NATIONAL INSTITUTE OF TECHNOLOGY, AGARTALA

DEPARTMENT OF ELECTRICAL ENGINEERING

Topic-Earthquake Monitoring

6th Semester, Sec-A, Group-5&6

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Contents

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Lab In-charge

Introduction

Earthquakes are among the most unpredictable and destructive natural disasters, often causing significant loss of life and property. The ability to detect ground vibrations and provide an early warning can play a crucial role in reducing the impact of such events. Traditional seismic monitoring systems are highly accurate but also expensive and complex, making them less accessible for small-scale applications or educational use.

This project aims to design and implement a low-cost, real-time earthquake detection system using a vibration sensor (SW-420) and an Arduino microcontroller. The system detects abnormal ground vibrations and responds by activating visual and audible alarms, thereby alerting people nearby to take immediate safety precautions. Though it does not replace advanced seismic instruments, this prototype serves as a practical demonstration of how embedded systems and sensors can be applied to disaster preparedness and awareness.

Objectives

- **Detect Ground Vibrations:** Use the SW-420 vibration sensor to identify abnormal motion that may indicate seismic activity.
- **Immediate Alert Mechanism:** Trigger a buzzer and LED to provide real-time audible and visual alerts during vibration detection.
- **Microcontroller-Based Automation:** Utilize an Arduino Nano for efficient monitoring, decision-making, and control of the detection system.
- **Cost-Effective Safety Solution:** Develop a low-cost, easy-to-assemble earthquake alert prototype suitable for educational and experimental purposes.

Components Required

SL. NO.	Components	Specifications	Quantity
1.	Arduino Nano	ATmega328P microcontroller	1
2.	Vibration Sensor	SW-420 Module, Digital output, 3.3–5 V operating voltage	1
3.	Buzzer	3–12 V, 5–30 mA, 85 dB sound output	1
4.	LED	5mm, 1.8–2.2 V (Red)	1
5.	Breadboard	400–800 tie-points, Plastic with metal contacts	1
6.	Resistor	220Ω	1
7.	Connecting Wires	Male-to-Male and Male-to-Female Jumper Wires	As required

SW-420 Vibration Sensor

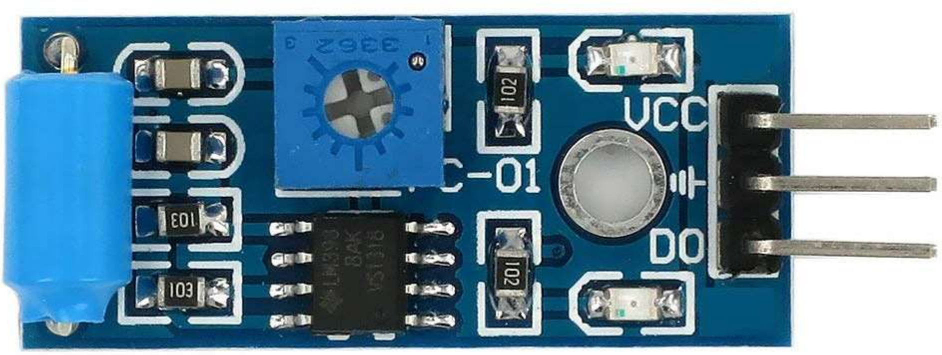

Fig.1: Vibration Sensor Module

Arduino Nano

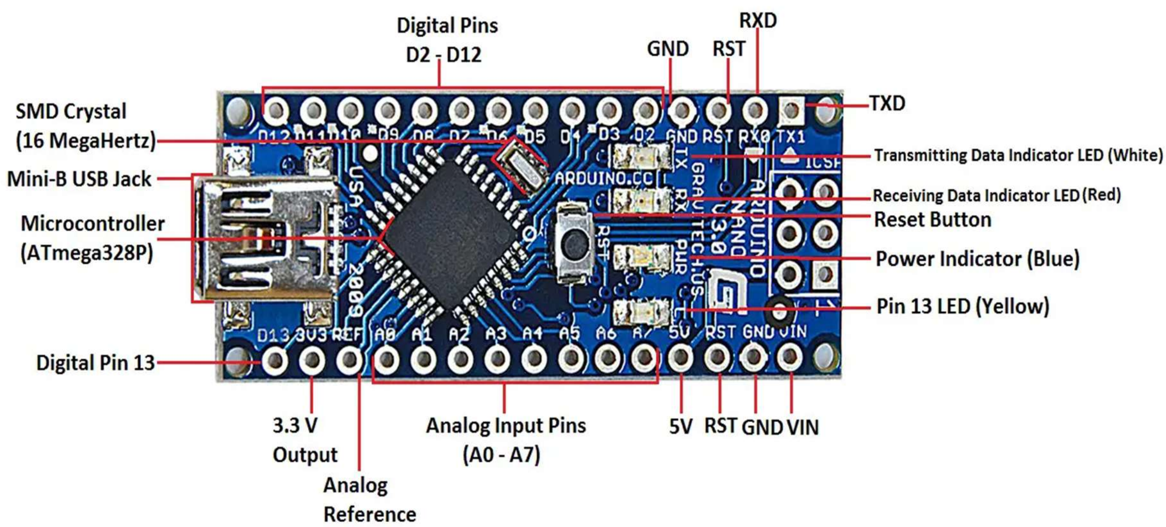

Fig.2: Arduino Nano module

Buzzer

Fig. 3: Buzzer

Working Principle

The **Earthquake Detection System** functions by sensing ground vibrations using an **SW-420 vibration sensor** and alerting users through a **buzzer** and **LED**. The entire process is managed by an **Arduino Nano**, which reads sensor output and activates the alarm system accordingly.

1. How the SW-420 Vibration Sensor Works

The SW-420 sensor is a vibration switch module that reacts to physical vibrations or shaking. It includes:

- A metallic spring inside a cylindrical enclosure.
- When stable, the spring stays away from the wall and the sensor outputs **HIGH**.
- Upon vibration, the spring touches the internal wall, closing the circuit and producing a **LOW** signal.
- This signal is sent to the Arduino via a digital pin.

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2. Detection Process in the System

- The SW-420 continuously monitors the surrounding physical state.
- In a vibration-free environment, its digital output remains **HIGH**.
- When ground vibration is detected, it outputs **LOW**, indicating possible seismic activity.
- This change is read by the Arduino Nano using digitalRead() on the sensor's signal pin.

3. Processing by Arduino Nano

- The Arduino runs a continuous loop checking for vibration events.
- When a LOW signal is detected:
    - The buzzer is activated to produce an audible alert.
    - An LED is turned on to provide a visual warning.
    - A message can be printed to the Serial Monitor for debugging or tracking purposes.
- After a short delay, the system resets the alert and resumes monitoring.

Wiring Connections

Vibration Sensor (SW-420) to Arduino Nano

- **VCC** → **5V** (Arduino Nano)
- **GND** → **GND** (Arduino Nano)
- **OUT** → **D2** (Arduino Nano)

Buzzer to Arduino Nano

- **Positive (+)** → **D8** (Arduino Nano)
- **Negative (-)** → **GND** (Arduino Nano)

LED to Arduino Nano

- **Positive (+)** → **D9** (through a 220Ω resistor)
- **Negative (-)** → **GND** (Arduino Nano)

Code for Arduino Nano

```
const int vibrationPin = 2;
const int buzzerPin = 8;
const int ledPin = 9;

void setup() {
  pinMode(vibrationPin, INPUT);
  pinMode(buzzerPin, OUTPUT);
  pinMode(ledPin, OUTPUT);
  Serial.begin(9600);              // Start serial monitor
}
void loop() {
  int sensorValue = digitalRead(vibrationPin);

  if (sensorValue == LOW) {
    digitalWrite(buzzerPin, HIGH);
    digitalWrite(ledPin, HIGH);
    Serial.println("Vibration detected! Possible Earthquake!");
    delay(1000);                              //Buzzer and LED on for 1 sec
    digitalWrite(buzzerPin, LOW);
    digitalWrite(ledPin, LOW);
  } else {
    digitalWrite(buzzerPin, LOW);              // Turn off buzzer
    digitalWrite(ledPin, LOW);                 // Turn off LED
  }
  delay(200);
}
```

Explanation of the Code

1. Defining the Hardware Pins

```
const int vibrationPin = 2;   // Input from SW-420
const int buzzerPin = 8;      // Output to buzzer
const int ledPin = 9;         // Output to LED
```

- **vibrationPin** is connected to **digital pin 2** of the Arduino.
- **buzzerPin** is connected to **digital pin 8** of the Arduino.
- **ledPin** is connected to **digital pin 9** of the Arduino.
- The **const int** keyword defines these pins as constants.

---

2. Setting Pin Modes in setup():

```
pinMode(vibrationPin, INPUT);     // Set vibration sensor as input
pinMode(buzzerPin, OUTPUT);       // Set buzzer as output
pinMode(ledPin, OUTPUT);          // Set LED as output
Serial.begin(9600);               // Start serial communication
```

- pinMode(vibrationPin, INPUT); → Configures the **Vibration sensor pin** as an input.
- pinMode(buzzerPin, OUTPUT); → Configures the **buzzer pin** as output.
- pinMode(ledPin, OUTPUT); → Configures the **led pin** as output.
- Serial.begin(9600); → Starts the **Serial Monitor** at a **9600 baud rate** for debugging.

3. Reading Sensor Data in loop()

```
int sensorValue = digitalRead(vibrationPin);  // Read sensor output
```

- digitalRead(vibrationPin); → Reads the value from the vibration sensor. If the sensor detects vibration, the output will be **LOW**; otherwise, it will be **HIGH**.

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4. Triggering Alerts Upon Vibration Detection

```
if (sensorValue == LOW) {                   // Vibration detected
  digitalWrite(buzzerPin, HIGH);            // Turn on buzzer
  digitalWrite(ledPin, HIGH);               // Turn on LED
  Serial.println("Vibration detected! Possible Earthquake!");
  delay(100);                               // Alert duration
}
```

- **if (sensorValue == LOW)** → Checks if the vibration sensor detects a vibration (when the sensor output is **LOW**).
- **digitalWrite(buzzerPin, HIGH);** → Turns on the buzzer to indicate an earthquake or vibration.
- **digitalWrite(ledPin, HIGH);** → Turns on the LED to provide a visual alert.
- **Serial.println("Vibration detected! Possible Earthquake!");** → Sends a message to the Serial Monitor for debugging.
- **delay(100);** → Creates a delay to keep the buzzer and LED on for a short period (100 milliseconds).

5. Turning Off Alerts When No Vibration is Detected

```
else {
  digitalWrite(buzzerPin, LOW);          // Turn off buzzer
  digitalWrite(ledPin, LOW);             // Turn off LED
}
```

- **else** → When the vibration sensor detects no vibration (output is **HIGH**), this block of code will execute.
- **digitalWrite(buzzerPin, LOW);** → Turns off the buzzer.
- **digitalWrite(ledPin, LOW);** → Turns off the LED.

Circuit Connection:

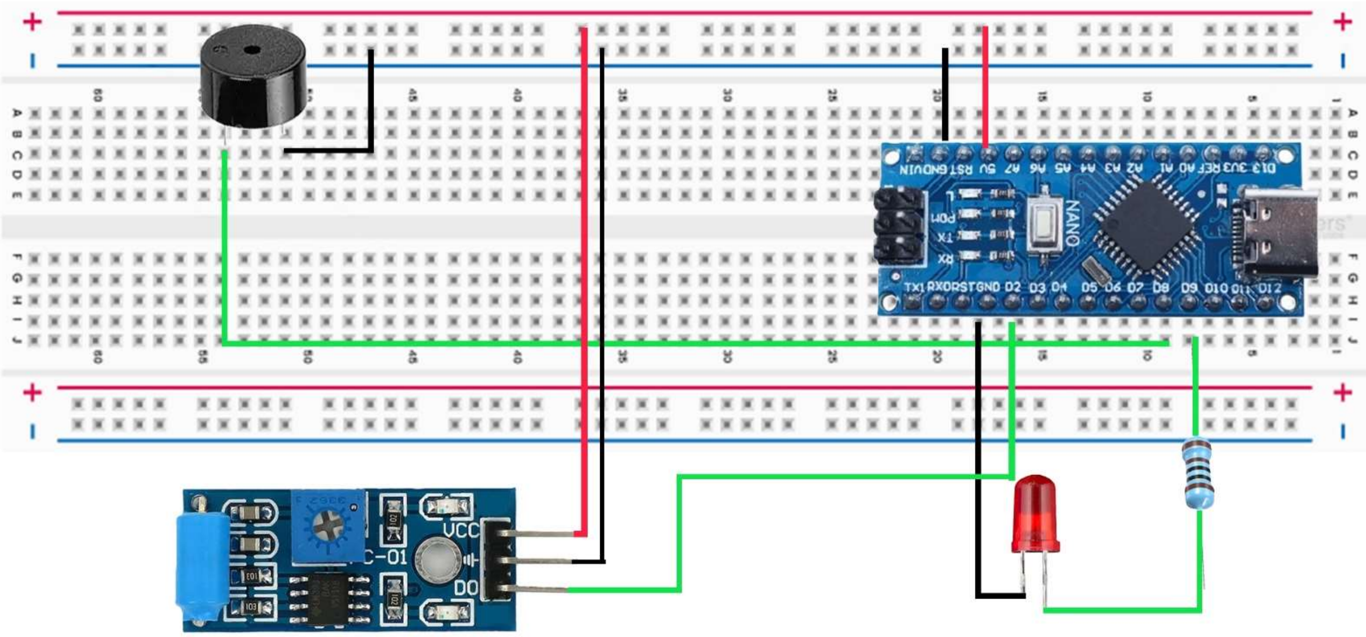

Fig. 4: Circuit Connection Diagram

Actual image of circuit:

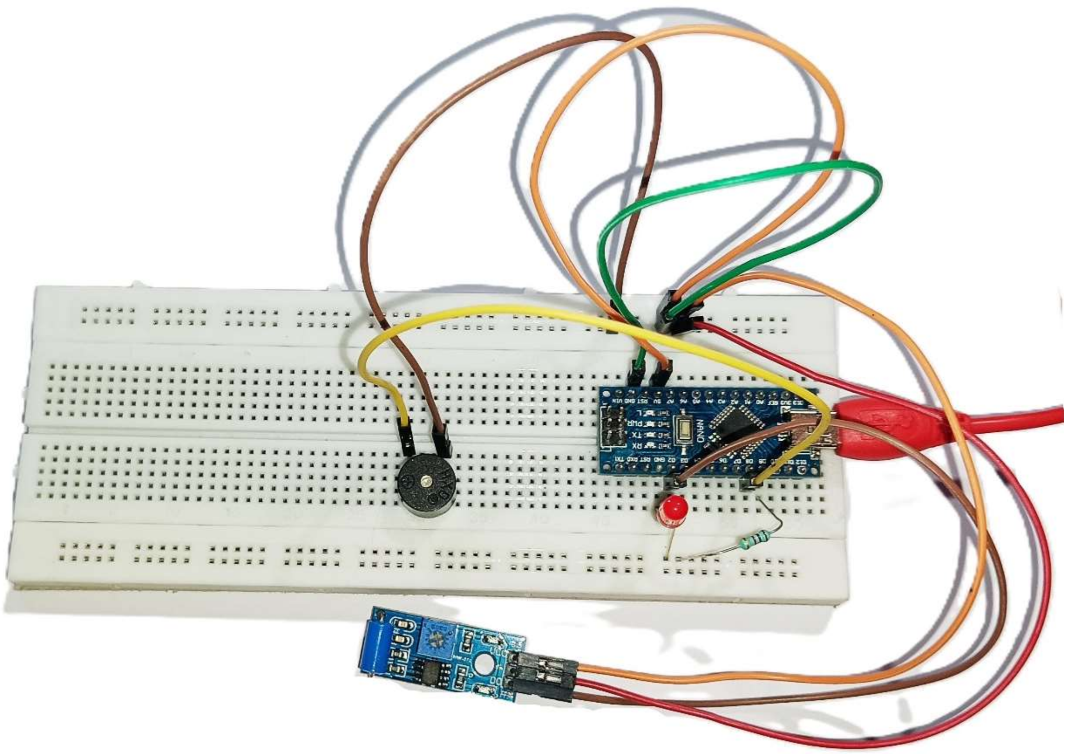

Fig.5: Actual Image of the Circuit

Applications

Applications of Earthquake Detection using Arduino Nano and Vibration Sensor

- **Early Warning System:** Detect initial tremors and provide immediate alerts to reduce risk in homes or schools.
- **Disaster Preparedness Demonstration:** Useful in educational setups to demonstrate how seismic sensors work.
- **Building Safety Monitoring:** Can be installed in structures to monitor ground movement and structural integrity.
- **Remote Monitoring Add-on:** Can be extended with IoT modules for real-time alerts and notifications.
- **Low-Cost Seismic Activity Logger:** Useful for rural or low-resource regions to track tremors over time.

Advantages

- **Low Cost**: Uses inexpensive and easily available components.
- **Simple to Build**: Beginner-friendly and requires minimal technical setup.
- **Quick Alerts**: Provides immediate visual and audible warning during vibration.
- **Customizable**: Can be enhanced with additional modules like GSM, Wi-Fi, or display units.
- **Portable**: Compact design makes it easy to install in small spaces.

Limitations

- **Not a Precise Seismograph:** It cannot measure magnitude, depth, or epicenter.
- **False Positives:** May trigger alerts due to non-seismic vibrations (e.g., heavy trucks).
- **Limited Range:** Detects vibrations only in close proximity to the sensor.
- **No Data Logging (Basic Version):** Without added modules, it cannot store or transmit event data.
- **Sensitivity Challenges:** Requires manual tuning of the vibration threshold to balance accuracy and noise.

Future Improvements:

- **Internet Connectivity (IoT):** Integrate Wi-Fi (ESP8266/ESP32) or GSM module to send alerts to smartphones or cloud platforms.
- **LCD or OLED Display:** Show live vibration status, intensity, and alert messages on a screen.
- **Mobile App Integration:** Push alerts to a mobile app or SMS for remote notifications.
- **Sensitivity Calibration:** Implement a potentiometer or software-based calibration to adjust sensor sensitivity.
- **Multi-Sensor Network:** Use multiple vibration sensors for better coverage and accuracy.
- **Battery Backup:** Add a rechargeable battery or UPS circuit to keep the system running during power outages.

Conclusion

This project successfully demonstrates a compact and **cost-effective** prototype that detects ground vibrations and provides **immediate alerts** through a buzzer and LED. It demonstrates how **basic electronic components** and a microcontroller can be used to build a simple **early warning system**. While not a replacement for professional-grade seismographs, this project is ideal for **educational use**, **proof-of-concept demonstrations**, or deployment in **low-resource areas**. With future upgrades like **IoT alerts**, **data logging**, and **calibration controls**, it can evolve into a more reliable and **real-world applicable safety tool**.

References

1. **Pakpahan, I. E. A., Sihombing, P., & Nasution, M. K. M. (2022)**. *Analysis of the SW-420 Vibration Sensor Performance on Vibration Tools by Using a Fuzzy Logic Method*. Proceedings of CESIT 2020.
   This paper analyzes SW-420 behaviour with Arduino, introducing fuzzy logic for vibration classification.
   Available: https://doi.org/10.4108/eai.7-12-2021.2314541

2. **Laila B. N. (2023)**. *A Proposal to Make a Device with SW-420 Vibration Sensor Module Interfacing with Arduino*.
   Explains SW-420 working and setup with Arduino, listing earthquake detection as a key application.
   Available: https://www.academia.edu/100940119

3. **Mahto, P. K. & Singh, S. K. (2024)**. *Measurement of Blast Induced Ground Vibration using Arduino-based SW-420 Vibration Sensor*. IJRASET, Vol. 12, Issue 9.
   Practical use of SW-420 in blast monitoring, explaining threshold-based vibration alerts using Arduino.
   Available: https://www.ijraset.com/fileserve.php?FID=48092

4. **Cirkit Designer (2023)**. *How to Use SW-420 Vibration Sensor: Pinouts, Specs, and Examples*.
   Component-level guide on SW-420 usage, describing its vibration-triggered switching and use in earthquake detection systems.
   Available: https://www.cirkitdesigner.com/learn/sw-420-vibration-sensor