



University of Asia Pacific

Department of Computer Science and Engineering

CSE 316: Microprocessors and Microcontrollers Lab

Assignment: - 03

Submitted by:

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Section : E

Submitted to:

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Date of Submission:

You are part of a research team at MediTech Logistics, a company designing smart vaccine transport systems for rural healthcare delivery. Your task is to design and explain a Cold Chain Vaccine Transport Box using an ESP32 microcontroller and appropriate sensors. The system must maintain vaccines within a safe temperature range (2°C to 8°C) during transportation. If the temperature goes outside this range or the box lid is opened for too long, the system should trigger alerts and record the event for traceability.

(i) Draw a hand-drawn block diagram of the system showing all sensors, actuators, and the ESP32 microcontroller with proper pin connections.

(ii) Write an explanation of how your system behaves under different conditions. Define and justify your own threshold values for temperature, humidity, and light intensity based on real vaccine storage requirements.

(iii) Design a flowchart and pseudocode showing:

- Continuous sensor monitoring
- Decision-making process
- Actuator control
- Alert conditions
- Timing or delay logic

(iv) Explain why the ESP32 is suitable for this system.

(v) Describe one innovative feature you would add.

(vi) Discuss how your design would handle sensor failure or false readings.

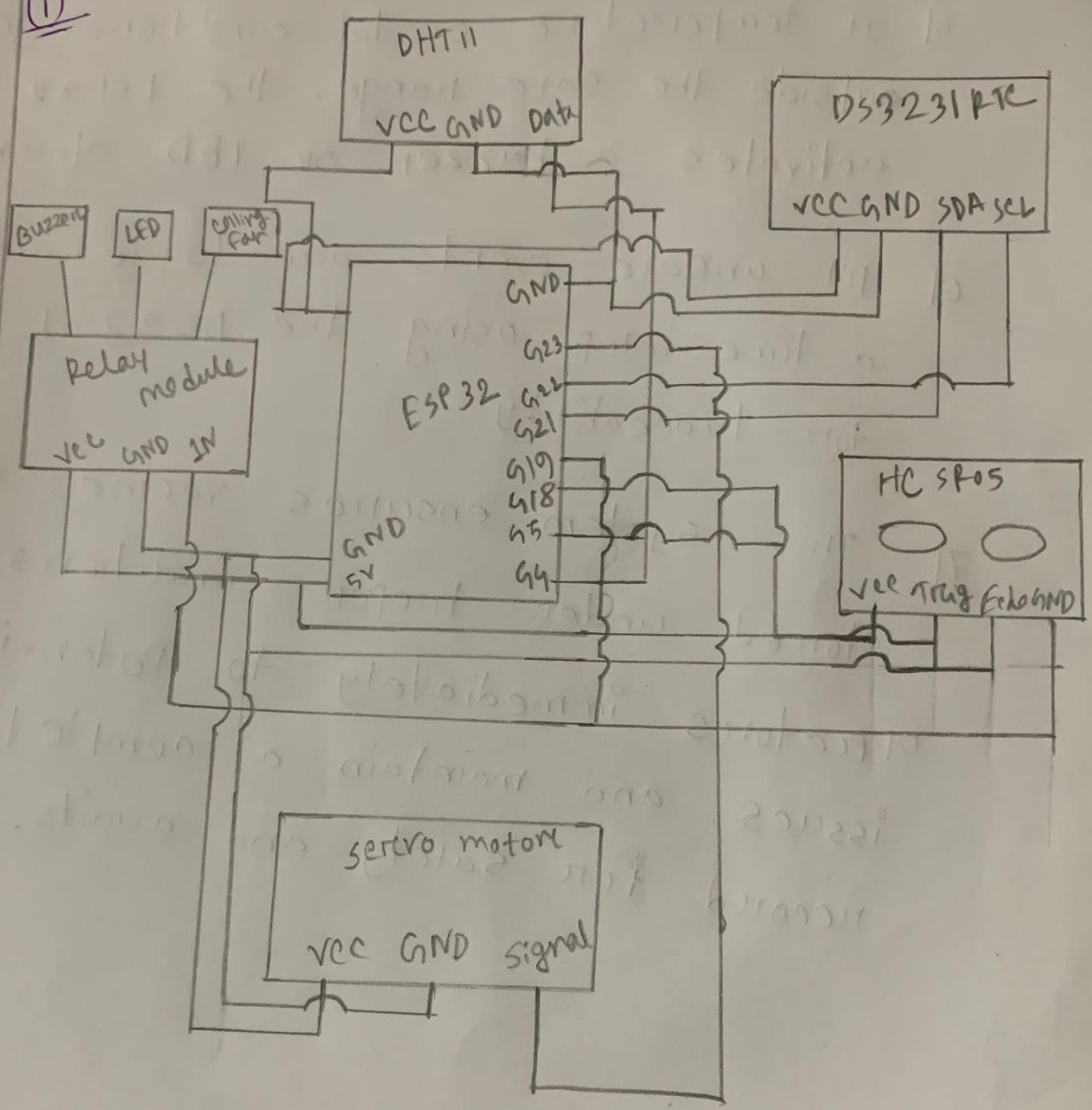
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Components :

- 1] ESP32 (microcontroller)
- 2] DHT11 / DHT22
- 3] DS3231 real time clock
- 4] HC-SR04 ultrasonic sensor
- 5] Relay Module
- 6] servo motor
- 7] Jumper wire
- 8] Arduino IDE
- 9] LED
- 10] Buzzer
- 11] cooling fan

(2)

(i)



(3)

ii

1] The cold chain vaccine Transport Box uses an ESP32 microcontroller to monitor vaccines during transportation.

2] Temperature is measured using a DHT22 sensor, with a safe range of 2°C to 8°C

i] Temperatures below 2°C can freeze vaccines

ii] Temperatures ~~above~~ above 8°C can reduce vaccine potency.

3] Humidity is also monitored with the DHT22 sensor, keeping it between 30% only 70% to prevent moisture damage to the packaging.

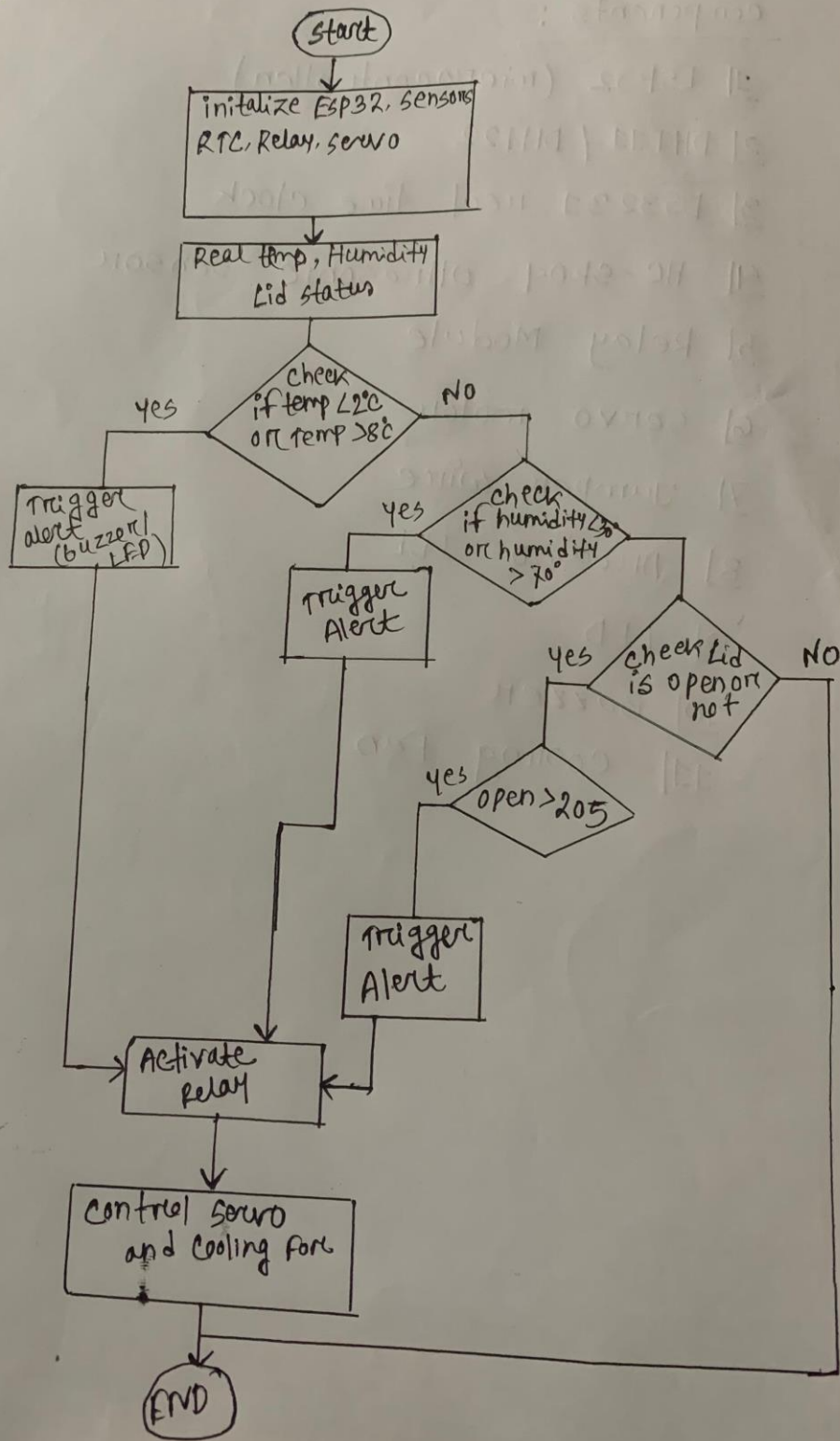
4] The HC-SR04 ~~an~~ ultrasonic sensor monitors the lid and triggers an alert if it stays open for more than 10 seconds, protecting the vaccines from heat or sunlight.

(4)

- 5] If temperature or lid conditions go outside the safe range, the ESP32 activates a buzzer or LED alarm.
- 6] All unsafe events are logged with a timestamp using the DS3231 RTC for traceability.
- 7] This system ensures vaccines are stored under proper conditions, alerts operators immediately to potential issues, and maintain a complete record for safety and audits.

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Pseudo code:

INITIALIZE sensors (DHT22, DS3231 RTC, HC-SR04)

INITIALIZE relay module

INITIALIZE servo motor

Loop Forever,

temp = read Temperature (DHT22)

humid = read Humidity (DHT22)

lid Distance = read Distance (HC-SR04)

If temp < 2 OR temp > 8

trigger Relay Alert ()

log Event ("Temp out of Range", DS3231)

END If

If humid < 30 OR humid > 70

log Event ("Humidity out of range", DS3231)

END If

If LidDistance indicates lid open

Start LidTimer ()

If lidTimer > 10

Trigger Relay Alert ()

log Event ("Lid open too long", DS3231)

ENDIF

ELSE

reset LidTimer ()

ENDIF

END LOOP control servo ()

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iv

- 1] It has built-in wifi and Bluetooth, which allows easy data transfer to cloud on mobile apps without extra hardware.
- 2] It provides multiple input/output pins enabling connection of many sensors at the same time.
- 3] It operates on low power, making it ideal for portable systems like vaccine transport boxes.
- 4] It has a fast processor/ which helps in real time data processing from temperature humidity and GPS sensor.
- 5] It is cost effective.

v.

An innovation feature would be to include a real time alert system that sends an automatic message on app notification if the vaccine temperature goes outside the safe range. This help the transport team take quick action.

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vi if a sensor fails or gives wrong data,
the system can use data validation
and redundancy for example, it can
compare reading from two sensors
measuring the same condition / or ignore
sudden abnormal values. If a sensor
completely stop working, the system will
show a warning message and store
the error in the log so that
maintenance can be done ~~over~~ quickly.