SECTION 4.0 DESIGN AND IMPLEMENTATION

In this section, we detailed the design and implementation process of the smart automatic eggs incubator. We documented the mathematical analysis of the design process, the consideration and selection of the materials for the design of the incubator, and the consideration of the factors that we intended to optimize. We also outlined the process involved in the implementation of the design methods to realize the working incubator and other vital functional parts of this project. The section comprises of the design of the physical incubator structure, the electrical connection, the selection of appropriate components for this project, the connection of the embedded components and the development of the mobile application.

4.1 THE INCUBATOR STRUCTURE

The incubator structure is the physical structure that houses all other physical components pertaining to the design of the incubator. It is the structure which provides the chamber for the eggs during the whole incubation period.

The incubator structure design involved separately designing the individual part that will be put together to realize the complete incubator structure. Some of the individual parts of the incubator structure design which will be further detailed in the documentation below include the, tray support, door panel, back panel, side panels, top and bottom panel. These individual parts have been designed with specific design details in mind.

4.1.1 TRAY SUPPORT

As can be seen in the figure below, the tray support is considered as the skeleton of the incubator structure. The tray support is the frame that supports the trays on which the eggs are placed in the incubator chamber. It also gives support to the incubator structure as a unit. The tray support as some specific parts labeled with some capital alphabets. These alphabets are the letters A, B, C, and D.

4.1.1.1 A – Vertical Frame

The part of the tray support labeled A is the vertical frame. The vertical frame is the part of the tray support structure which holds the tray holders that contain the egg in place. The vertical frame sits on both sides of the tray holder with a nob connecting the frame and the trays together in a manner that allows free motion. The connection is firm but slightly spaced to prevent friction between the try and the frame which will impede frame movement of the trays during turning of the eggs. The vertical frame is 80cm in height and is spaced to accommodate the dimension of the trays accordingly.

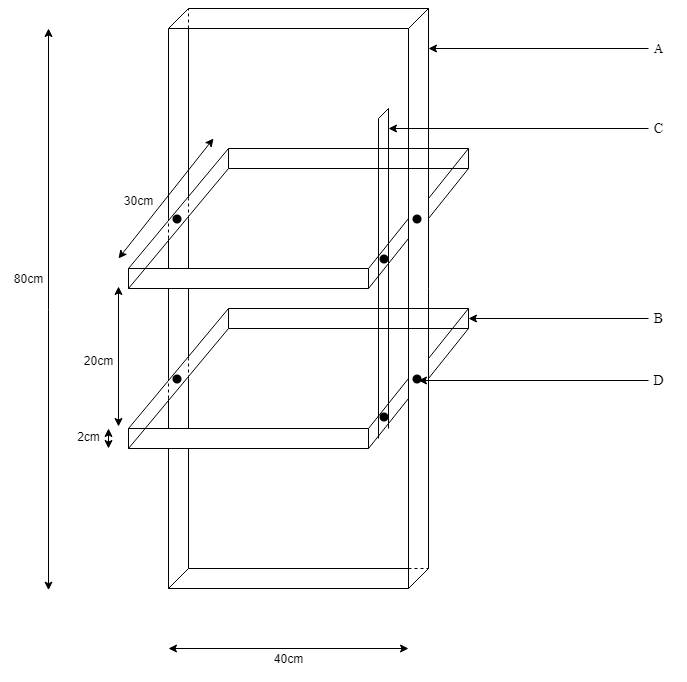


Figure – Tray Support

4.1.1.2 B – Tray Holder

The tray is the part of the tray support structure which is designed to hold the eggs during incubation. The tray holder is connected to the vertical frame to hold it in place. This connection is aided by nobs that connect these two components in a manner that allows free movement. The tray holders are 40cm x 30cm in dimension. There are two tray holders in our prototype which are separated by a distance of 20cm. The tray holders are connected to a structure labeled C. This is to coordinate simultaneous movement of the tray holders during turning of the eggs when incubation is taking place.

4.1.1.3 C – Moveable Bar

The moveable bar connects the tray holders together. The connection is made possible by the nob. The moveable bar is connected to the tray holders in a manner that allows movement of the tray holders. There is a tiny space provided in between the moveable bar and the tray holders too permit easy movement of the tray holders during the up and down movement of the moveable bar when the eggs are being turned. This component of the tray support enables the movement of all trays at the same time when the eggs are being turned.

4.1.1.4 D – Nob

The nob is the part of the tray support that allows us to connect to individual components together. It is used to connect the tray holders to the vertical frame and the moveable bar respectively. There is however a technical consideration during this connection to connect the individual components in a manner that allows easy movement to reduce friction. The nob can be a screw, nail or any structure that can connect two individual components together in order to allow movement between these components.

4.1.2 DOOR PANEL

The door panel is the opening and close to the incubator structure. It has a transparent window which is made from any transparent material which has the capacity to withstand heat energy for long hours. The transparent window enables sight into the incubator during incubation without having to open the incubator. It has a position for locker to lock the incubator from outside interference. The door pane also has a handle for easy opening and closing. The dimension of the door panel is (40cm + 2Xcm + 2Ycm) x 80cm where the variable X is the thickness of each side of the vertical frame and the variable Y is the thickness of the wedge on the side panel as will be shown later. The door panel is designed to cover the dimensions of the tray support as well as the wedges which are attached to each of the side panels to create space for electrical wiring inside the incubator chambers. The diagram of the door panel is as illustrated by the figure below.

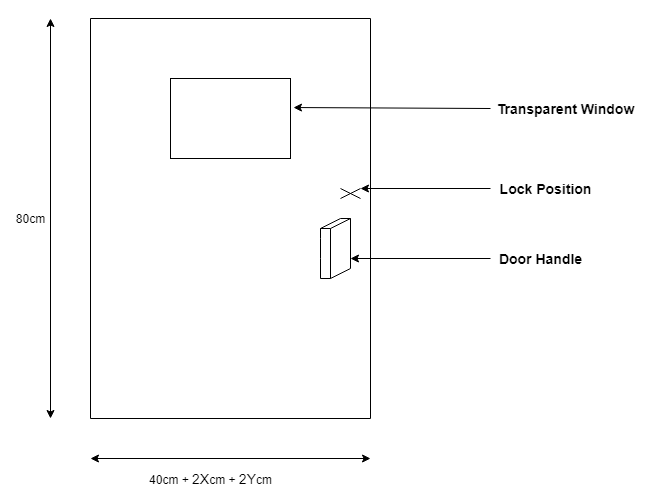


Figure – Door Panel

4.1.3 BACK PANEL

The back panel as suggested by its name encloses the back of the incubator structure. The back panel is intended to cover the dimensions of the tray support, the wedges on the side panels and the thickness of the side panels. The dimension of the back panel is (40cm+2Xcm+2Ycm + 2Zcm) x 80cm where X is the thickness of each side of the vertical frame, Y is the thickness of the wedges on each side panel and Z is the thickness of the side panels. The back panel has perforations at the top left and right regions. These perforations facilitate ventilation by enable the exchange of air between the incubator chamber and the surrounding of the incubator structure. Warm air leaves form inside the incubator through the perforations and relatively cold air from the surrounding enters the incubator through these perforations. This aids in temperature control. The figure below illustrates the diagram of the back panel of the incubator structure.

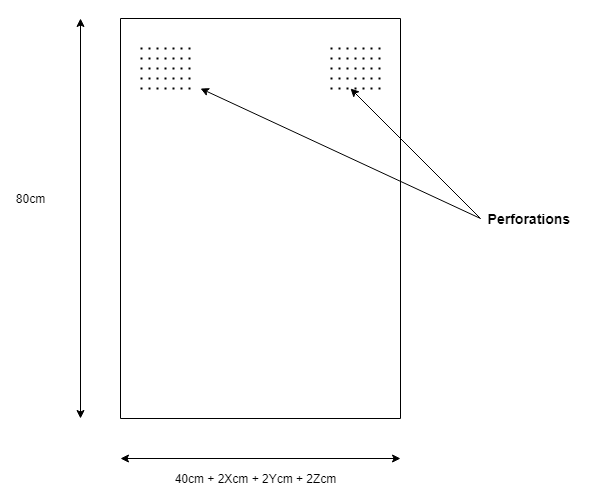


Figure – Back Panel

4.1.4 SIDE PANELS

There are two side panels, respectively, the left panel and the right panel to enclose the sides of the incubator structure. Each side panel has a dimension of 40cm in width and 80cm in height. There are two wedges on both the left and right panels. These wedges support the tray support structure and creates a space between the tray support and each side panel. The space provided by the wedges create room for wiring elements during electrical connections. It is a design intention to provide means for easy wiring. These figures illustrate the left and right side panels.

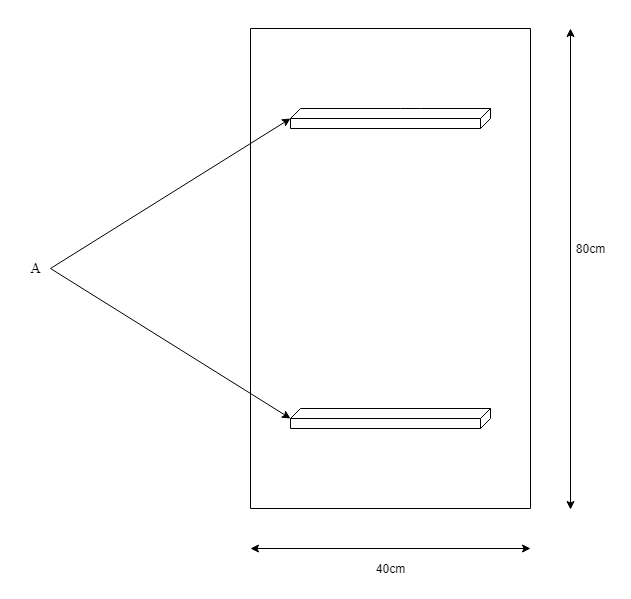


Figure – Left Panel

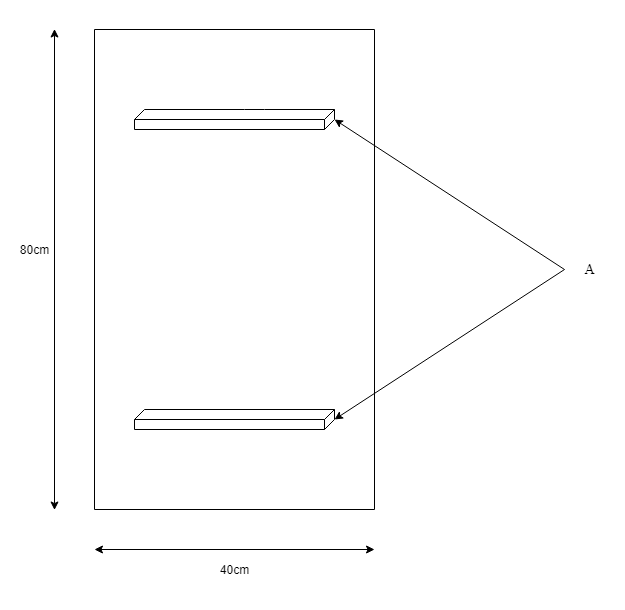


Figure – Right Panel

4.1.5 TOP AND BOTTOM PANEL

These panels enclose the top and bottom of the incubator structure. The top and bottom panels are of the same design and dimensions. These panels cover the dimensions of the tray support, the wedges, the side panels, the door panel and the back panel. The dimension of the top as well as bottom panel is (40cm + Xcm + Ycm +Zcm) x (40cm + Qcm + Rcm) where X is the thickness of each side of the vertical frame, Y is the thickness of the wedges on the side panels, Z is the thickness of the side panels, Q is the thickness of the door panel, and R is the thickness of the back panel. The figure below represents the illustration of both the top and bottom panel as they equivalent in design.

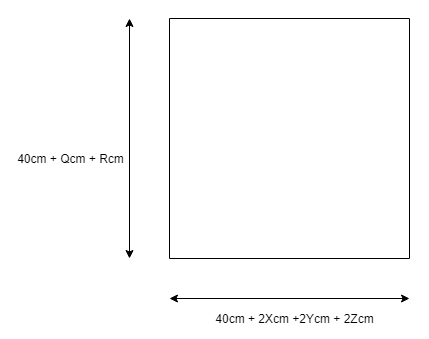


Figure – Illustration of top and bottom panel.

4.2 ELECTRICAL WIRING SCHEMATIC

The electrical wiring schematic shows how the various electrical components are connected in the incubator. It basically illustrates how electrical power is supplied to the electrical components. This diagram does not detail how the other embedded components are connected to the microcontroller but gives an overview of how the power supply of from the main power source is distributed to the electrical components based on the power rating of each component. The detailed connection of components to the microcontroller is shown later in the connection of the embedded device. The connection to the microcontroller as well as the relays do not exhibit the detailed configuration of these components. The figure that follows shows the electrical wiring in the design of the incubator.

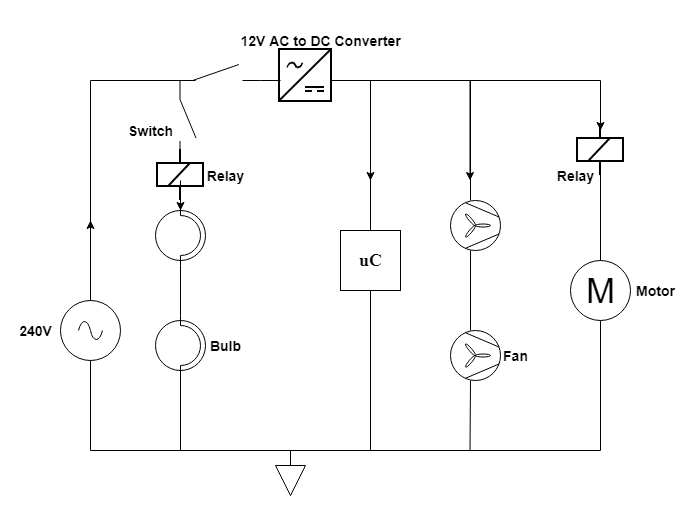


Figure - Electrical Wiring Schematic

4.2.1 Heating Effect of Electric Current

When Current flows through a conductor, heat energy is generated in the conductor. The heating effect of an electric current depends on three factor:

The resistance of the conductor. A higher resistance produces more heat.

The time t, for which the current flows. The longer the time of flow, the larger the amount of heat generated.

The amount of current, I flowing through the conductor. A higher amount of current produces a larger amount of heat.

The heating effect produced by an electric current, I through a conductor of resistance, R for time, t is given by Joule’s equation of electrical heating. This is represented by the mathematical equation: H = I2 x R x t.

The amount of heat energy generated is given by the electrical power dissipated for time, t

H = V x I x t = P x t

From, the Joule’s equation of electrical heating, we realized that the higher the voltage and resistance rating of the heating element of choice, the more effective it is to attain the optimum temperature required for the incubation of fertile eggs.

4.3 MATERIALS AND COMPONENTS SELECTION

The selection of material for the fabrication of the incubator was influenced by the following factor:

Availability: We looked for materials that were available locally to speed up the implementation process. Materials that were readily available were given preference after careful analysis of other key factors that influenced the materials selection process.

Cost: The selection process was greatly influenced by the cost of the material. One of our main objectives for this project is to design and implement an incubator which is affordable.

Strength of material: In order to meet the durability goal of the project, the materials used for the fabrication of the incubator were carefully chosen based on their strength.

Thermal property of material: Of higher priority of consideration for design during the selection period was the thermal property of the material. The performance of the incubator would be greatly influenced by the heat capacity and conductivity of the design material. A material that is a good conductor of heat is not a good choice for this project. If a conductive material is chosen for the purpose of its strength, then the inside walls of the incubator should be sealed with non-conductive materials to prevent excessive heat loss.

4.3.1 MATERIALS AND COMPONENTS SELECTED

- Wood   
- 100W, 240V Bulbs

- Stepper Motor Nema17

- L298N Motor Driver

- Wire Mesh

- Screws



