International Islamic University, Islamabad

Faculty of Engineering and Technology

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MICROPROCESSOR AND INTERFACING

LAB-EXAM REPORT

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Microprocessor Lab Exam

Lab Exam Title: Interfacing Sensors and Display with Arduino

Introduction: The use of microcontrollers has become essential in modern electronics due to their versatility and ability to control various sensors and devices. In this lab exam, an Arduino Uno microcontroller is used to interface multiple components, including a DHT11 temperature and humidity sensor, a PIR motion sensor, and a 4x3 keypad. These sensors provide real-time data that can be utilized for various applications such as environmental monitoring and security systems. The data from the sensors is displayed on an I2C LCD, which simplifies the visualization process. The keypad is used to select which sensor's data is displayed, making the system interactive and user-friendly. This project demonstrates the integration of sensors, input devices, and output displays, which are fundamental in embedded system design.

Objective:

1. To understand the interfacing of DHT11 temperature and humidity sensor, PIR motion sensor, and a 4x3 keypad with an Arduino Uno.
2. To develop a system that allows real-time monitoring of sensor data using an I2C LCD.
3. To implement an interactive control mechanism using a keypad to display specific sensor data based on user input.
4. To explore practical applications of embedded systems in fields such as environmental monitoring and security.

Components Used:

1. Arduino Uno
2. DHT11 Temperature and Humidity Sensor
3. PIR Motion Sensor
4. 4x3 Keypad
5. I2C LCD (16x2)
6. Jumper Wires
7. Breadboard

Pin Configuration:

- **DHT11:** Connected to Pin 10
- **PIR Sensor:** Connected to Pin 11
- **4x3 Keypad:**
  - Rows: Pins 9,8,7,6
  - Columns: Pins 4,3,2
- **I2C LCD:**
  - SDA: Pin 12
  - SCL: Pin 13

Working Principle:

1. The DHT11 sensor is used to measure the temperature and humidity of the environment. It communicates with the Arduino via a single digital pin using the DHT library.
2. The PIR motion sensor detects motion by sensing changes in infrared radiation. When motion is detected, it outputs a HIGH signal; otherwise, it outputs LOW.
3. The 4x3 keypad serves as an input device that allows the user to select which sensor's data is displayed on the LCD. The keys '1' and '2' correspond to the PIR and DHT11 sensors, respectively.
4. An I2C LCD is used to display the data. This type of LCD uses fewer pins, as it communicates with the Arduino via the I2C protocol.
5. The system operates in real-time, where the user can press a key to fetch data from the corresponding sensor, and the data is displayed on the LCD.

Code Explanation:

1. **Initialization:**
   - The LCD is initialized with its I2C address (0x27) and configured to display 16x2 characters.
   - The DHT11 sensor is initialized using the DHT library.
   - The PIR sensor pin is configured as an input.
   - The keypad is configured to read key presses.
2. **Keypad Input Handling:**
   - The `loop()` function continuously checks for key presses.
   - If '1' is pressed, the system reads the PIR sensor to check for motion and displays "Motion: Detected" or "Motion: None" on the LCD.

- If '2' is pressed, the system reads the DHT11 sensor to fetch temperature and humidity values. If the sensor fails to provide valid readings, an error message is displayed.

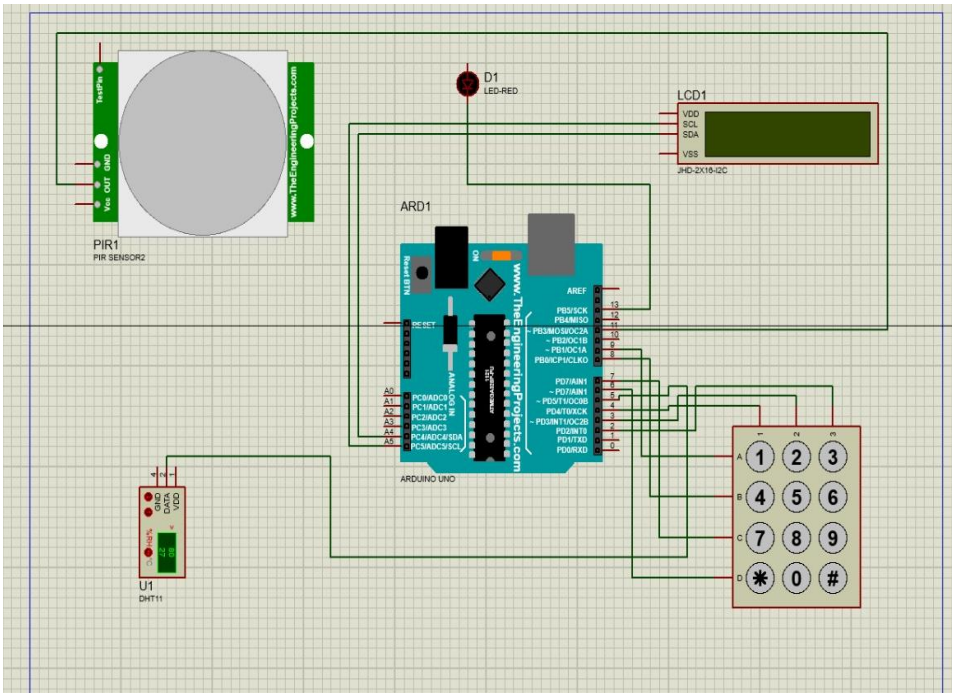
3. **Data Display:**
   - Sensor data is displayed on the LCD for 2 seconds before the screen is cleared, allowing the user to make another selection.

Code:

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <Keypad.h>
#include <DHT.h>

// Define DHT11 sensor
#define DHTPIN 5
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

// Define PIR sensor
#define PIRPIN 11

// Initialize the LCD
LiquidCrystal_I2C lcd(0x27, 16, 2); // Adjust the address (0x27) if
needed

// Define the 4x3 keypad
const byte ROWS = 4;
const byte COLS = 4;
char keys[ROWS][COLS] = {
  {'1', '2', '3',},
  {'4', '5', '6',},
  {'7', '8', '9',},
  {'*', '0', '#',}
};
byte rowPins[ROWS] = {9, 8, 7, 6}; // Connect to the row pins of the
keypad
byte colPins[COLS] = {4, 3, 2}; // Connect to the column pins of the
keypad
Keypad keypad = Keypad(makeKeymap(keys), rowPins, colPins, ROWS,
COLS);

void setup() {
  // Initialize LCD
  lcd.begin();
  lcd.backlight();
  lcd.print("System Initializing");

  // Initialize DHT sensor
```

```
  dht.begin();

  // Initialize PIR sensor
  pinMode(PIRPIN, INPUT);

  // Wait for 2 seconds
  delay(2000);
  lcd.clear();
  lcd.print("Ready");
  delay(1000);
}

void loop() {
  // Read keypad input
  char key = keypad.getKey();
  if (key) {
    lcd.clear();
    if (key == '1') {
      // Read PIR sensor
      int pirState = digitalRead(PIRPIN);
      if (pirState == HIGH) {
        lcd.print("Motion: Detected");
      } else {
        lcd.print("Motion: None");
      }
    } else if (key == '2') {
      // Read temperature and humidity from DHT11
      float temperature = dht.readTemperature();
      float humidity = dht.readHumidity();

      // Check if the readings are valid
      if (isnan(temperature) || isnan(humidity)) {
        lcd.print("Sensor Error");
      } else {
        lcd.print("Temp: ");
        lcd.print(temperature);
        lcd.print("C");
        lcd.setCursor(0, 1);
        lcd.print("Humidity: ");
        lcd.print(humidity);
        lcd.print("%");
      }
    } else {
      lcd.print("Invalid Key");
    }
    delay(2000);
    lcd.clear();
  }
}
```

Schematics:



Applications:

1. **Home Automation:** The system can monitor environmental conditions and detect motion for security purposes.
2. **Weather Monitoring:** The DHT11 sensor can be used to measure temperature and humidity in real-time.
3. **Interactive Systems:** The keypad provides a user-friendly way to interact with the system.

Conclusion: The lab exam successfully demonstrated the integration of multiple sensors, an input device, and a display with the Arduino Uno. The system was able to read and display real-time data based on user input on the keypad. This project highlights the potential of embedded systems in applications such as smart homes, security systems, and environmental monitoring. The modular design of the system makes it scalable and adaptable for additional sensors or features in future implementations. Special thanks to Sir Asad for his invaluable guidance during the lab lectures.