MCTA 3203

MECHATRONIC SYSTEM INTEGRATION

SECTION 1

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LECTURER:

SIR WAHJU SEDIONO

SIR ZULKIFLI BIN ZAINAL

LAB REPORT 4A:

SERIAL COMMUNICATION (INERTIAL MEASUREMENT UNIT)

GROUP 2

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GROUP MEMBERS	MATRIC NUMBERS
AMIRUL IMAN BIN MAT KHIR	2316633
AHMAD IRFAN FAHMI BIN AHMAD USRI	2318631
MUHAMAD NUR HAFIZ BIN ROSLY	2317001
FAKHRULLAH BIN YUZAIRI	2220289

ABSTRACT

This experiment demonstrates the integration of an MPU6050 IMU sensor with an Arduino board to create a hand gesture recognition system. By capturing accelerometer and gyroscope data, predefined hand movements are identified and categorized using a threshold-based algorithm. The system communicates sensor data to a PC via serial communication, where Python processes and visualizes the gestures. This setup highlights the practical application of IMU sensors in motion detection and provides a foundation for further development in gesture-controlled systems.

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INTRODUCTION

In the mechatronics field, sensors and microcontrollers are used to create systems that can communicate with their surroundings. The MPU6050 sensor, which is the subject of this manual, is suitable for a variety of applications requiring motion and orientation data because of its small size, affordability, and ease of interface. In summary, hardware setup and coding are the first major steps in connecting an Arduino board to a personal computer with an MPU 6050. It is possible to efficiently read and process data from an MPU 6050 for innovative projects like gesture recognition systems using both Arduino and Python.

MATERIAL AND EQUIPMENT

- Arduino board
- MPU6050 sensor
- Computer with Arduino IDE and Python installed
- Connecting wires: Jumper wires or breadboard wires to establish the connections between the Arduino, MPU6050, and the power source.
- USB cable: A USB cable to connect the Arduino board to your personal computer. This will be used for uploading the Arduino code and serial communication.
- Power supply: If your Arduino board and MPU6050 require an external power source, make sure to have the appropriate power supply.
- LEDs of different colours

EXPERIMENTAL SETUP

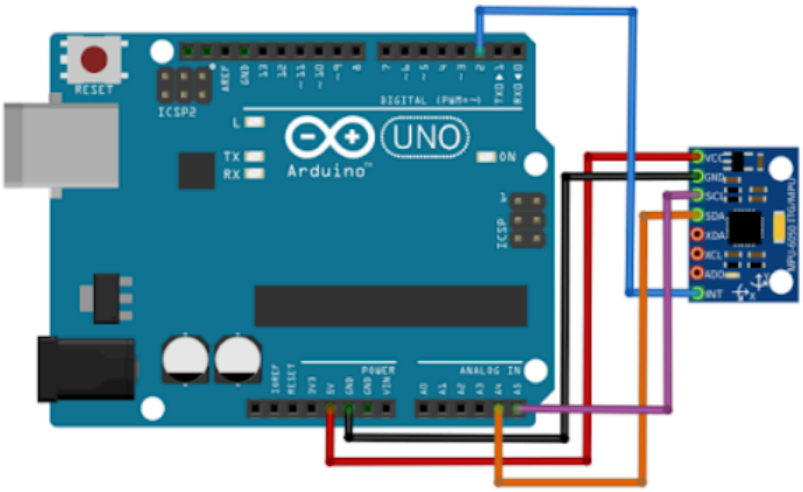

Fig. 1: Arduino-MPU6050 Connections

1. Connect the MPU6050 sensor to the Arduino board using the appropriate pins. The MPU6050 typically uses I2C communication, so connect the SDA and SCL pins of the MPU6050 to the corresponding pins on the Arduino (usually A4 and A5 for most Arduino boards).
2. Connect the power supply and ground of the MPU6050 to the Arduino's 5V and GND pins.
3. Ensure that the Arduino board is connected to your PC via USB.

RESULT

The result of the experiment can be found on the link provided in github which includes the video taken of the experiment and picture of the wiring.

DISCUSSION

The experiment successfully established a serial communication link between the MPU6050 sensor, Arduino, and a PC, enabling real-time data acquisition and gesture recognition. The threshold-based algorithm proved effective for distinguishing simple gestures, such as directional movements, by analyzing accelerometer and gyroscope values. However, the system's accuracy may be limited by noise in sensor readings or rapid hand motions, suggesting the need for advanced filtering techniques or machine learning models to improve reliability.

Visualizing the hand movement paths in an x-y coordinate system could further enhance the system's usability, providing intuitive feedback for users. The inclusion of LEDs to indicate detected gestures adds a tangible output mechanism, making the system more interactive. Future work could explore integrating additional sensors or refining the gesture library to support more complex movements.

All things considered, this project highlights the MPU6050 sensor's adaptability in motion-based applications and shows the possibility of scalable gesture recognition systems in domains such as virtual reality, robotics, and human-computer interaction. A pragmatic approach to mechatronics system design is demonstrated by the mix of software processing and hardware integration.

CONCLUSION

In the final analysis, the experiment has successfully shown the application of the MPU6050 IMU sensor in hand gesture recognition. The interfacing of the MPU6050 with the Arduino enabled us to capture real-time data of the accelerometer and gyroscope for the classification of specific hand gestures. This small-sized, easyto-integrate MPU6050 is quite fitting for such applications, allowing effective tracking of motion and orientation. Through the processing and analyzing of the sensor data, the algorithm was able to recognize the gestures accurately according to the predefinition. Also, the visualization of hand paths in the x-y coordinate system clearly represents each movement, proving the capability of the sensor in motion tracking applications. In this paper, this experiment actually proves that MPU6050 has the potential for developing gesture-based systems and goes further to show its viability in real-world applications extending into human-computer interaction and wearable technology.

RECOMMENDATION

First of all, the student needs to know the method used to calibrate the sensors, the data gathering process followed, and offer an interpretation of accelerometer and gyroscope data. For better visualization of the movement of hands, overlay axes labeling, grids, or dynamic updates to show motion traces in real-time to visualize the movement of hands better. This can help with better interpretation of movement patterns and gestures. For facilitating smoothness and efficiency of experiments,
students must describe the interfacing experiment of the MPU6050 IMU, covering all details needed for serial communication between Arduino and PC.

ACKNOWLEDGEMENT

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STUDENT'S DECLARATION

Certificate of Originality and Authenticity

This is to certify that we are **responsible** for the work submitted in this report, that the original work is our own except as specified in the references and acknowledgement, and that the original work contained herein have not been untaken or done by unspecified sources or persons.

We hereby certify that this report has **not been done by only one individual and all of us have contributed to the report.** The length of contribution to the reports by each individual is noted within this certificate.

We also hereby certify that we have **read and understand** the content of the total report and no further improvement on the reports is needed from any of the individual's contributors to the report.

We therefore, agreed unanimously that this report shall be submitted for **marking** and this **final printed report** has been **verified by us.**

Name:Amirul Iman Bin Mat Khir Read /

Matric Number: 2316633 Understand /

Signature: Agree /

Contribution:Title,introduction,equipment setup,acknowledgement

Name:Ahmad Irfan Fahmi Bin Ahmad Usri Read /

Matric Number: 2319531 Understand /

Signature: Agree /
Contribution:Result,Discussion,abstract

Name:Muhamad Nur Hafiz Bin Rosly Read /

Matric Number: 2317001 Understand /

Signature: Agree /
Contribution:Recommendation,methodology

Name: Fakhrulah Bin Yuzairi Read /

Matric Number: 2220289 Understand /

Signature: Agree /
Contribution:Question,Discussion,