Real Time Monitoring and Analysis of Temperature, Humidity, and Light Intensity

Group 4

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1 Introduction

The project involves the development of a real-time monitoring system utilizing the LunchBox microcontroller, which is powered by the MSP430G2553 microcontroller unit. This system aims to measure temperature, humidity, and light intensity using the DHT11 sensor for temperature and humidity readings and an LDR (Light Dependent Resistor) for light intensity. Additionally, an ADC (Analog-to-Digital Converter) module is utilized to convert analog signals from the LDR into digital data for processing. An LCD display is incorporated to provide real-time visualization of the collected data.

2 Hardware Components:

The key hardware components utilized in this project include:

- LunchBox Microcontroller (based on MSP430G2553) with built-in ADC and UART modules.
- DHT11 Sensor for temperature and humidity measurements.
- Light Dependent Resistor (LDR) for light intensity detection.
- LCD (Liquid Crystal Display) for real-time data visualization.

3 Project Objectives:

The primary objective of this project is to design a monitoring system capable of capturing and displaying real-time environmental data, including temperature, humidity, and light intensity. By leveraging the capabilities of the LunchBox microcontroller and its built-in peripherals, including ADC and UART, the system aims to offer a compact and efficient solution for monitoring environmental conditions. Additionally, the collected data is transmitted to a host device for further analysis and logging, facilitating long-term data collection and trend analysis.

4 Microcontroller and Sensors Connection:

The MSP430 microcontroller is utilized in conjunction with sensors such as the DHT11 temperature and humidity sensor, as well as an LDR (Light Dependent Resistor). The connections between the microcontroller and these sensors are as follows:

- DHT11 Sensor:

  The DHT11 sensor is connected to the microcontroller's GPIO pins for data communication. Specifically, the data pin of the DHT11 sensor is connected to one of the microcontroller's GPIO pins configured for input.

- LDR (Light Dependent Resistor):

  Similar to the DHT11 sensor, the LDR is connected to another GPIO pin of the microcontroller, allowing it to measure light intensity variations. Analog-to-Digital Converter (ADC) Interfacing:

  The MSP430 microcontroller integrates an Analog-to-Digital Converter (ADC) module, enabling it to convert analog signals from sensors into digital data for processing. The ADC module is configured as follows:

- Sensor Input:

  Analog sensors, such as the LDR, are connected to specific analog input pins of the microcontroller. For example, the LDR may be connected to the microcontroller's AIN pin.

- ADC Configuration:

  The ADC module is configured to sample the analog input signals and convert them into digital values. This configuration involves setting reference voltages, sampling time, and other parameters to ensure accurate conversion.

- LCD Interfacing:

  An LCD (Liquid Crystal Display) is interfaced with the microcontroller for visual feedback. The connections between the microcontroller and the LCD module include:

  1.Data Lines:

  Data lines (D4 to D7) of the LCD module are connected to GPIO pins of the microcontroller for sending data.

  2.Control Lines:

  Control lines, including RS (Register Select) and EN (Enable), are connected to separate GPIO pins of the microcontroller to control data transmission and LCD operation.

5 Working of Sensors

5.1 DHT11 Sensor

The DHT11 sensor is a digital sensor used for measuring temperature and humidity levels in the surrounding environment. It consists of a humidity sensing component and a thermistor for temperature measurement.

Humidity Sensing Component: The humidity sensing component of the DHT11 sensor typically comprises a moisture-sensitive material, such as a polymer, that changes its electrical resistance based on the moisture content in the air. As the humidity increases, the resistance of the material decreases, and vice versa.

Thermistor for Temperature Measurement: The DHT11 sensor also includes a thermistor, a type of resistor whose resistance changes with temperature. When the temperature rises, the resistance of the thermistor decreases, and when it drops, the resistance increases.

Functioning: The DHT11 sensor utilizes these two components to measure temperature and humidity. It sends a signal to the microcontroller, which then calculates the temperature and humidity values based on the resistance readings from the humidity sensing component and the thermistor.

5.2 LDR (Light Dependent Resistor)

An LDR, also known as a photoresistor, is a type of resistor whose resistance changes based on the amount of light falling on it. LDRs are often used in circuits to detect ambient light levels.

Semi-Conductive Material: LDRs are made of a semiconductor material, typically cadmium sulfide (CdS), whose conductivity changes with the amount of light it receives.

Functioning: When exposed to light, photons excite electrons in the semiconductor material, causing a decrease in resistance. This change in resistance is inversely proportional to the intensity of the light falling on the LDR. In other words, when more light is present, the resistance decreases, and when less light is present, the resistance increases.

Application: In electronic circuits, LDRs are commonly used to control the operation of devices based on ambient light levels. For example, they can be used in streetlights to automatically turn them on at dusk and off at dawn by sensing changes in light intensity.

6 UART Module Connection:

The UART (Universal Asynchronous Receiver/Transmitter) module of the MSP430 microcontroller facilitates communication with an external host device, such as a laptop. The UART module is connected as follows:

TX and RX Lines: The UART's Transmit (TX) and Receive (RX) lines are connected to corresponding pins of the microcontroller. The TX line of the UART module is connected to a GPIO pin configured for UART transmission, while the RX line is connected to another GPIO pin configured for UART reception.

7 Host Device Interface:

The other end of the UART communication is connected to the host device, typically a laptop or PC, via a suitable communication interface such as USB-to-serial converter. This enables bidirectional serial communication between the microcontroller and the host device, facilitating data exchange and control.

8 Software Implementation:

In the software implementation of the project, the microcontroller is programmed to perform several key functions, including reading sensor data, displaying real-time values on an LCD, and transmitting data to a host device via UART communication. Here's an overview of how these functions are achieved:

9 Reading Temperature and Humidity from DHT11 Sensor:

- The microcontroller interfaces with the DHT11 sensor using GPIO pins.
- A protocol is implemented to communicate with the DHT11 sensor and retrieve temperature and humidity data.
- The received data is processed and converted into meaningful temperature and humidity values.
- Reading Light Intensity from the LDR Using the ADC Module.
- The microcontroller's built-in ADC module is configured to interface with the LDR sensor.
- Analog signals from the LDR are sampled and converted into digital values using the ADC module.
- The converted digital values represent the light intensity level, which can be further processed and utilized in the application.

10 Displaying Real-time Values on the LCD

- The LCD module is interfaced with the microcontroller using GPIO pins for data and control lines.
- Functions are implemented to send data and control signals to the LCD for displaying real-time sensor values.
- The microcontroller continuously updates the LCD display with the latest temperature, humidity, and light intensity readings.

11 Transmitting Data to the Host Device Using the UART Module

- The microcontroller's built-in UART module is configured to establish serial communication with a host device, such as a laptop or PC.
- Sensor data, including temperature, humidity, and light intensity values, are formatted into strings.
- The formatted data strings are transmitted via UART communication to the host device in real-time.

12 Code Structure and Key Functions

The code for the microcontroller is structured into modular functions, each responsible for specific tasks such as sensor interfacing, data processing, LCD control, and UART communication. Here are some key functions

- **readDHT11Sensor()**: Reads temperature and humidity values from the DHT11 sensor.
- **readLDRValue():** Reads light intensity values from the LDR sensor using the ADC module.
- **updateLCD():** Updates the LCD display with real-time sensor values.
- **transmitDataUART():** Transmits sensor data to the host device via UART communication.
- **main():** The main function orchestrates the execution flow of the program, calling the above functions in a loop to continuously read sensor data, update the LCD display, and transmit data via UART.

By organizing the code into modular functions and implementing efficient algorithms for sensor interfacing and data processing, the microcontroller is able to perform the specified functions reliably and in real-time, providing valuable environmental monitoring capabilities.

13 Data Logging and Transmission

In the project, sensor data, including temperature, humidity, and light intensity values, are transmitted to a host device (e.g., laptop) via UART (Universal Asynchronous Receiver/Transmitter) communication. Here's how the data logging and transmission process works

- **Sending Values via UART Communication:**
  - Sensor readings are formatted into strings containing the relevant data, such as temperature, humidity, and light intensity.
  - These strings are then transmitted via UART communication from the microcontroller to the host device.
  - UART communication enables serial data transmission in real-time, allowing continuous updates of sensor values on the host device.
- **Use of PuTTY Software for Data Logging:**
  - PuTTY, a versatile terminal emulator application, is utilized on the host device to establish a serial connection with the microcontroller.
  - PuTTY is configured to receive data transmitted by the microcontroller over UART and log it into a text file.
  - The logged data is saved in a structured format, typically comma-separated values (CSV), for easy parsing and processing.

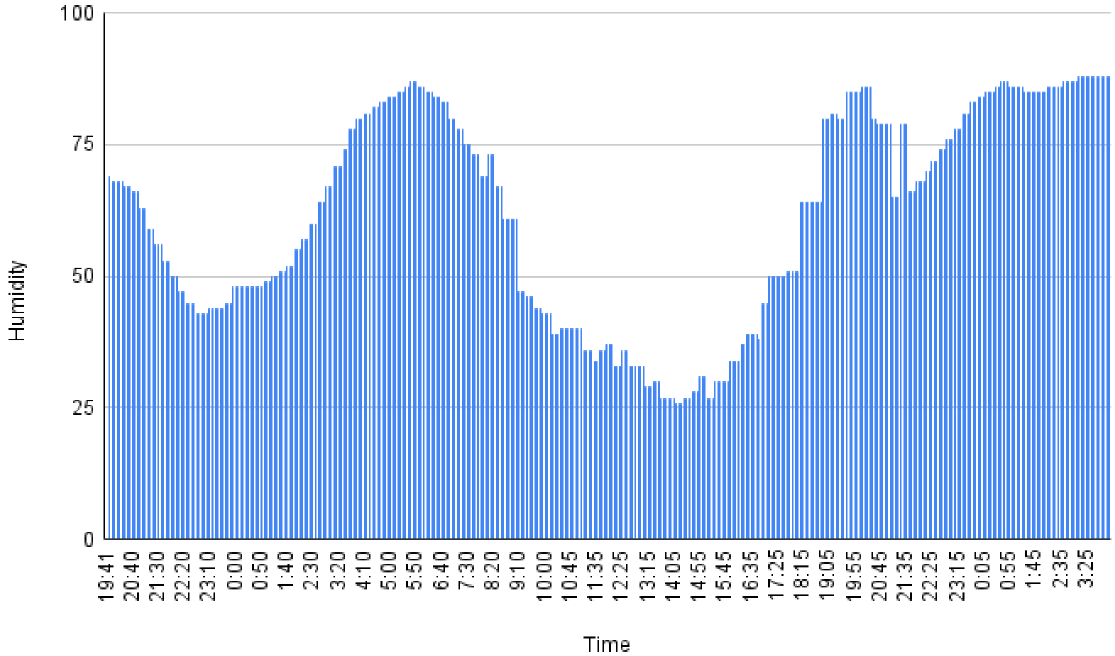

Figure 1: Humidity vs Time
Start: Day 1, 19:41 Pm
End: Day 3, 04:00 Am

14 Data Processing and Visualization:

After logging the data into a text file using PuTTY, it can be processed and visualized for further analysis.

- Processing Log File into Excel Sheet.
- The log file containing the transmitted sensor data is imported into spreadsheet software, such as Microsoft Excel.
- Data parsing techniques are applied to extract temperature, humidity, and light intensity values from the log file and organize them into separate columns.
- Timestamps associated with each data point are also extracted and formatted for analysis.
- Plotting Sensor Data Against Timestamps
- Once the data is organized in spreadsheet software, graphs and charts are created to visualize trends and patterns over time.
- Temperature, humidity, and light intensity values are plotted against their respective timestamps on a time-series graph.
- Graphical representation facilitates the identification of trends, correlations, and anomalies in environmental data.

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15 Result:

Here you can describe the results of your experiment or analysis.

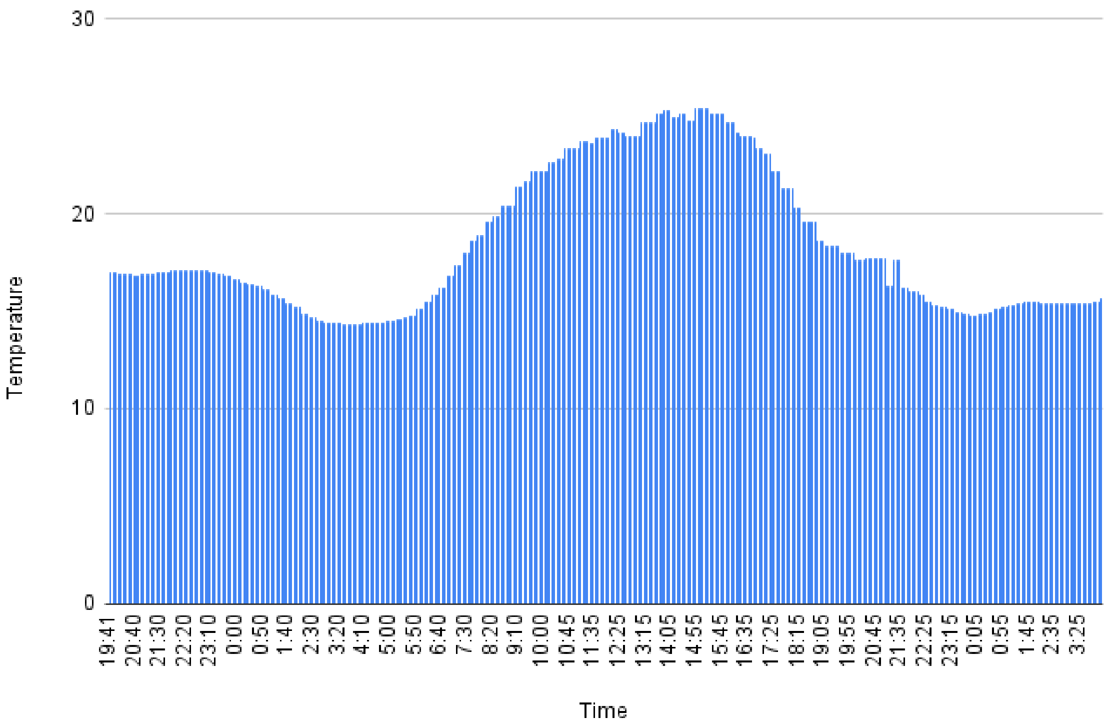

Figure 2: Temperature vs Time.
Start: Day 1, 19:41 Pm
End: Day 3, 04:00 Am

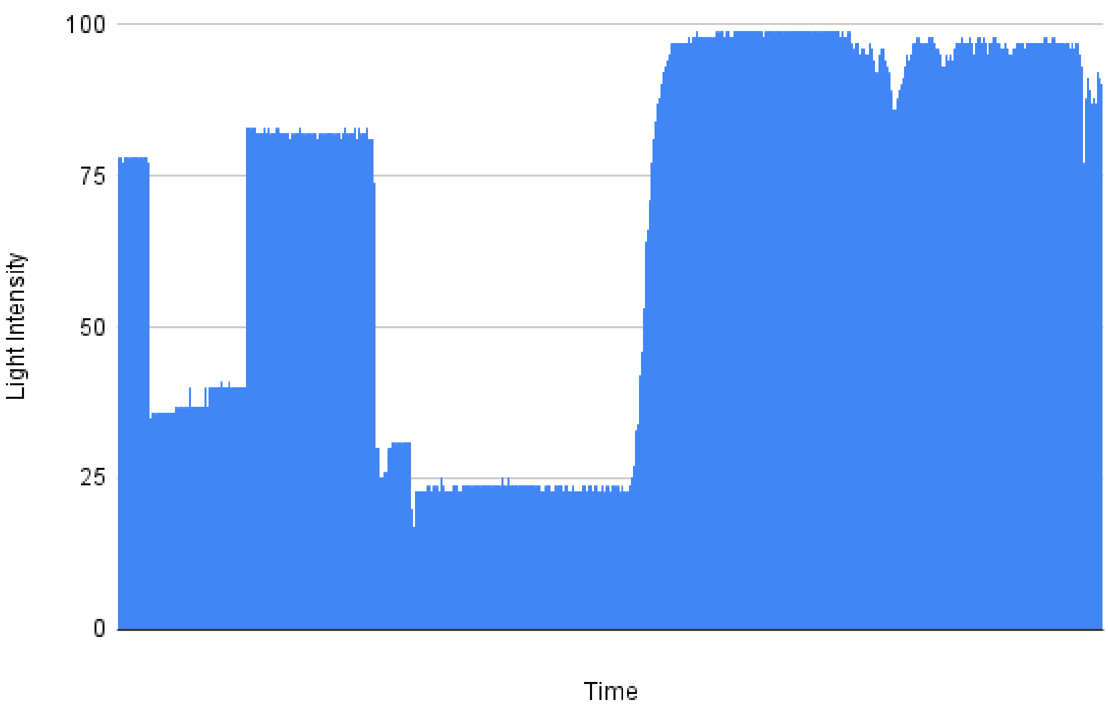

Figure 3: Light Intensity vs Time

16 Conclusion:

In conclusion, the project aimed to develop a real-time monitoring system using the LunchBox microcontroller powered by the MSP430G2553, capable of measuring temperature, humidity, and light intensity and transmitting this data to a host device for analysis and logging. The ultimate result of the project was the successful recording of 24-hour data encompassing temperature, humidity, and light intensity readings.