BRAC UNIVERSITY

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Department of Electrical and Electronic Engineering

BSRM School of Engineering

Project Title:

Incubator Box with Automated Temperature Control

Assignment-01

Semester: Fall 2023
Course Code: EEE305
Course Title: Control Systems

Section: 02

by

Group: A

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Abstract:

Incubators used in hospital and laboratories are designed to provide the optimal environment for cell growth. Since proteins are extremely sensitive to environmental deviations, a temperature difference by as little as 6°C from the body temperature of 37°C, have a negative impact on cell health. If too cold, cell growth slows and if too hot, sensitive proteins begin to denature. Not only temperature needs to be controlled, also humidity, carbon dioxide and oxygen levels are important factors. Our Temperature Box can be used in this proper application of limiting the temperature of the incubator box.

Introduction:

The primary function of an incubator is to endow a controlled, contaminant-free environment for safe and reliable work with cell and tissue cultures by regulating conditions such as **temperature**, **humidity**, and **CO_2**. Laboratory incubators are fundamental for the growth and storage of bacterial cultures, cell and tissue culture, biochemical and haemato-logical studies, pharmaceutical work and food analysis.

Incubators are often deployed in modern research laboratories to preserve a stable atmosphere for processes such as growing cells and microbiological cultures and incubating antibodies and cells for fluorescence microscopy. It is used for growing cell cultures, reproduction of germ colonies with subsequent germ count in the food industry, reproduction of germ colonies and subsequent determination of biochemical oxygen demand in wastewater monitoring, reproduction of microorganisms such as bacteria, fungi, yeast or viruses; breeding of insects and hatching of eggs in zoology, controlled sample storage and in growing of crystals/protein crystals. An incubator typically ranges from **15.6 to 48.9** degrees Celsius. We can introduce our Temperature box limiting the temperature to 15.6 to 48.9 degrees and make it an automated **Closed Loop system**.

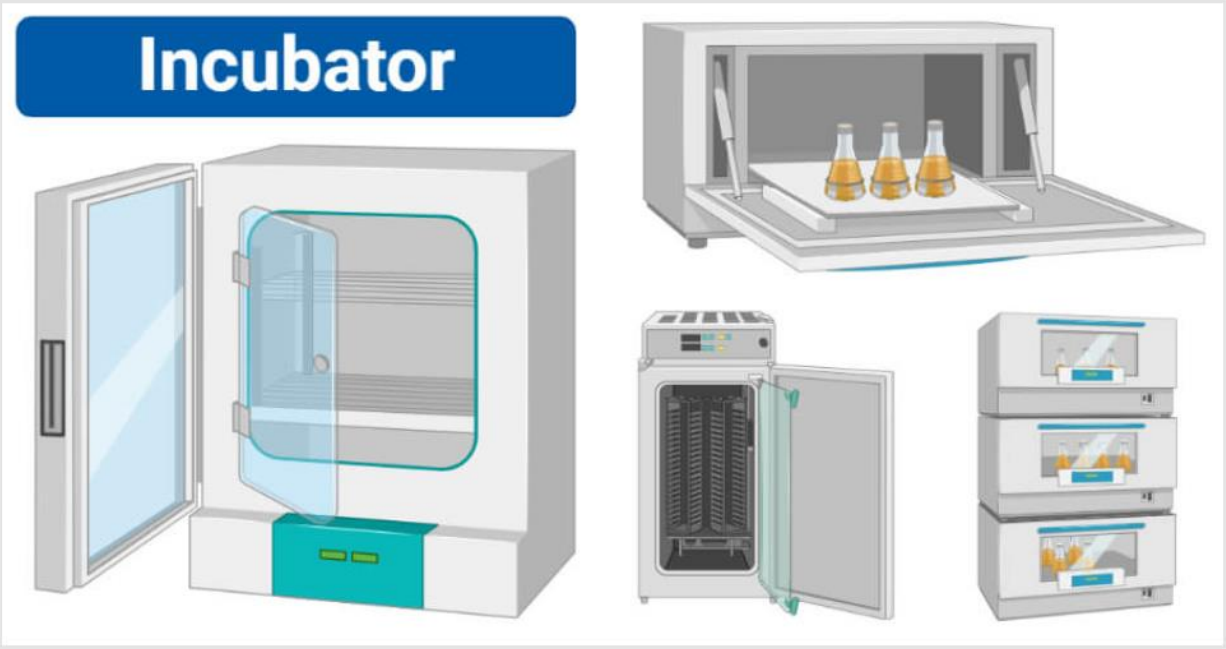
Vision:

The main goal of an Incubation Box is to limit the temperature between a certain level which is 15.6 to 48.9 degrees we can introduce our Temperature Box in this scenario. The Temperature box works at some certain conditions which are,

- **ON** for $V_T \leq V_L < V_H$
- **OFF** for $V_T \geq V_H > V_L$
- **UNCHANGED** for $V_L < V_T < V_H$

The Incubator keeps the temperature at an optimal stage between 15.6 to 48.9 degrees thus we can limit our V_L & V_T accordingly. The purpose of this limiting the temperature will help us to keep the microbiological particles safe and sound. The highest temperature will allow a cooler to be turned on and make the temperature un between the optimal stage. For the temperature box we can use the DS18B20 Digital Circuit.

Project Details:



Principal of an Incubator :

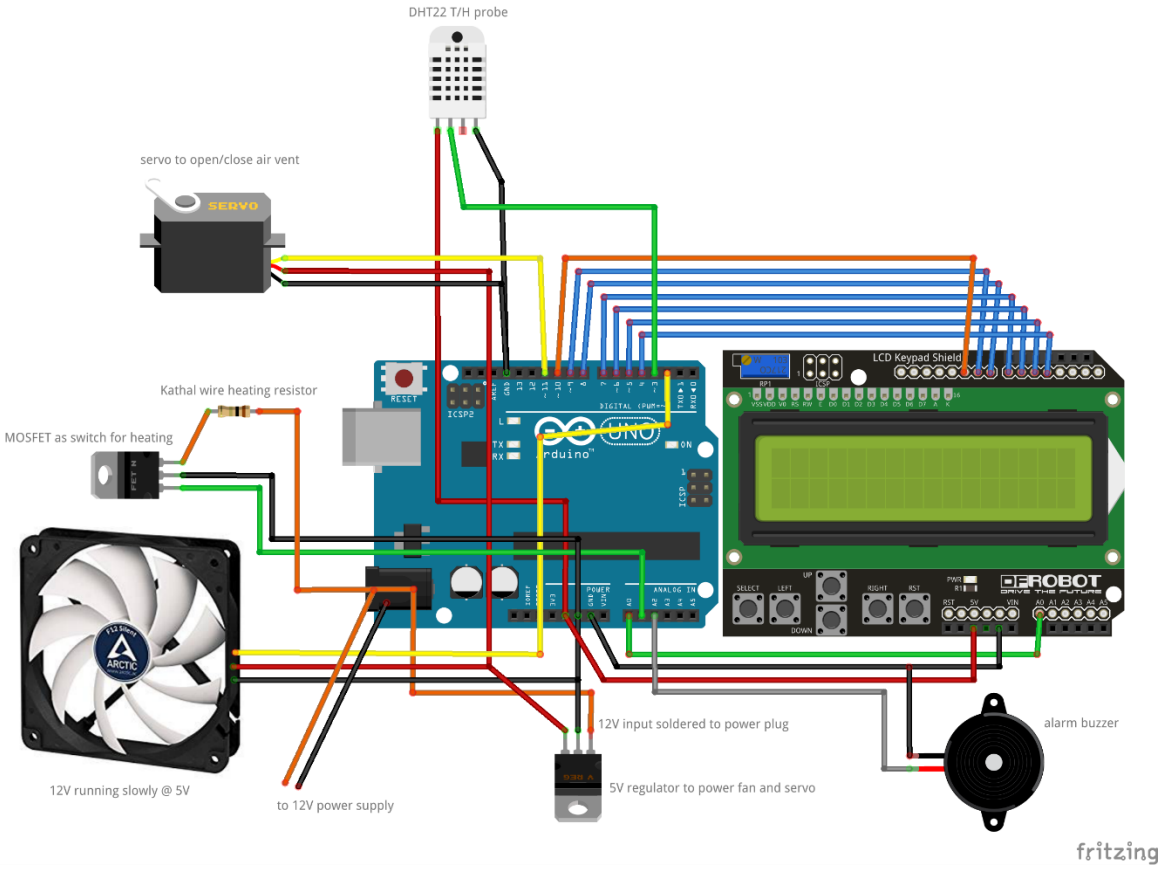
- An incubator is based on the principle that microorganisms require a particular set of parameters for their growth and development.
- All incubators are based on the concept that when organisms are provided with the optimal condition of temperature, humidity, oxygen, and carbon dioxide levels, they grow and divide to form more organisms.
- In an incubator, the thermostat maintains a constant temperature that can be read from the outside via the thermometer.
- The temperature is maintained by utilizing the heating and no-heating cycles.

Incubators usually only are able to heat but not to cool their chambers. For a precise regulation of the inside temperature, they have to be located in a room that has a lower temperature. We will build Heated Incubator that will range from 15.6 to 48.9 Degrees. In this optimal temperature range our Digital Circuit for DS18B20 will work accordingly. The DS18B20 sensor will sense the values from the incubator and the room temperature. In addition, the sensor should compare the necessary temperature difference between the surrounding lab and incubator temperature. Sensing the temperature the Micro Controller Arduino UNO R3 will act accordingly to these conditions,

- **ON** for $V_T \leq V_L < V_H$
- **OFF** for $V_T \geq V_H > V_L$
- **UNCHANGED** for $V_L < V_T < V_H$

The Sensor will sense the temperature and send the voltage (V_T) to the Micro Controller. According to the code initiated in the Controller the parameters will be adjusted. We will use a Thermo-electric heater as the heating device here which will be activated whenever the temperature goes up to 49 degree. It will keep its unchanged state until 15.6 Degree and the heater will be again activated to keep the incubator in a optimal temperature.

As prototype to the Incubator we can simply make an Egg Incubator before going to any trial and error for the original incubator,



For the prototype we can simply use an Arduino UNO R3 for the micro controller, MOSFET for the Heating Device, for ventilation we can use a Cooling fan an LCD and most importantly our DS18B20 Sensor. Combining all of these elements together with the micro controller we can easily make a closed loop system that will range the value of temperature from 15.6 to 48.9 Degrees and act according to the conditions. Here the Fan will be activated if the condition is above 49 degree and the Heater will be turned off. Vice versa for the lower temperature the Heater will turn ON at 15.6 degree and the fan will Turn Off. This could be a real life implementation in a prototype of our Temperature BOX.

In case if the prototype runs well we don't need the cooling conditions in our Incubator. As long as the Heat reaches the highest temperature or the threshold voltage it will keep the heater ON and then turn it OFF.

Issues :

Whilst implementing this project we would face many hassles which we have to troubleshoot through many trials and errors. Alongside the circuit issues we have to keep in account about the medical terminologies as well. This could greatly effect the project if something goes wrong with the readings of the temperature sensor.

Impacts:

If the project is successful we can have a automated temperature controlled Incubation system which can solely measure the temperature from its own and take the actions accordingly.

Limitations:

1. The Actuator of the Heating Device would be costly and combining it with the Microcontroller would be tough.
2. Sensor Reading would be the crucial factor here as microorganisms are susceptible to temperature change, the fluctuations in temperature of the cabinet would cause serious problem.
3. Devices along with the incubator should be in sterile condition constantly sterilizing these devices might damage in worst case scenarios.

Budget:

The budget for the Temperature Control Box is as follows

DS18B20 (DIGITAL)			
Components	Cost(BDT)	Quantity	Net Total
Arduino UNO R3	1300/-	1	1300/-
DS18B20	220/-	1	220/-
Resistors	1/-	2	2/-
C828	3	1	3/-
Relay switch	30	1	30/-
DC LED 5v	50	1	50/-
Jumper wire	95/-	1 Bundle	95/-
NET TOTAL			**1700**/-

This can be used along with the other components of the Incubators and the overall budget will be considered after that.

References:

1. https://microbenotes.com/incubator/
2. https://lairdthermal.com/applications/medical-storage-chambers
3. https://www.sciencedirect.com/science/article/pii/S0301479722003577