WEATHER STATION USING BEAGLE BONE BLACK

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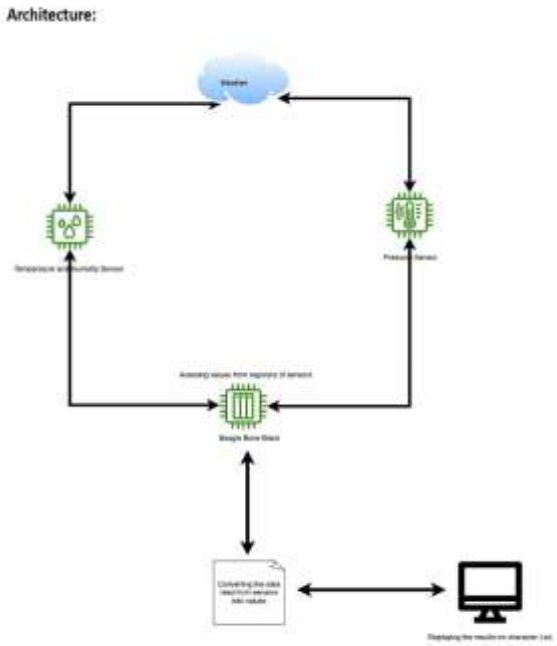
PROJECT OVERVIEW

- Temperature, pressure , and humidity sensors are integrated with a Beagle Bone system which can serve various purposes and have multiple applications across different fields.
- These sensors, when integrated into a Beagle Bone can provide data that can be used for control, monitoring, research, and decision-making in a wide range of applications. The versatility of these sensors makes them valuable tools across various industries and fields
- The data collected here will be processed and displayed in LCD display.



architecture

HARDWARE AND SOFTWARE ARCHITECTURE:

Hardware Components :

1. Beagle Bone Black
2. Solderless Breadboard
3. Jumper wires
4. Temperature Sensor we used BME280
5. Humidity Sensor we used BME280
6. Pressure Sensor we used BMP280
7. Communication Modules(Wi-Fi Module)
8. Resistor’s , Power Supply and LCD(16x02)module

SOFTWARE COMPONENTS

1. Operating System:

- Preempt_RT Kernel: Downloading, configuring, and integrating for Beagle Bone Black. And then we Configure tasks, timers, and synchronization primitives according to project requirements.
- We used preempt_rt kernel to achieve priority threading.

2. C Programming Language:

Writing application logic and tasks using the C programming language.

3. Device Drivers:

- Implementing device drivers for sensors (temperature, humidity, pressure.) interfacing with GPIO, I2C protocols.
- We used **I2C bus** communication for communicating between hardware components and the micro controller

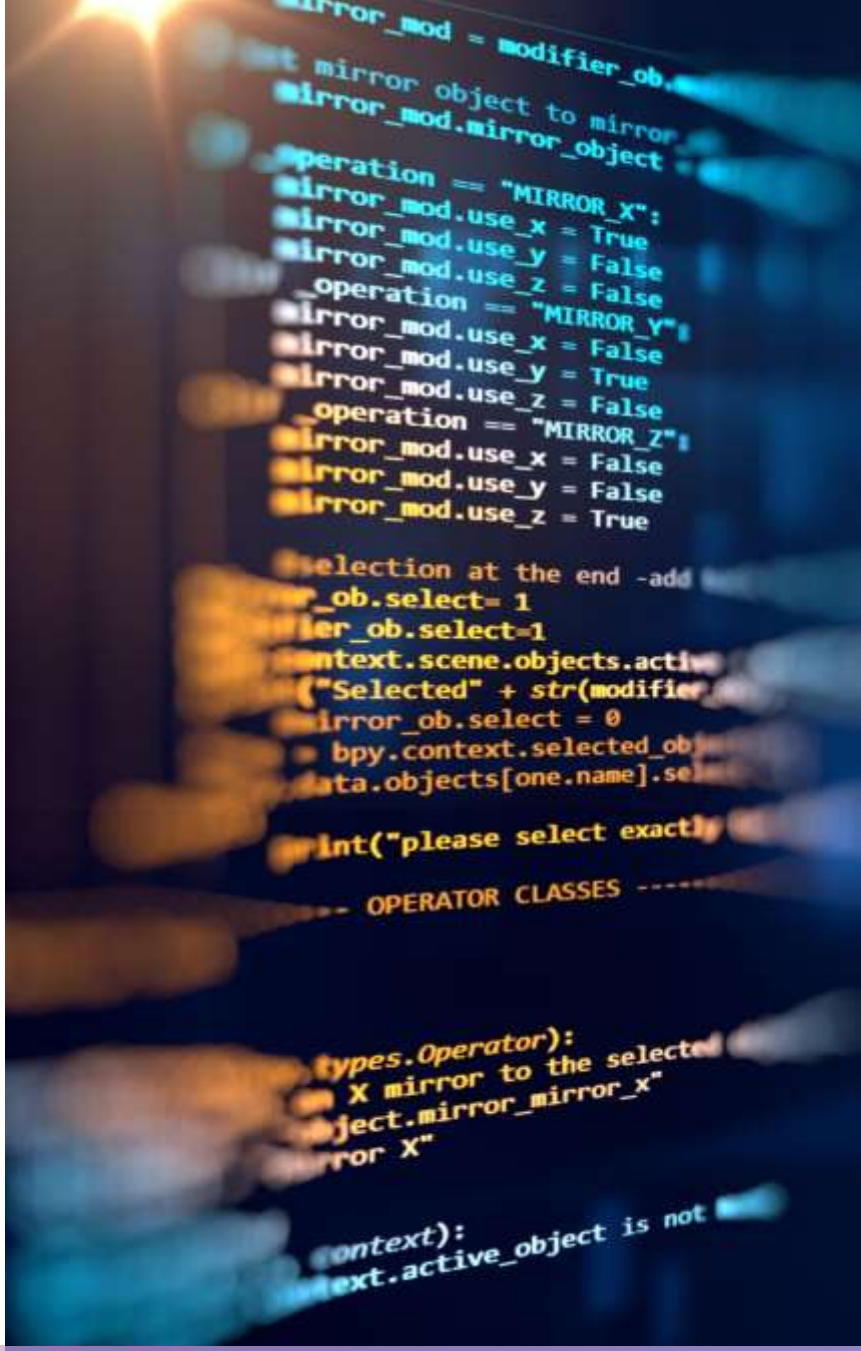
SOFTWARE COMPONENTS

RTOS Tasks:

• Sensor Reading Task: Implementing tasks to read data from various sensors. Use appropriate cmd's to interact with GPIO, I2C peripherals.

• Data Processing Task: Processing raw sensor data, perform calculations, and convert sensor readings into meaningful weather metrics.

• User Interface Task: We are using LCD display to render the output read from the sensors.



SOFTWARE COMPONENTS

- **RTOS Synchronization** : Implementing proper synchronization between sensor reading, data processing, and networking tasks to avoid conflicts and race conditions.
- **Memory Management**: Managing memory allocation and deallocation carefully, especially if dynamic memory allocation is used. Be mindful of memory fragmentation.
- **Testing and Debugging**: Using tools and features for debugging and then testing our application thoroughly under different conditions to ensure real-time performance and reliability

DESGIN DECISIONS

1.Sensors Selection: Selecting Sensors based on accuracy, compatibility, and power consumption.

2.**Operating System**: opting for Linux distribution which is compatible with BBB and well-supported by the community.

3.**Data Processing:** We process the data for data manipulation using various libraries in C programming.

DESGINDECISIONS

4. **Power Management:** Implementing power-saving strategies for prolonged sensor and system lifespan. And Considering sleep modes for sensors during idle periods to conserve power.

5. **Safety and Durability:** Enclosing the system in a weatherproof case to protect it from environmental elements. And Using high-quality sensors and components for reliability and longevity.

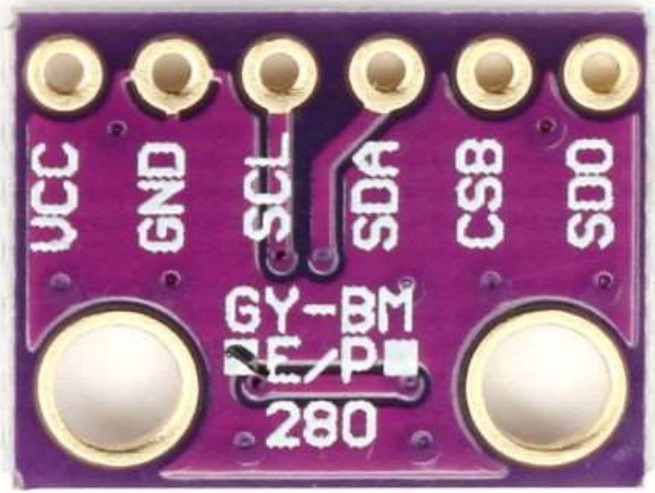
6. **Testing and Calibration:** Implementing thorough testing procedures for sensors and communication modules. And for Calibrate sensors for accuracy, especially if precise weather data is crucial.

By considering these aspects and making informed decisions, Our Beagle Bone Black weather station can be developed to be a robust, accurate, and user-friendly solution for weather monitoring.

BME280

- This Sensor is used for reading temperature and humidity data.
- It uses I2C bus communication protocol for interacting with the beagle bone
- It uses I2C address of 0x76
- It has 4 connections

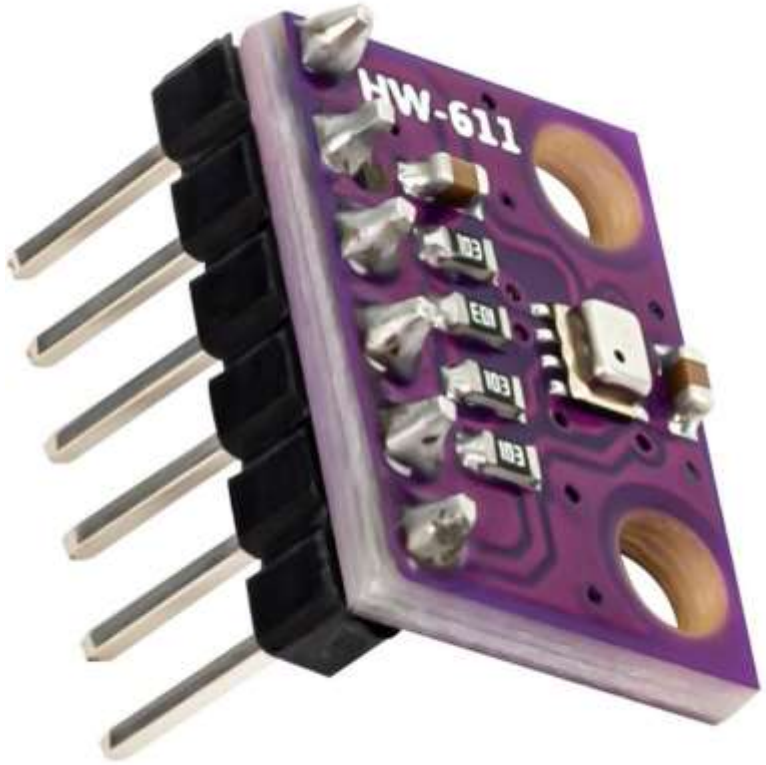
1. GND -> GND.
2. POWER -> 3.3V.
3. SDA -> Port 20
4. SCL -> Port 19 connected to BBB.



BMP 280

- This sensor is used for reading pressure data.
- It uses I2C bus communication protocol for interacting with the beagle bone.
- It uses I2C address of 0x76.
- It has 4 connections

1. GND -> GND.
2. POWER -> 3.3V.
3. SDA -> Port 20
4. SDO -> 3.3V for changing the I2C address.
5. SCL -> Port 19 connected to BBB.



LCD16X02

- It is used to write the weather reading data and display it on screen.
- It uses I2C bus communication protocol for interacting with the beagle bone.
- It uses I2C address of 0x27.
- It has 4 connection

1. GND -> GND.
2. POWER -> 5V.
3. SDA -> Port 20
4. SCL -> Port 19 connected to BBB.

DESGIN V/S ACTUAL

Initially, we began the process by using BMP180 FOR PRESSURE, DHT22 for humidity and DS18B20 for temperature. Later on we faced problems related to reading in data and connecting it the beagle bone for various reasons like:

1. BMP180 -- We have faced issue with connecting it with beagle bone black as we were unable to solder the component perfectly.
2. DHT22 -- It was not using I2C bus communication protocol, it uses gpio ports for communication with the micro controller which we found out to be completely different from other sensors we are using, so we decided not use a component for that.
3. DS18B20 -- This component needs to be soldered and this sensor is not that widely used for working on micro controllers it is more of commercial use component, so we have discarded it.

DESGIN V/S ACTUAL

Instead of these we have used these sensor components for efficient performance.

1. BME280 FOR TEMP AND HUMIDITY
2. BMP280 FOR PRESSURE

- These sensors are very compatible for working with micro controllers and both components uses I2C bus communication protocol for interacting with the beagle bone black which saves us from the lot of nitty gritty connection wires.

- These sensors shows less faults for the actual data.

CHALLENGES

- **Same I2C Address for BMP 280 and BME 280.**

1. While Connecting both these sensors using the i2c bus to beagle bone black we have found that both these sensors use same address for bus communication with the beagle bone black i.e 0x76.
2. So, to avoid conflict between these two sensors we have connected the BMP280 sensors SDO connection to the 3.3V to make the address change from 0x76 to 0x77.

- **No datasheet for LCD 16x02.**

1. We have faced problem regarding to LCD that we were unable to find the proper data sheet for the component. we had a reference link from the site we have purchased but it did not explain about the register's that need to be accessed to write the data to the display nor how to communicate with LCD.
2. We have made use of a public git hub repo taken that as a reference for implementing the LCD display, we have also referenced the link to the repo in the documentation

CONCLUSION

- The integration of temperature, pressure, and humidity sensors with the Beagle Bone system establishes a comprehensive and adaptable platform with wide-reaching applications.
- This integrated system proves versatile, finding utility across diverse industries such as agriculture, and manufacturing. The real value lies in its ability to transform raw sensor data into actionable insights, empowering informed decision-making across sectors.
- The real-time processing and LCD display feature enhance the system's responsiveness, making it ideal for applications like smart home systems and weather stations.
- In essence, the Beagle Bone system, enriched by these sensors, emerges as a dynamic and indispensable tool for monitoring, control, research, and decision-making in various domains.


Thank
you!