Building a Simple Magnetic Levitation System using an Arduino UNO Board

Adarsh Gupta, Hritankar Sarkar, Ishaan Kothari , Rishik Bhaduri, Riya Sai Nayak, Sombit Mukuthi, Sombrito Sardar, Souradip Ghosh , Suman Kumar, Yash Vardhan Choudhary

Department of Basic Science and Humanities, Institute of Engineering & Management, Kolkata-700091

Abstract

With the help of an Arduino UNO board, an electromagnet, a magnet, and a Hall effect sensor, this project tries to create a straightforward magnetic levitation system. The mechanism measures the separation between the magnet and the electromagnet using a Hall effect sensor and regulates the electromagnet's intensity to keep the levitation stable. The project report offers a step-by-step tutorial for constructing the system and writing the necessary Arduino code to operate it.

1. Introduction

The process of magnetic levitation suspends an object in the air without any physical contact. In order to counteract the effects of gravity and maintain the object in a stable position, this method makes use of the principle of magnetic repulsion or attraction. The object can be lifted and moved without conventional support systems by creating a magnetic field, either with electromagnets or permanent magnets. Magnetic levitation, one application of this technology, allows for less friction and higher efficiency in high-speed trains. It has a wide range of practical applications in numerous sectors, including transportation, energy storage, and medical equipment. Magnetic levitation can be used in transportation to build ultra-fast trains that can move at incredible rates of speed. In order to increase the effectiveness and dependability of renewable energy sources, this technology is also being investigated for its application in energy storage systems. Additionally, by enabling non-contact and precise manipulation of delicate instruments during surgical procedures, magnetic levitation has the potential to revolutionise medical equipment. Using an Arduino UNO board, a well-liked microcontroller board for DIY projects and prototyping, the aim of this project is to construct a straightforward magnetic levitation system. In addition to serving as a foundation for additional research and development, this project aims to illustrate the fundamental concepts of magnetic levitation. The Arduino UNO board offers users a simple way to manipulate the magnetic field and levitate objects, opening up possibilities for numerous applications in sectors like transportation, robotics, and aerospace.

2. Materials and Methods

Materials:

- Arduino UNO board
- Electromagnet
- Magnet
- Hall effect sensor
- NPN transistor (2N2222)
- Resistor (220 ohms)
- Power supply (9V)
- Breadboard
- Jumper wires

Methods:

- Connect the Hall effect sensor to the Arduino UNO board as follows:
- VCC of the Hall effect sensor to 5V pin of the Arduino UNO board
- GND of the Hall effect sensor to GND pin of the Arduino UNO board
- DO of the Hall effect sensor to digital pin 2 of the Arduino UNO board
- Connect the NPN transistor to the Arduino UNO board as follows:
- Base of the NPN transistor to digital pin 9 of the Arduino UNO board
- Collector of the NPN transistor to the positive terminal of the electromagnet
- Emitter of the NPN transistor to GND of the power supply
- Connect the resistor between the base of the NPN transistor and the digital pin 9 of the Arduino UNO board.
- Connect the electromagnet to the power supply.
- Upload the provided Arduino code to the board.
- Place the magnet over the Hall effect sensor and adjust the distance between the magnet and the electromagnet until the magnet levitates.

```
int sensorPin = 2; // Define the Hall effect sensor input pin
int controlPin = 9; // Define the electromagnet control pin
int sensorValue = 0; // Initialize the sensor value variable
void setup() {
  pinMode(controlPin, OUTPUT); // Set the electromagnet control pin as an output
  Serial.begin(9600); // Initialize the serial communication
}

void loop() {
  sensorValue = digitalRead(sensorPin); // Read the sensor value
  if (sensorValue == LOW) { // If the magnet is too far from the electromagnet, turn on the electromagnet
    digitalWrite(controlPin, HIGH);
  }
  else { // If the magnet is too close to the electromagnet, turn off the electromagnet
    digitalWrite(controlPin, LOW);
  }
  Serial.println(sensorValue); // Print the sensor value to the serial monitor
  delay(10); // Delay for stability
}
```

3. Result and Discussion

The magnet was able to levitate at a stable distance from the electromagnet after the system was successfully constructed and tested. The Arduino code was able to control the strength of the electromagnet in order to maintain a stable levitation, and the Hall effect sensor was able to measure the separation between the magnet and the electromagnet. This successful application of magnetic levitation demonstrates the potential for improvements in transportation systems, such as frictionless high-speed trains. This technology can also be used in a variety of industries because the precise control of the electromagnet's strength through the Arduino code enables adaptability in various situations.

This accomplishment shows the design's efficacy and validates the viability of using magnetic levitation in real-world applications. The achievement of stable levitation opens up opportunities for numerous industries, including transportation and energy, where this technology can be used to improve performance and efficiency. In order to strengthen and stabilise the system, additional sensors or control systems can be added. The magnetic levitation system can be made even more dependable and adaptable to various operating conditions by incorporating cutting-edge sensors and control systems. This would make it possible for it to seamlessly integrate into the current infrastructure and guarantee its long-term viability as a workable solution for sectors looking to increase productivity and efficiency.

For instance, a PID control system can be used to more precisely control the electromagnet and lessen oscillations during levitation. Additionally, the magnetic levitation system's capacity to adjust and improve its performance based on real-time data can be improved by the incorporation of machine learning algorithms. This would allow it to continuously learn from its mistakes and develop better control methods, which would increase the stability and precision with which it could maintain levitation. Additionally, incorporating predictive maintenance techniques can help find problems before they arise, minimising downtime and increasing overall system reliability.

4. Conclusion:

A basic magnetic levitation system was successfully constructed using an Arduino UNO board, a Hall effect sensor, an electromagnet, and a magnet in the project. The electromagnet produced a magnetic field to defy gravity and levitate the magnet, while the Hall effect sensor was in charge of determining the magnet's location. The control system was an Arduino UNO board, which used signals from the Hall effect sensor to regulate the current in the electromagnet. The system can serve as a starting point for further investigation and the development of more complex magnetic levitation systems. These systems have a variety of uses, including magnetic bearings for rotating machinery and high-speed trains. These systems have a variety of uses, including magnetic bearings for rotating machinery and high-speed trains. Researchers may be able to increase the effectiveness and stability of these systems by exploring the principles behind magnetic levitation in more detail. The development of new technologies that use magnetic levitation for transportation or energy storage could also be facilitated by developments in this field.

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