SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, Dharwad-580002

An autonomous Institution affiliated to

Visvesvaraya Technological University, Belgaum – 590018

Department of Electronics and Communication Engineering

A Report on Minor Project-1 [22UECL505]

" THERAPEUTIC PLAY FOR CEREBRALPALSY CHILDREN "

Submitted by

CHAITANYA KAWALE– 2SD22EC017

HARSHVARDHAN B.M-2SD22C025

KEDAR MUJUMDAR-2SD22EC027

PREM PATIL-2SD22EC056

Students of 5th Semester,

Bachelor of Engineering in Electronics and Communication.

Under the Guidance of

PROF.SUMANGALA N BHAVIKATTI

Dept. of E&CE

Academic Year 2024-25

SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, Dharwad-580002

An autonomous Institution affiliated to

Visvesvaraya Technological University, Belgaum – 590018

Department of Electronics and Communication Engineering

CERTIFICATE

It is hereby certified that the team consisting of

CHAITANYA KAWALE –2SD22EC017
HARSHVARDHAN B.M -2SD22EC025
KEDAR MUJUMDAR -2SD22EC027
PREM PATIL -2SD22EC056

has satisfactorily completed the **Minor Project - 1 [22UECL505] entitled "THERAPEUTIC PLAY FOR CEREBRAL PALSY CHILDREN"** for the partial fulfillment of the requirements for the completion of **5th semester** of Bachelor of Engineering in Electronics and Communication during academic year 2024-25.

Prof. Sumangala N bhavikatti Project guide Dept. of E&CE.	**Dr. Shreedhar A Joshi,** Head of the Department, Dept. of E&CE.	**Dr. Ramesh L. Chakrasali,** Principal, SDMCET, Dharwad.

Signature:

Name:

Designation:

Department:

Examiner -1 **Examiner -2**

CONCEPTION OF THE PROJECT:

INTRODUCTION:

There is a need for innovation to improve the engagement and accessibility of rehabilitation programs for children and adults with upper extremity motor impairments due to neurodevelopmental disorders, acquired brain injuries, or spinal cord injuries. For this purpose, a computer game-based telerehabilitation platform (GTP) was developed to address this need. . Through the application of a miniature inertial-based computer mouse and the wide variety of commercial computer games, the developed GTP can provide engaging task-specific exercises for the rehabilitation of manual dexterity (object handling and manipulation). It is crucial to create experiences that improve the brain's ability to learn, and for manual dexterity this is best achieved by performing precise object manipulation tasks through guided and assisted repetition. Some game-based rehabilitation systems use a handle such as the game controller. The handle is grasped and moved using pronation-supination or elbow and shoulder motion. There is a large number of inexpensive and readily available common and modern commercial games that are engaging, therapeutic, and can be played with a computer mouse or an equivalent.

MOTIVATION:

1. **Empowering Children with Cerebral Palsy**:
   Cerebral palsy (CP) affects motor skills, coordination, and movement, limiting children's ability to engage in regular physical activities. This project aims to provide a fun, interactive, and therapeutic gaming experience that promotes physical and mental development.
2. **Rehabilitation Through Play**:
   Traditional rehabilitation methods can be monotonous and unengaging for children. Integrating gameplay with rehabilitation ensures children remain motivated, improving their therapy outcomes while they enjoy the process.
3. **Cost-Effective Solution**:
   Many advanced rehabilitation tools are expensive and inaccessible to many families or organizations. Using affordable components like Arduino and MPU6050 ensures a budget-friendly yet effective solution, making therapy accessible to more children.
4. **Real-Time Feedback and Monitoring**:
   The MPU6050 sensor provides accurate motion tracking, allowing therapists or parents to monitor the child's progress in real-time. This feedback can be used to customize therapy sessions based on individual needs.
5. **Encouraging Skill Development**:
   The project not only improves motor skills but also enhances cognitive abilities like focus, problem-solving, and hand-eye coordination, which are often areas of challenge for children with CP.
6. **Personalized Therapy**:
   By leveraging the flexibility of Arduino programming, the gameplay can be tailored to each child's capabilities and progress, ensuring an inclusive and adaptive rehabilitation experience.
7. **Promoting Independence and Confidence**:
   Successfully engaging with the gameplay can boost the child's confidence and sense of accomplishment, fostering a positive attitude towards therapy and self-improvement.

PROBLEM STATEMENT:

Children with **cerebral palsy (CP)** face significant challenges in developing motor skills, coordination, and physical mobility due to their condition. Traditional rehabilitation methods are often repetitive, unengaging, and expensive, leading to decreased motivation and limited accessibility for many families.

There is a need for an **affordable, interactive, and engaging solution** that combines therapy with entertainment to encourage consistent participation and improve motor skill development.

This project aims to address these challenges by developing a **game-based rehabilitation system** using **Arduino** and the **MPU6050 sensor**. The system will provide real-time motion tracking to measure and enhance the child's movements, making therapy sessions both effective and enjoyable.

By integrating technology and play, the solution seeks to offer an innovative, cost-effective, and customizable platform to improve the quality of life for children with cerebral palsy while promoting their physical and cognitive development.

OBJECTIVES:

1. **Develop an Interactive Gaming System**
   Create a game-based platform that integrates therapeutic exercises with engaging gameplay to encourage participation among children with cerebral palsy.
2. **Utilize Affordable and Accessible Technology**
   Leverage cost-effective components like **Arduino** and the **MPU6050 sensor** to design a solution that is budget-friendly and widely accessible to families and rehabilitation centers.
3. **Enhance Motor Skill Development**
   Provide activities within the game that focus on improving motor skills, hand-eye coordination, and movement accuracy in children with cerebral palsy.
4. **Enable Real-Time Motion Tracking**
   Use the MPU6050 sensor to accurately track and analyze the child’s movements, offering real-time feedback for therapists and caregivers to monitor progress.
5. **Promote Engagement and Motivation**
   Design the system to make therapy sessions enjoyable, helping children stay motivated and consistent with their rehabilitation exercises.
6. **Ensure Customization and Adaptability**
   Allow the system to be tailored to individual needs and progress levels, ensuring that children of varying abilities can benefit from the therapy.
7. **Support Cognitive and Emotional Growth**
   Incorporate elements in the game that also foster problem-solving, focus, and a sense of accomplishment, contributing to the child's overall development.
8. **Facilitate Remote or Assisted Therapy**
   Make the system suitable for use at home or in therapy centers, enabling caregivers and therapists to guide children effectively without needing advanced technical expertise.

By achieving these objectives, the project aims to create a holistic, innovative solution that integrates therapy with technology to improve the lives of children with cerebral palsy.

WORKING :

1. **System Overview**

   The project combines an **Arduino microcontroller** with an **MPU6050 sensor** to track a child's movements and interact with a therapeutic game. The game provides feedback and engages the child in motor skill exercises.

2. **Hardware Components**
   - **Arduino Uno**: Acts as the brain of the system, processing motion data and communicating with the game.
   - **MPU6050 Sensor**: Measures motion and orientation using its accelerometer and gyroscope, providing real-time movement data.
   - **Computer or Display**: Hosts the game interface and displays feedback to the child.
   - **Power Supply**: Powers the Arduino and connected components.
3. **Game Setup**
   - A therapeutic game is developed (e.g., a simple ball-catching or obstacle-avoiding game).
   - The game reacts to the child's physical movements detected by the MPU6050 sensor.
4. **Data Flow and Operation**
   - **Motion Tracking**: The child performs movements while wearing or holding the MPU6050 sensor.
   - **Sensor Data Acquisition**: The MPU6050 captures acceleration and gyroscopic data, which is sent to the Arduino.
   - **Processing**: Arduino processes the raw sensor data and maps it to control the game actions (e.g., moving an object on the screen).
   - **Game Interaction**: The child's movements are reflected in the game in real time, providing visual feedback and encouraging specific therapeutic exercises.
5. **User Feedback and Engagement**
   - The game provides positive reinforcement through animations, sounds, and rewards to motivate the child.
   - Real-time feedback helps the child understand how to improve their movements.

By translating physical therapy into an engaging gaming experience, the system ensures that rehabilitation becomes both effective and enjoyable for children with cerebral palsy.

KEY FEATURES :

1. **Interactive Gameplay**
   - Combines therapeutic exercises with fun and engaging gaming elements to keep children motivated and consistent in their rehabilitation efforts.
2. **Customizable Difficulty Levels**
   - Allows the game to be adjusted based on the child's motor abilities and progress, ensuring accessibility and adaptability for various skill levels.
3. **Affordable and Portable Design**
   - Uses low-cost components like Arduino and MPU6050, making the system budget-friendly and portable for home or clinic use.
4. **Real-Time Feedback**
   - Provides immediate visual and auditory feedback through the game interface, helping children understand and correct their movements during gameplay.
5. **Therapeutic Focus**
   - Encourages specific motor skill development, such as coordination, controlled movement, and balance, tailored to the needs of children with cerebral palsy.
6. **Engaging and Rewarding Experience**
   - Incorporates animations, sounds, and rewards within the game to make therapy sessions enjoyable and emotionally uplifting for the child.

AREAS OF APPLICATION :

- **Home-Based Therapy**
    - Provides an affordable and portable solution for families to continue rehabilitation exercises at home under caregiver supervision.
- **Special Education Centers**
    - Integrated into the curriculum of special education schools to combine learning with therapeutic play for children with motor impairments.
- **Pediatric Neurology Clinics**
    - Used as a tool in pediatric neurology clinics to support motor rehabilitation programs tailored to children with neurological disorders like cerebral palsy.
- **Occupational Therapy**
    - Assists occupational therapists in helping children develop fine and gross motor skills needed for daily activities.
- **Research and Development**
    - Utilized in academic and clinical research to study the effectiveness of motion-tracking-based rehabilitation for children with motor disabilities.
- **Inclusive Playgrounds**
    - Can be implemented in inclusive play areas to enable children with motor disabilities to participate in therapeutic yet enjoyable activities alongside their peers

BENEFITS :

1. **Improved Motor Skills**
    - Enhances coordination, balance, and controlled movements, which are essential for children with cerebral palsy to perform daily activities more independently.
2. **Engaging and Enjoyable Therapy**
    - Transforms monotonous rehabilitation exercises into fun and interactive gaming experiences, increasing the child's willingness to participate consistently.
3. **Cost-Effective Solution**
    - Provides an affordable alternative to expensive therapeutic devices, making rehabilitation accessible to families and organizations with limited resources.
4. **Customizable for Individual Needs**
    - Adapts to the specific abilities and progress of each child, ensuring a personalized therapeutic experience.
5. **Accessible for Home Use**
    - Allows therapy to be continued at home, reducing the need for frequent visits to rehabilitation centers and providing convenience for families.
6. **Supports Cognitive Developmen**.

Design of the project

FLOW CHART

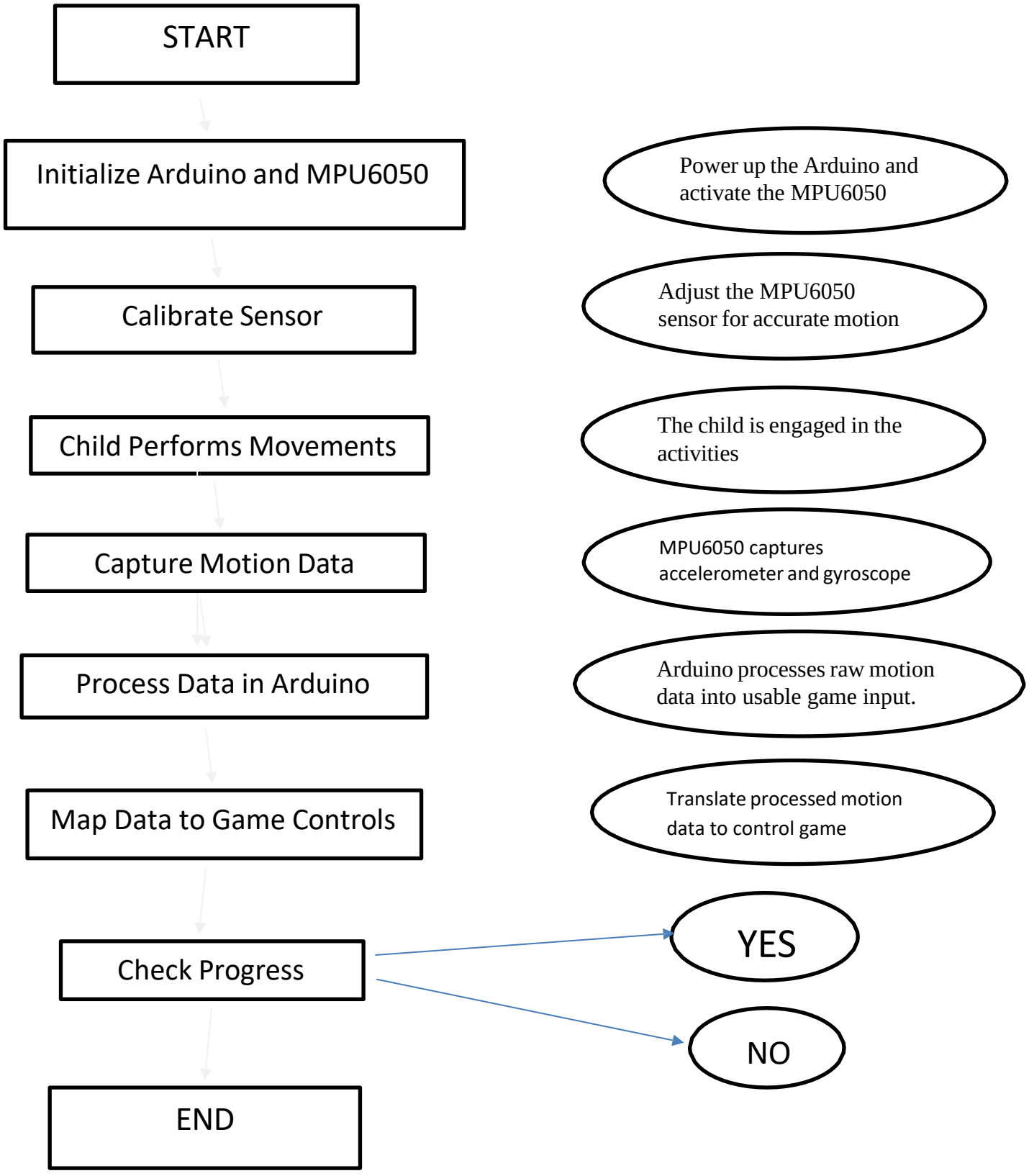
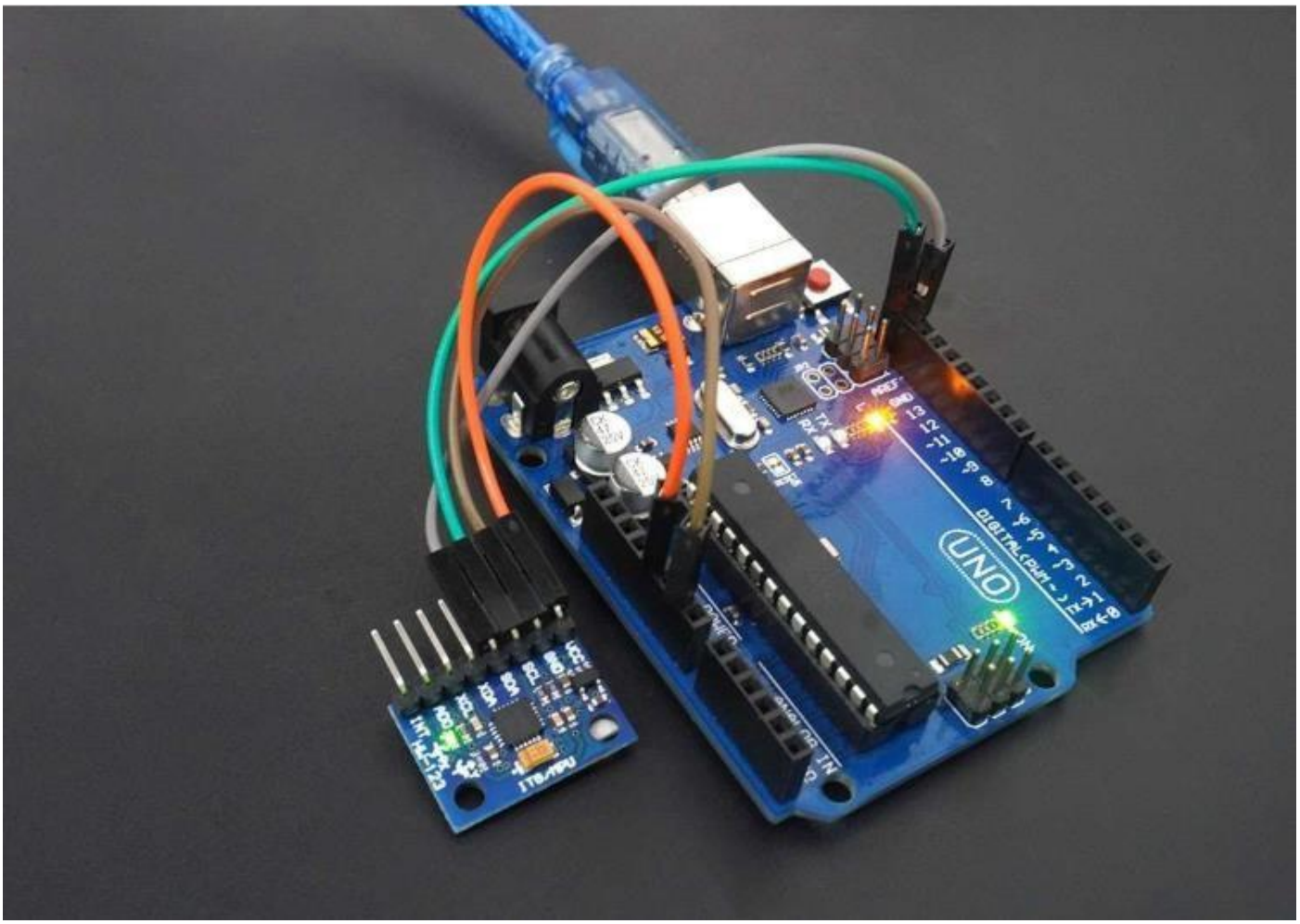


DIAGRAM:



UNO&MPU6050 CONNECTION

MPU6050 Module

Implementation of the project

COMPONENTS LIST AND SPECIFICATION

1. **Arduino Uno**
   - **Type**: Microcontroller board
   - **Specifications**:
     - ATmega328P microcontroller
     - Operating Voltage: 5V
     - Input Voltage: 7-12V
     - Digital I/O Pins: 14 (6 PWM outputs)
     - Analog Input Pins: 6
     - Clock Speed: 16 MHz
2. **MPU6050 Sensor**
   - **Type**: 6-axis accelerometer and gyroscope
   - **Specifications**:
     - Supply Voltage: 3.3V-5V
     - Accelerometer Range: ±2g, ±4g, ±8g, ±16g
     - Gyroscope Range: ±250, ±500, ±1000, ±2000 °/s
     - Communication: I2C (SDA, SCL pins)
     - In-built Digital Motion Processor (DMP)
3. **Game Interface (PC or Display Device)**
   - **Type**: Computer or display for hosting the game
   - **Specifications**:
     - Minimum Requirement: Any PC or device capable of running basic graphics or game applications
     - Interface: USB connection to Arduino
4. **Connecting Wires**
   - **Type**: Male-to-Male, Male-to-Female jumper wires
   - **Specifications**:
     - Length: 10-20 cm
     - Compatibility: Standard breadboard and Arduino pins
5. **Power Supply**
   - **Type**: USB power or external adapter
   - **Specifications**:
     - USB Input: 5V
     - External Adapter: 7-12V
6. **Breadboard (Optional)**
   - **Type**: Solderless prototyping board
   - **Specifications**:
     - Size: Medium or large for multiple connections
     - Compatibility: Supports standard jumper wires and Arduino pins
7. **Game Software**
   - **Type**: Custom-designed therapeutic game application
   - **Specifications**:
     - Supports motion-based inputs from Arduino
     - Provides real-time feedback and records progress
8. **Cables**
   - **Type**: USB cable (Type A to B for Arduino)
   - **Specifications**:
     - Length: 1-2 meters
     - Compatibility: Standard USB ports

ALGORITHM:

We have implemented the code using Arduino Idle.

1. **Start**
   - Include necessary libraries (Wire.h, MPU6050.h).
   - Create an MPU6050 object.
2. **Initialization**
   - Begin serial communication at 9600 baud rate.
   - Start I2C communication using Wire.begin().
   - Initialize the MPU6050 sensor using mpu.initialize().
   - Check the sensor connection with mpu.testConnection().
     - If the connection fails, print an error message and halt execution.
     - Otherwise, print "MPU6050 connected".
3. **Read Sensor Data** (in the loop function):
   - Declare variables for acceleration data (ax, ay, az).
   - Read acceleration values from the MPU6050 using mpu.getAcceleration(&ax, &ay, &az).
4. **Calculate Angles**
   - Compute the tilt angle along the x-axis: xAngle=arctan⁡(axay2+az2)×57.3xAngle = \arctan\left(\frac{ax}{\sqrt{ay^2 + az^2}}\right) \times 57.3xAngle=arctan(ay2+az2ax)×57.3.
   - Compute the tilt angle along the y-axis: yAngle=arctan⁡(ayax2+az2)×57.3yAngle = \arctan\left(\frac{ay}{\sqrt{ax^2 + az^2}}\right) \times 57.3yAngle=arctan(ax2+az2ay)×57.3.
5. **Display Data**
   - Print xAngle and yAngle to the Serial Monitor in the format: xAngle, yAngle.
6. **Delay**
   - Wait for 100 milliseconds to allow smooth readings.
7. **Repeat**
   - Return to Step 3.
8. **End**

RESULTS OF THE PROJECT:

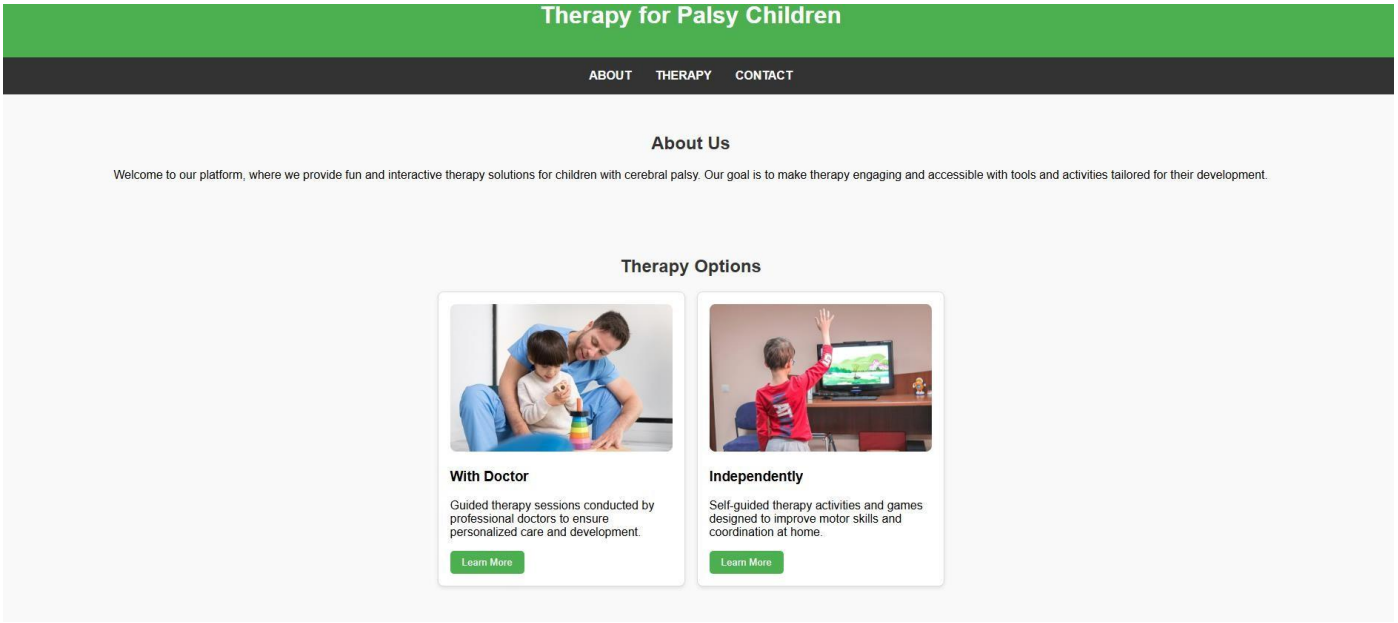
Output Serial Monitor ×

Message (Enter to send message to 'Arduino Uno' on 'COM7')

```
15:28:00.315 -> -89.38,-89.28
15:28:00.434 -> -89.36,-89.00
15:28:00.538 -> -89.45,-88.77
15:28:00.615 -> -89.35,-89.70
15:28:00.752 -> -89.22,nan
15:28:00.811 -> -89.34,-88.93
15:28:00.926 -> nan,-89.19
15:28:01.035 -> nan,nan
15:28:01.158 -> nan,-88.85
15:28:01.222 -> -89.64,nan
15:28:01.337 -> -89.42,-88.96
15:28:01.453 -> nan,nan
15:28:01.553 -> nan,nan
15:28:01.660 -> nan,nan
15:28:01.747 -> nan,nan
15:28:01.830 -> nan,-89.84
15:28:01.944 -> nan,-89.05
15:28:02.070 -> -89.29,nan
15:28:02.175 -> -89.39,nan
15:28:02.241 -> -89.57,nan
15:28:02.355 -> nan,-89.17
15:28:02.464 -> -89.19,nan
15:28:02.576 -> nan,nan
15:28:02.646 -> nan,nan
15:28:02.776 -> nan,-89.25
15:28:02.849 -> nan,-88.81
15:28:02.951 -> nan,-88.72
15:28:03.056 -> -89.43,nan
15:28:03.155 -> nan,-88.73
15:28:03.260 -> -89.21,-89.19
15:28:03.375 -> -89.59,-89.05
15:28:03.495 -> nan,-88.90
```

DETECTION OF POSITION UISNG MPU6050

WEBSITE VIEW:



LIMITATIONS:

- **Limited Motion Range**
  - The MPU6050 sensor is effective for detecting basic movements but may struggle with highly complex or subtle motions, limiting its applicability for advanced therapy needs.
- **Dependency on External Game Interface**
  - The system relies on an external computer or display device for the game interface, which may not be portable or convenient in all scenarios.
- **Accuracy and Calibration Challenges**
  - Regular calibration of the MPU6050 sensor is required to ensure accuracy, which might be cumbersome for non-technical users.
  - External factors like vibrations or improper sensor placement can affect motion tracking.
- **Customization Complexity**
  - Adapting the game and sensitivity settings to individual needs requires some technical knowledge, which may not be readily available to caregivers.
- **Limited Therapeutic Scope**
  - The system focuses on motor skill improvement but does not address other rehabilitation aspects like speech or cognitive therapy.
- **Data Analysis and Storage**

- The system records progress but may lack robust tools for advanced data analysis, making it challenging to derive detailed insights without additional software.

- **Hardware Durability**
  - The MPU6050 sensor and Arduino setup might not withstand prolonged use or rough handling, particularly in a pediatric setting.

CONCLUSION:

The game-based rehabilitation system for children with cerebral palsy using Arduino and MPU6050 sensor offers a cost-effective, engaging, and innovative solution to enhance motor skill development. By integrating motion tracking with interactive gameplay, the system makes therapy enjoyable, motivating children to participate consistently in rehabilitation exercises.

The project demonstrates the potential of affordable technology in addressing real-world challenges faced by children with disabilities. Its adaptability, ease of use, and ability to provide real-time feedback make it a valuable tool for caregivers, therapists, and families.

Through its focus on accessibility, personalization, and measurable progress, this system bridges the gap between traditional therapy and modern, interactive solutions, contributing significantly to improving the quality of life for children with cerebral palsy.

REFERENCES:

1. Cans, C.; Dolk, H.; Platt, M.; Colver, A.; Prasauskene, A.; Rägeloh-mann, I.K. Recommendations from the SCPE collaborative group for defining and classifying cerebral palsy. Dev. Med. Child Neurol. 2007, 49, 35–38.

2. James, S.; Ziviani, J.; Ware, R.S.; Boyd, R.N. Relationships between activities of daily living, upper limb function and visual perception in children and adolescents with unilateral cerebral palsy. Dev. Med. Child Neurol. 2015, 57, 852–857.

3. Di Carlo, A. Human and economic burden of stroke. Age Ageing 2009, 38, 4–5.

4. Hendricks, H.T.; Van Limbeek, J.; Geurts, A.C.; Zwarts, M.J. Motor recovery after stroke: A systematic review of the literature. Arch. Phys. Med. Rehabil. 2002, 83, 1629–1637.

5. Mutai, H.; Furukawa, T.; Araki, K.; Misawa, K.; Hanihara, T. Long-term outcome in stroke survivors after discharge from a convalescent rehabilitation ward. Psychiatry Clin. Neurosci. 2013, 67, 434–440.

6. Rosero-Montalvo, P.D.; Batista, V.F.L.; Rosero, E.A.; Jaramillo, E.D.; Caraguay, J.A.; Pijal- Rojas, J.; Peluffo-Ordóñez, D.H. Intelligence in Embedded Systems: Overview and Applications; Springer: Cham, Switzerland, 2019; pp. 874–883