Defiarl'menl' of Sofl'ware Engineering

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Submitted To :

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Course:

Embedded Systems

Date:

9th June 2024

"Presentation Assignment"

“Timer and Interrupts in AVR microcontrollers and I2C communication”

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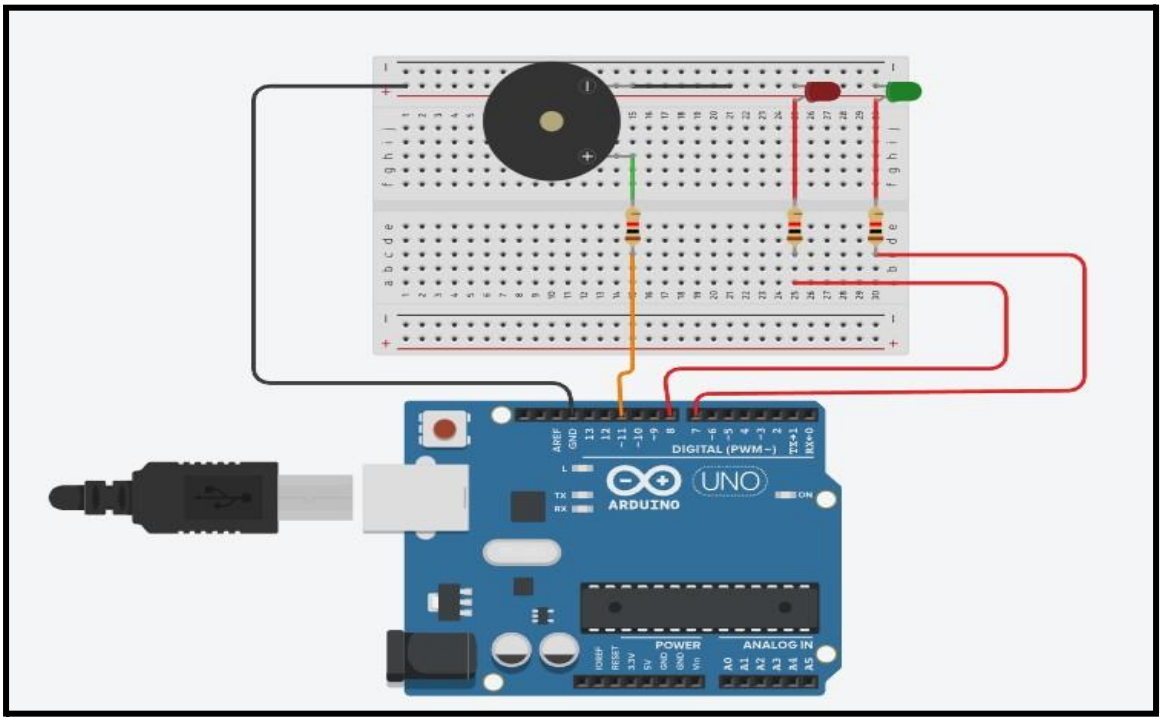
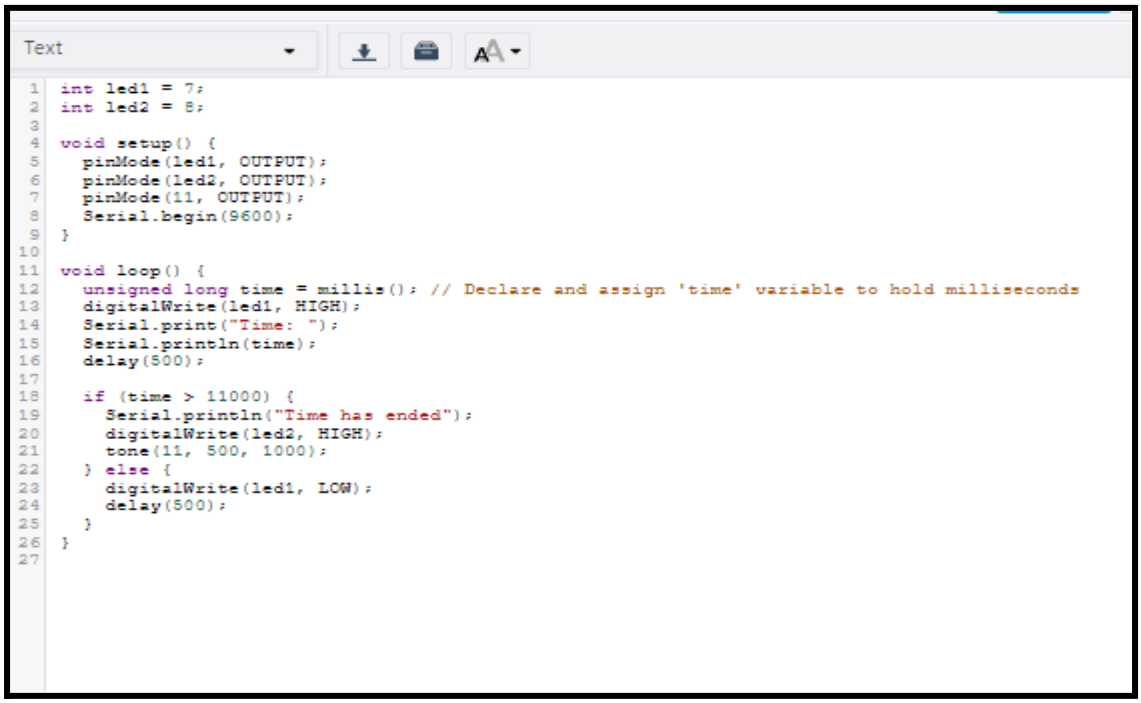
Timer:

Timers in AVR microcontrollers have input pins designed to trigger input capture events. When a signal change is detected at such a pin, the timer value is immediately read and stored in the Input Capture Register (ICRx). Concurrently, the Input Capture Flag (ICFx) in the Timer/Counter Interrupt Flag Register (TIFRn) is set. This feature is particularly useful for measuring the duration of external pulses.

Circuit diagram:



Code:



```
Text

int led1 = 7;
int led2 = 8;

void setup() {
  pinMode(led1, OUTPUT);
  pinMode(led2, OUTPUT);
  pinMode(11, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  unsigned long time = millis(); // Declare and assign 'time' variable to hold milliseconds
  digitalWrite(led1, HIGH);
  Serial.print("Time: ");
  Serial.println(time);
  delay(500);

  if (time > 11000) {
    Serial.println("Time has ended");
    digitalWrite(led2, HIGH);
    tone(11, 500, 1000);
  } else {
    digitalWrite(led1, LOW);
    delay(500);
  }
}
```

Components:

- **Arduino Uno**: The main microcontroller board.
- **Breadboard**: For prototyping the circuit.
- **LEDs (Red and Green)**: Connected to digital pins 7 and 8 through resistors.
- **Piezo Buzzer**: Connected to digital pin 11 for sound output.
- **Resistors**: Current limiting resistors for LEDs.
- **Connecting Wires**: To establish connections between components and Arduino

Connections:

- **Red LED**: Anode connected to digital pin 8 via a resistor, cathode connected to ground.
- **Green LED**: Anode connected to digital pin 7 via a resistor, cathode connected to ground.
- **Buzzer**: Connected to digital pin 11 and ground.
- **Power and Ground Lines**: Connected from the Arduino to the breadboard to supply power to components

This cricut create using a simple timer with Arduino. The green LED blinks until 11 seconds have passed, after which the red LED lights up, and the buzzer sounds for 1 second. The current time is continuously printed to the serial monitor for debugging purposes.\

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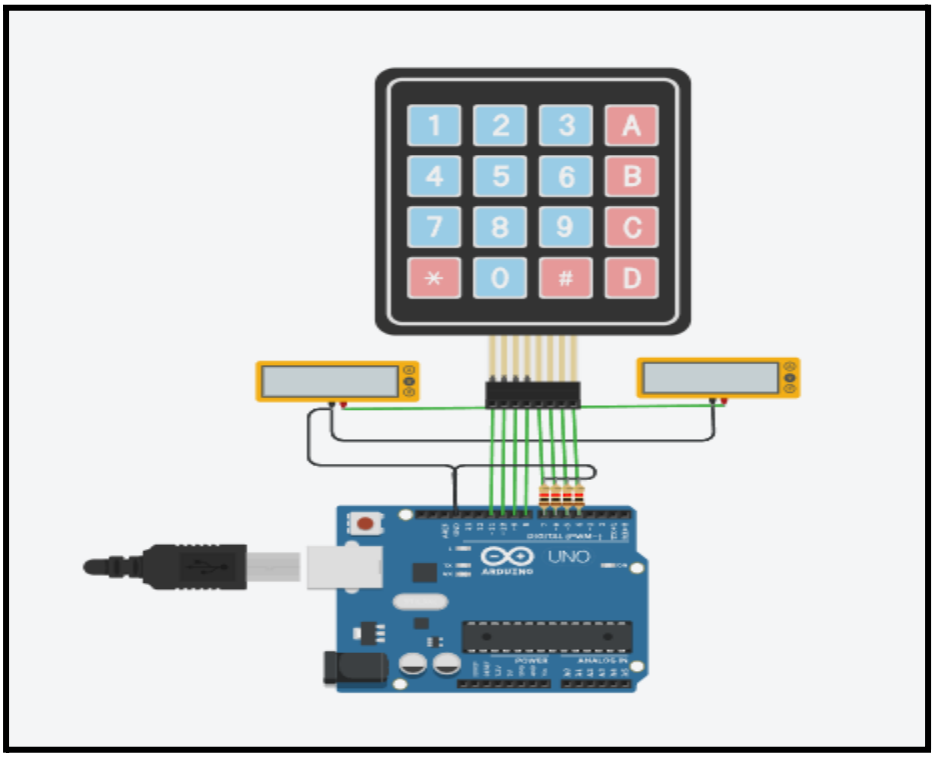
Interrupt:

AVR devices are equipped with external interrupts that can wake the device from sleep mode in response to a rising or falling edge signal or a change in the digital voltage level at an I/O pin. Once awakened, the device processes the application based on the interrupt source before returning to sleep mode.

Circuit diagram:



code:

```
#include <Keypad.h>

const byte ROWS = 4; // Four rows
const byte COLS = 4; // Four columns

char keys[ROWS][COLS] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};

byte rowPins[ROWS] = {2, 3, 4, 5};
byte colPins[COLS] = {6, 7, 8, 9};

Keypad keypad = Keypad(makeKeymap(keys), rowPins, colPins, ROWS, COLS);

void setup() {
  Serial.begin(9600);
}

void loop() {
  char key = keypad.getKey();

  if (key) { // Check if a key is pressed
    Serial.println(key);
    // Convert the character key to a voltage signal and print it
    float voltage = mapKeyToVoltage(key);
    Serial.print("Voltage: ");
    Serial.println(voltage);
  }
}

// Function to map keypad keys to a voltage signal (for demonstration)
float mapKeyToVoltage(char key) {
  // Here, we arbitrarily map each key to a specific voltage value
  // You can adjust these values to fit your needs or experiment with different mapping
  if (key >= '0' && key <= '9') {
    return (key - '0') * 0.1; // Map keys '0' to '9' to voltages from 0.0V to 0.9V
  } else if (key == '*') {
    return 1.0; // Map '*' key to 1.0V
  } else if (key == '#') {
    return 2.0; // Map '#' key to 2.0V
  } else {
    return 0.0; // Map other keys to 0.0V
  }
}
```

Rows (R1, R2, R3, R4) are connected to Arduino digital pins 2, 3, 4, 5.
Columns (C1, C2, C3, C4) are connected to Arduino digital pins 6, 7, 8, 9

The code sets up a 4x4 keypad and uses pin change interrupts to handle key presses. The keyPressed function is called whenever there is a change on one of the column pins.

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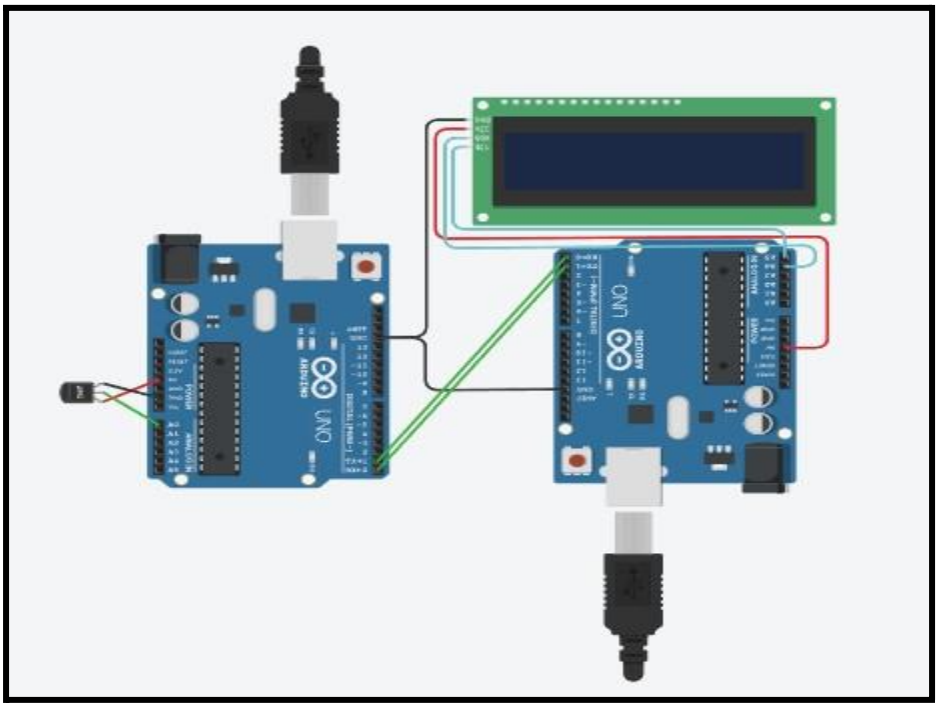
Spi and I2C communication:

I2C combines the best features of SPI and UART communication protocols. Like SPI, I2C allows you to connect multiple slave devices to a single master. Additionally, I2C supports multiple masters, enabling multiple microcontrollers to control one or more slaves. This feature is particularly useful when you need several microcontrollers to log data to a single memory card or display text on a single LCD.

Circuit diagram:



Components:

- **TMP36 Temperature Sensor**: Connected to an analog input pin (A0) on the Arduino.
- **Arduino Uno (Master)**: Reads the temperature and sends it over I2C
- **MCP23008-based LCD Module**: For I2C communication with the LCD.
- **Arduino Uno (Slave)**: Receives temperature data and displays it on the LCD.

Master Arduino:

Text 1 (Arduino Uno R3)

```
#include <Wire.h>

#define TMP36_PIN A0 // Analog pin connected to TMP36 sensor

void setup() {
  Wire.begin(); // Initialize I2C communication
  Serial.begin(9600); // Initialize serial communication
}

void loop() {
  // Read temperature from TMP36 sensor
  int sensorValue = analogRead(TMP36_PIN); // Read the temperature sensor value
  float voltage = sensorValue * (5.0 / 1023.0); // Convert the analog reading to voltage (0 to 5V)
  float temperatureC = (voltage - 0.5) * 100; // Convert voltage to temperature (in degrees Celsius) for TMP36 sensor

  // Send temperature data over I2C to slave Arduino
  Wire.beginTransmission(0x27); // Slave address (0x27 for example, adjust as needed)
  Wire.write((byte*)&temperatureC, sizeof(temperatureC)); // Send temperature data
  Wire.endTransmission(); // Stop transmitting

  Serial.println(temperatureC); // Print temperature to serial monitor

  delay(1000); // Wait for 1 second before the next reading
}
```

Slave Aduino:

Text

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

#define LCD_ADDRESS 0x20 // Address of the MCP23008-based LCD module

#define LCD_COLUMNS 16 // Number of columns in the LCD
#define LCD_ROWS 2     // Number of rows in the LCD

LiquidCrystal lcd(12, 11, 5, 4, 3, 2); // Initialize LCD

void setup() {
  Wire.begin(9); // Initialize I2C communication as Slave with address 9
  Wire.onReceive(receiveData); // Register callback for receiving data
  Serial.begin(9600); // Initialize serial communication
  lcd.begin(LCD_COLUMNS, LCD_ROWS); // Initialize LCD
  lcd.print("Temperature: "); // Print static message
}

void loop() {
  // Do other stuff if needed, but keep it non-blocking
}

void receiveData(int byteCount) {
  float temperatureC;
  while (Wire.available()) {
    Wire.readBytes((uint8_t*)&temperatureC, sizeof(temperatureC)); // Receive temperature data
  }

  Serial.println(temperatureC); // Print received temperature to serial monitor

  lcd.setCursor(0, 1); // Set cursor to the beginning of the second row
  lcd.print("Temp: ");
  lcd.print(temperatureC); // Print the temperature
  lcd.print(" C   ");      // Print units and clear any leftover characters
}
```

- The master Arduino reads temperature data from a TMP36 sensor and sends it via I2C to a slave Arduino.
- The slave Arduino receives the temperature data and displays it on an LCD screen.
- The master Arduino also prints the temperature data to the serial monitor for debugging

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