Department of Computer Science and Engineering

BRAC University

Course Title: Computer Interfacing.

Course Code:360

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Project Title: Smart Crutch

Introduction:

we are developing a smart crutch designed to mitigate the difficulties faced by individuals with mobility impairments, especially those with leg issues. The research indicates that many patients experience significant challenges due to the absence of an intelligent, supportive device. This project aims to fill that gap by providing an innovative and practical solution to enhance their daily mobility and overall quality of life.

Tools and technology:

- Buzzer: Provides an alert noise when the crutch falls.
- LDR (Light Dependent Resistor): Senses the dimness of light in the environment and helps to turn on the LED.
- LED: Turns on based on the pressure applied.
- Switch: For turning the device on and off.

Sensors Working Mechanism:

In this project, we use a pressure sensor (BMP) along with LED lights to measure the stress applied by the user. The LED lights are connected in the screw holes of the crutch. As a result, when the user applies pressure to the crutch, the LED lights will turn on proportionally to the pressure, ranging from low to high. Our goal is to monitor the user's improvement over time. Essentially, the LEDs have a proportional relationship with the pressure sensor: higher pressure results in more lights turning on, and lower pressure results in fewer lights turning on. As the user improves and applies less pressure, fewer lights will turn on.

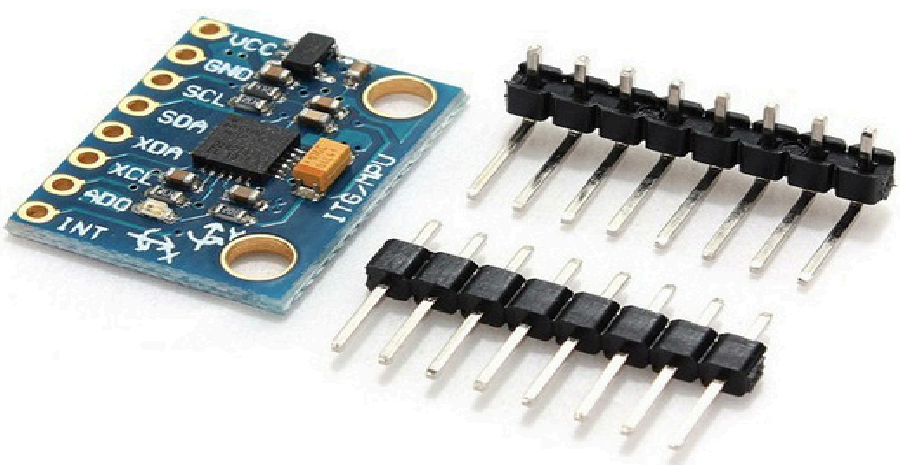
Secondly, we incorporate a 6DOF (Degrees of Freedom) gyro sensor into the crutch. If the crutch falls, or if the user falls, the buzzer will automatically sound, drawing the attention of nearby people. This feature is particularly useful for patients with severe mobility issues, as it can help reduce their hassle in emergency situations.
Lastly, we add a light sensor (LDR) and install additional lights. When the ambient light level drops below a certain threshold, the LDR senses the dimness and automatically turns on the preinstalled LED lights. This feature eliminates the need for the patient to carry a flashlight, enhancing convenience and safety in low-light conditions.

Required Components:

- Arduino
- Buzzer
- Led lights-3mm
- Led lights
- LDR
- 6 dof MPU gyro sensor
- Bmp280 pressure sensor

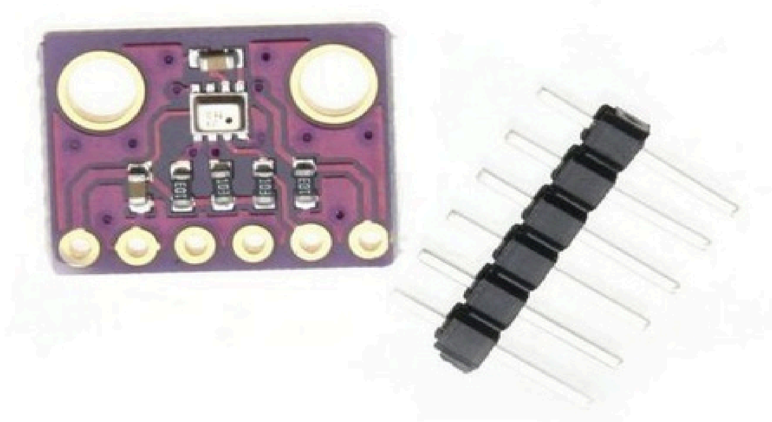
Sensors:

Pressure sensor(6-dof-Mpu)



- Light sensors-LDR:

- Light Dependent Resistor (LDR)



- BMP280 Pressure Sensor

- crutch

Circuit Design

The smart crutch system is designed to integrate multiple sensors and components to achieve its functionality. The key components used are a pressure sensor (BMP280), LED lights, a 6DOF gyro sensor, a buzzer, a light-dependent resistor (LDR), and a switch. Below are the steps and details of the design and implementation:

1. Pressure Sensor (BMP280) and LED Integration:
    - Components:
        - BMP280 pressure sensor
        - LED lights
    - Connection:
        - The BMP280 sensor is connected to the microcontroller, with its output pins wired to the input pins of the microcontroller.
        - LEDs are connected to the microcontroller through resistors to limit the current.
        - The LEDs are placed in the screw holes of the crutch.
    - Working:
        - The pressure sensor measures the stress applied by the user. The microcontroller reads this data and lights up the LEDs proportionally to the pressure level. Higher pressure lights up more LEDs, indicating the user's reliance on the crutch.

Circuit Design

2. 6DOF Gyro Sensor and Buzzer Integration:

- Components:
  - 6DOF gyro sensor
  - Buzzer
- Connection:
  - The gyro sensor is connected to the microcontroller to detect the orientation and movement of the crutch.
  - The buzzer is connected to a digital output pin of the microcontroller.
- Working:
  - When the gyro sensor detects a fall or unusual tilt, it sends a signal to the microcontroller, which then activates the buzzer to alert nearby people.

3. Light-Dependent Resistor (LDR) and LED Lights:

- Components:
  - LDR sensor
  - Additional LED lights
- Connection:
  - The LDR is connected to an analog input pin of the microcontroller to measure ambient light levels.
  - Additional LEDs are connected to the microcontroller through resistors.
- Working:
  - The LDR senses the dimness of the environment. When the ambient light falls below a certain threshold, the microcontroller turns on the additional LEDs to provide illumination, eliminating the need for the patient to carry a flashlight.

Circuit Design

4. Switch Integration:

- Components:
  - On/Off switch
- Connection:
  - The switch is connected to the power supply line of the microcontroller to control the entire system.
- Working:
  - The switch allows the user to turn the smart crutch system on or off as needed.

Implementation Steps

Assembling the Hardware:

- Connecting the BMP280 sensor, 6DOF gyro sensor, LDR, LEDs, buzzer, and switch to the microcontroller on a breadboard or a custom PCB.
- Ensuring all connections are secure and properly insulated to prevent short circuits.

Programming the Microcontroller:

Reading Data from the BMP280 Sensor and Adjusting LED Brightness
To read data from the BMP280 sensor and adjust the brightness of the LEDs based on the pressure readings, we will use the Arduino IDE and the Adafruit BMP280 library.

```
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_BMP280.h>

Adafruit_BMP280 bmp; // I2C

const int ledPin = 9; // PWM pin for LED

void setup() {
  Serial.begin(9600);
  if (!bmp.begin()) {
    Serial.println(F("Could not find a valid BMP280 sensor, check
wiring!"));
    while (1);
  }
  pinMode(ledPin, OUTPUT);
}

void loop() {
  float pressure = bmp.readPressure();
  Serial.print(F("Pressure = "));
  Serial.print(pressure);
  Serial.println(" Pa");

  int ledBrightness = map(pressure, 90000, 110000, 0, 255);
  analogWrite(ledPin, ledBrightness);

  delay(500);
}
```

Reading Gyro Sensor Data and Activating the Buzzer

To read data from the 6DOF gyro sensor and activate the buzzer if a fall is detected, we will use the MPU6050 library.

```
#include <Wire.h>
#include <MPU6050.h>

MPU6050 mpu;
const int buzzerPin = 8;

void setup() {
  Serial.begin(9600);
  Wire.begin();
  mpu.initialize();
  pinMode(buzzerPin, OUTPUT);

  if (!mpu.testConnection()) {
    Serial.println(F("MPU6050 connection failed!"));
    while (1);
  }
}

void loop() {
  Vector rawAccel = mpu.readRawAccel();
  int16_t ax = rawAccel.XAxis;
  int16_t ay = rawAccel.YAxis;
  int16_t az = rawAccel.ZAxis;

  if (abs(ax) > 15000 || abs(ay) > 15000 || abs(az) < 5000) {
    digitalWrite(buzzerPin, HIGH);
  } else {
    digitalWrite(buzzerPin, LOW);
  }
```

Monitoring LDR Readings and Turning on LEDs in Low-Light Conditions

To monitor the LDR readings and turn on additional LEDs in low-light conditions, we will read the analog value from the LDR and control the LED accordingly.

```
const int ldrPin = A0;
const int lightLedPin = 10;

void setup() {
  Serial.begin(9600);
  pinMode(lightLedPin, OUTPUT);
}

void loop() {
  int ldrValue = analogRead(ldrPin);
  Serial.print(F("LDR Value = "));
  Serial.println(ldrValue);

  if (ldrValue < 300) {
    digitalWrite(lightLedPin, HIGH);
  } else {
    digitalWrite(lightLedPin, LOW);
  }

  delay(500);
}
```

Project Results

The smart crutch project successfully integrated sensors and components to address common mobility challenges. The BMP280 pressure sensor provided accurate measurements, with LEDs lighting up proportionally to the pressure, allowing for monitoring user improvement. The MPU6050 gyro sensor effectively detected falls, activating a buzzer to alert nearby individuals and enhance user safety. Additionally, the LDR sensor ensured automatic LED activation in low-light conditions, offering improved visibility and convenience. Overall, the smart crutch achieved its goal of reducing the difficulties faced by individuals with mobility issues.

Conclusion

The smart crutch project successfully achieved its objectives of mitigating the challenges faced by individuals with mobility issues. By integrating pressure monitoring, fall detection, and automatic lighting, the smart crutch provided real-time feedback, enhanced safety, and improved convenience for users. The project demonstrated the feasibility and effectiveness of using sensor technology in assistive devices, highlighting its potential to significantly improve the quality of life for those with mobility impairments.

Future Work

Future enhancements could improve power management by implementing low-power modes and exploring alternative power sources. User interface improvements, such as adding a display and haptic feedback, would provide real-time feedback and additional sensory input. Incorporating wireless connectivity through Bluetooth or Wi-Fi would enable remote monitoring and control, while a mobile application could assist caregivers in tracking user progress and receiving alerts. Additional sensors, like GPS for location tracking and health monitoring sensors for comprehensive health data, could further refine and enhance the smart crutch, providing even greater support and assistance to users.