Vibration Detection for Machinery Safety System
(Arduino UNO Project Report)

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1 Introduction

Industrial machines are prone to unsafe conditions such as abnormal vibrations, overheating, or unauthorized access. To enhance workplace safety, a monitoring system was developed using an Arduino UNO. This project continuously observes vibration, tilt, temperature, humidity, and access status, and then provides real-time alerts when abnormal conditions are detected.

2 Problem Statement

The goal is to design and implement a safety system that:

- Detects abnormal vibration or tilt in machinery.
- Monitors environmental conditions (temperature and humidity).
- Detects unauthorized access to machinery using a reed switch.
- Provides real-time alerts through an RGB LED and LCD display.
- Activates safety mechanisms using a relay.

3 Hardware Components

The system consists of the following components:

1. Arduino UNO (microcontroller).
2. SW-200D vibration/tilt sensor (connected to D2).
3. Reed switch for access detection (connected to D3).
4. DHT11 sensor for temperature and humidity (connected to D4).
5. RGB LED with resistors (pins D9, D10, D11).
6. Relay module to control safety mechanisms (D7).
7. 16x2 I2C LCD (SDA=A4, SCL=A5).

4 Circuit Design

The circuit integrates all sensors and actuators with the Arduino UNO. The vibration and reed switches are connected using internal pull-ups, while the RGB LED provides visual status. The relay is used to control external safety devices, and the LCD shows real-time status.

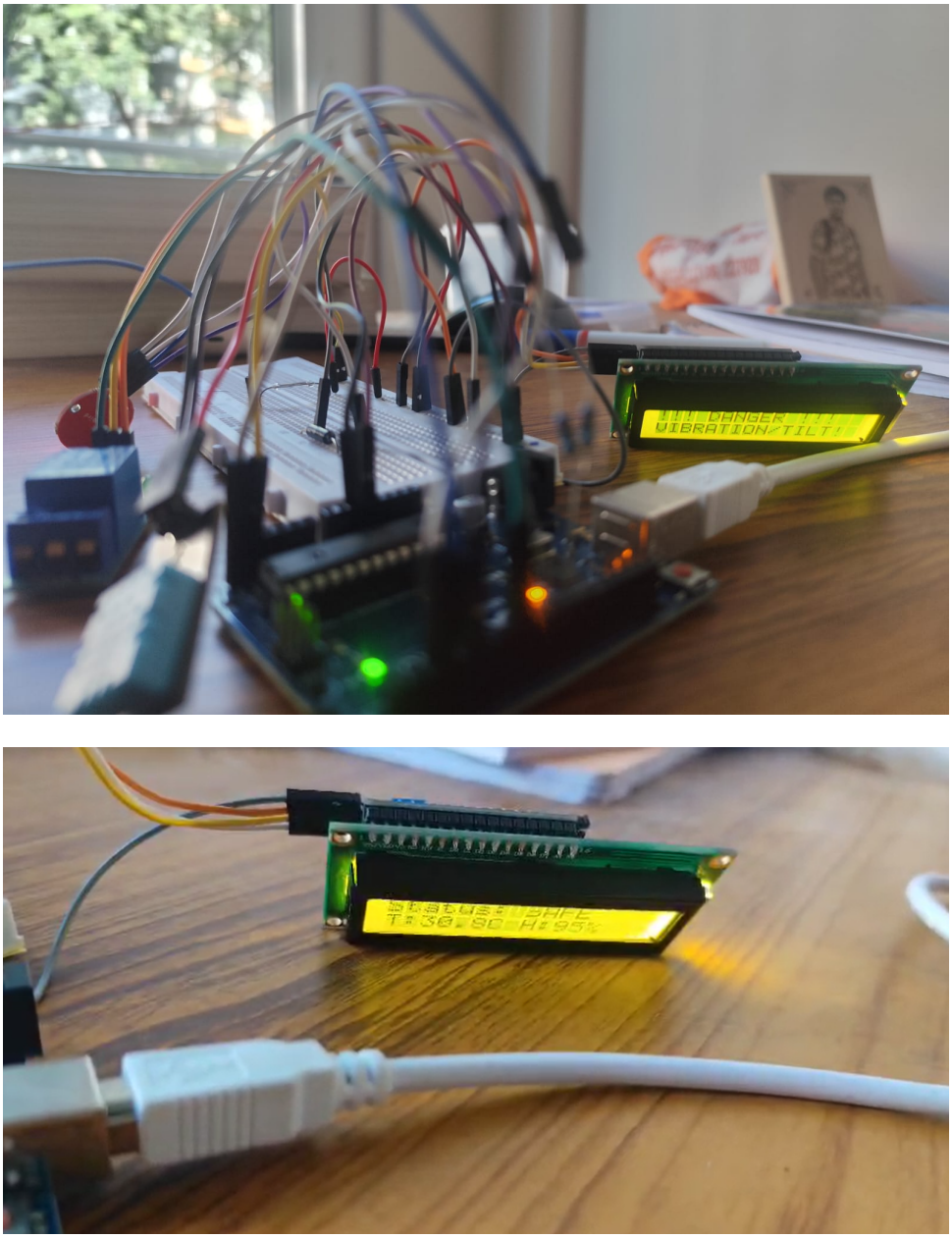

Figure: Conceptual Circuit Design

5 Block Diagram

The following block diagram illustrates the overall system flow and interaction between components:

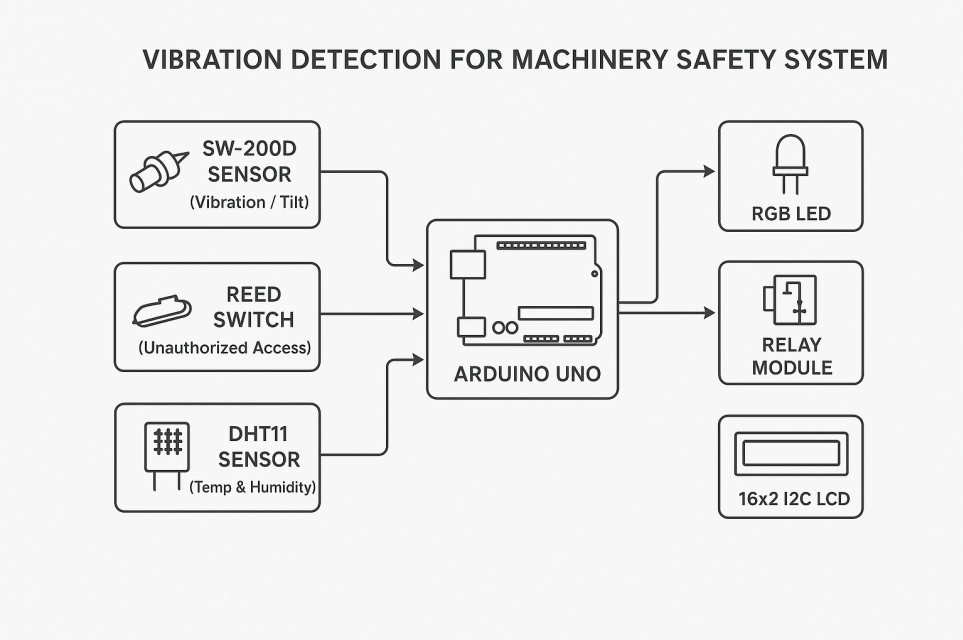

Figure: Block Diagram of Vibration Detection System

6 Working Principle

The system operates as follows:

1. The Arduino continuously checks vibration and access status.
2. Temperature and humidity are read periodically from the DHT11 sensor.
3. If any unsafe condition is detected (vibration, unauthorized access, high temperature, or high humidity), the RGB LED turns red, the relay is activated, and a warning is displayed on the LCD.
4. If conditions are normal, the RGB LED glows green, the relay remains inactive, and live sensor values are shown on the LCD.

7 Code Overview

The Arduino program performs the following tasks:

- Initializes all sensors and output devices.
- Debounces vibration input to avoid false alarms.
- Periodically reads DHT11 data with a 2-second interval.
- Implements safety thresholds: temperature above 55°C or humidity above 100% triggers alerts.
- Displays alerts or safe status on the LCD.

8 Arduino Code

```
// Libraries
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include "DHT.h"

// Pin definitions
#define VIB_PIN 2
#define REED_PIN 3
#define RELAY_PIN 7
#define RED_PIN 9
#define GREEN_PIN 10
#define BLUE_PIN 11
#define DHT_PIN 4
#define DHT_TYPE DHT11

// Initialize devices
DHT dht(DHT_PIN, DHT_TYPE);
LiquidCrystal_I2C lcd(0x27, 16, 2);

void setup() {
  pinMode(VIB_PIN, INPUT_PULLUP);
  pinMode(REED_PIN, INPUT_PULLUP);
  pinMode(RELAY_PIN, OUTPUT);
  pinMode(RED_PIN, OUTPUT);
  pinMode(GREEN_PIN, OUTPUT);
  pinMode(BLUE_PIN, OUTPUT);
  dht.begin();
  lcd.init();
  lcd.backlight();
}

void loop() {
  // Read sensors
  int vibStatus = digitalRead(VIB_PIN);
  int doorStatus = digitalRead(REED_PIN);
  float temp = dht.readTemperature();
  float hum = dht.readHumidity();

  // Safety logic
  bool unsafe = (vibStatus == LOW || doorStatus == LOW || temp > 55 ||
      hum > 100);

  // LED and relay
  if (unsafe) {
    digitalWrite(RED_PIN, HIGH);
    digitalWrite(GREEN_PIN, LOW);
    digitalWrite(BLUE_PIN, LOW);
    digitalWrite(RELAY_PIN, HIGH);
    lcd.setCursor(0, 0);
    lcd.print("ALERT! Unsafe");
  } else {
    digitalWrite(RED_PIN, LOW);
    digitalWrite(GREEN_PIN, HIGH);
    digitalWrite(BLUE_PIN, LOW);
    digitalWrite(RELAY_PIN, LOW);
```

```
    lcd.setCursor(0, 0);
    lcd.print("Temp: ");
    lcd.print(temp);
    lcd.print("C");
    lcd.setCursor(0, 1);
    lcd.print("Hum: ");
    lcd.print(hum);
    lcd.print("%");
  }
  delay(2000); // Read every 2 seconds
}
```

9 Results

- Under normal conditions, the RGB LED glows green and the LCD shows current temperature and humidity.
- On detecting vibration or tilt, the system raises an immediate alert.
- Unauthorized access detection triggers a red LED alert and relay activation.
- When temperature exceeds 55°C or humidity crosses 100%, the system warns the operator.

10 Conclusion

The Arduino-based safety monitoring system successfully detects unsafe conditions in machinery environments. It provides real-time alerts and can be extended to log data or send wireless notifications.

11 YouTube Link

For a demonstration video of this project, visit: Vibration Detection System Demo on YouTube