	80.00	1	80.00
20	4MHz crystal oscillator	80.00	1	80.00

21	22pF capacitors	30.00	4	120.00
22	LM317Voltage regulators	200.00	2	400.00
24	Bolts and nuts	100	1(dozen)	100.00
25	LCD	1000	1	1000.00
26	Transformer	1200	1	1200.00
27	LM741 Op-Amp	80	1	80.00
28	Lamp Holder	100	1	100.00
29	Bulb	250	1	250.00
30	Broiler Birds	500	10	5000.00
31	Feed(Starter)	4000	0.5 bag	2000.00
32	Feed (Finisher)	4000	1 bag	4000.00
33	Drugs	1000	1	1000.00
34	Wood shavings	100	3 bags	300.00
35	Pad lock	150	2	300.00
36	Miscellaneous	5000		5000.00
	TOTAL			34,470.00