Smart Home Energy Monitor

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Course: NET3001 Computer Systems

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Due on April 10th, 2024

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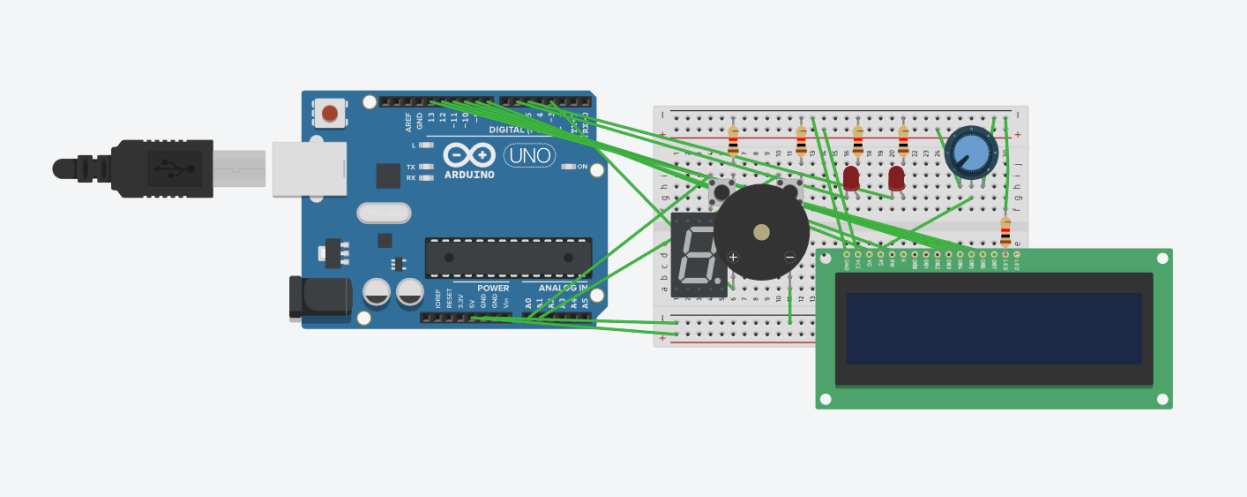
Brief description of the system:

The Smart Home Energy Monitor is an embedded system designed to monitor and optimize energy usage within a home. It tracks electricity consumption in real-time and provides users with insights to help them make informed decisions about energy usage and conservation.

This project aims to empower homeowners to monitor and manage their energy usage more effectively, promoting energy conservation and cost savings while reducing environmental impact.

Circuit Diagram:



- The 7 segment is not connected in the diagram because there was no space.

Components and topics used in the project:

Mandatory Topics and Components:

GPIO: Used for interfacing with energy monitoring sensors and controlling output devices.

Timers: Scheduled tasks for data logging and reporting.

Interrupts: Handle events such as sensor readings or user inputs.

LEDs: Indicate energy consumption levels or system status.

Push Buttons: Enable user interaction for viewing data or configuring settings.

7-segment Display: Display real-time energy consumption data.

LCD: Display detailed energy usage statistics and system status.

Shift Registers: Expand GPIO capabilities for driving multiple LEDs or displays efficiently.

Optional Topic and Components:

USART: Enable communication with external devices or data logging systems.

Active or Passive Buzzers: Provide audible alerts for high energy consumption levels or system warnings.

Potentiometer: Allow users to adjust display brightness or contrast.

Detailed explanation of the system:

Include necessary header files for AVR I/O, interrupts, LCD, and timer functionalities

Declare global variable:

received_char as volatile char

Define functions:

usart_init()

Set baud rate to 9600

Enable receiver and transmitter

Set frame format: 8 data bits, 1 stop bit

Enable USART receive interrupt

usart_transmit(char data)

Wait for empty transmit buffer

Put data into buffer, sends the data

usart_receive()

Wait for data to be received

Get and return received data from buffer

ISR(USART_RX_vect)

Update received_char with received data

lcd_init()

Initialize LCD in 4-bit mode

Set up display parameters

Wait for LCD initialization to complete

lcd_cmd(unsigned char cmd)

Send a command to the LCD

lcd_data(unsigned char data)

Send data to the LCD

lcd_send_nibble(unsigned char nibble)

Send a 4-bit data to the LCD

lcd_trigger()

Send a trigger signal to the LCD

timer1_init()

Initialize Timer1 with a prescaler of 64

Enable overflow interrupt

button_init()

Initialize push buttons as inputs with pull-up resistors enabled

display7Segment(uint8_t combinedState)

Display a combined state on a 7-segment display using a shift register

Main function:

Initialize USART, LCD, shift register pins, push buttons, LEDs, and Timer1

Enable global interrupts

Loop:

Control LEDs based on button states

Display button states on a 7-segment display

Transmit received USART data to the LCD

Reflection:

During the project's planning phase, we deliberated between developing a smart energy monitor and a thermostat. Ultimately, we opted against pursuing the thermostat due to a lack of requisite components.

After thorough evaluation of both options, we settled on creating a smart energy monitoring system. This decision stemmed from its compatibility with various components from the Arduino kit, thus reducing the complexity of coding compared to the thermostat project.

Throughout the development process, we encountered several challenges. One notable issue was aligning timers to respond within designated timeframes. Additionally, we faced difficulties with button functionality and the LCD screen.

Experimenting with different LCDs helped resolve the latter issue. Furthermore, coordinating work remotely posed a challenge due to our disparate locations. Leveraging GitHub proved instrumental in facilitating collaboration despite this obstacle.

In hindsight, we acknowledge a couple of areas where we could have improved our approach. Firstly, we regret not pursuing the thermostat project, as we believe our experience gained from the energy monitoring system could have enhanced our execution. Secondly, seeking assistance from professors or teaching assistants when encountering obstacles could have expedited problem-solving and enriched our learning process.