Project: Environment Parameters Monitoring using IoT

Document: Design Document

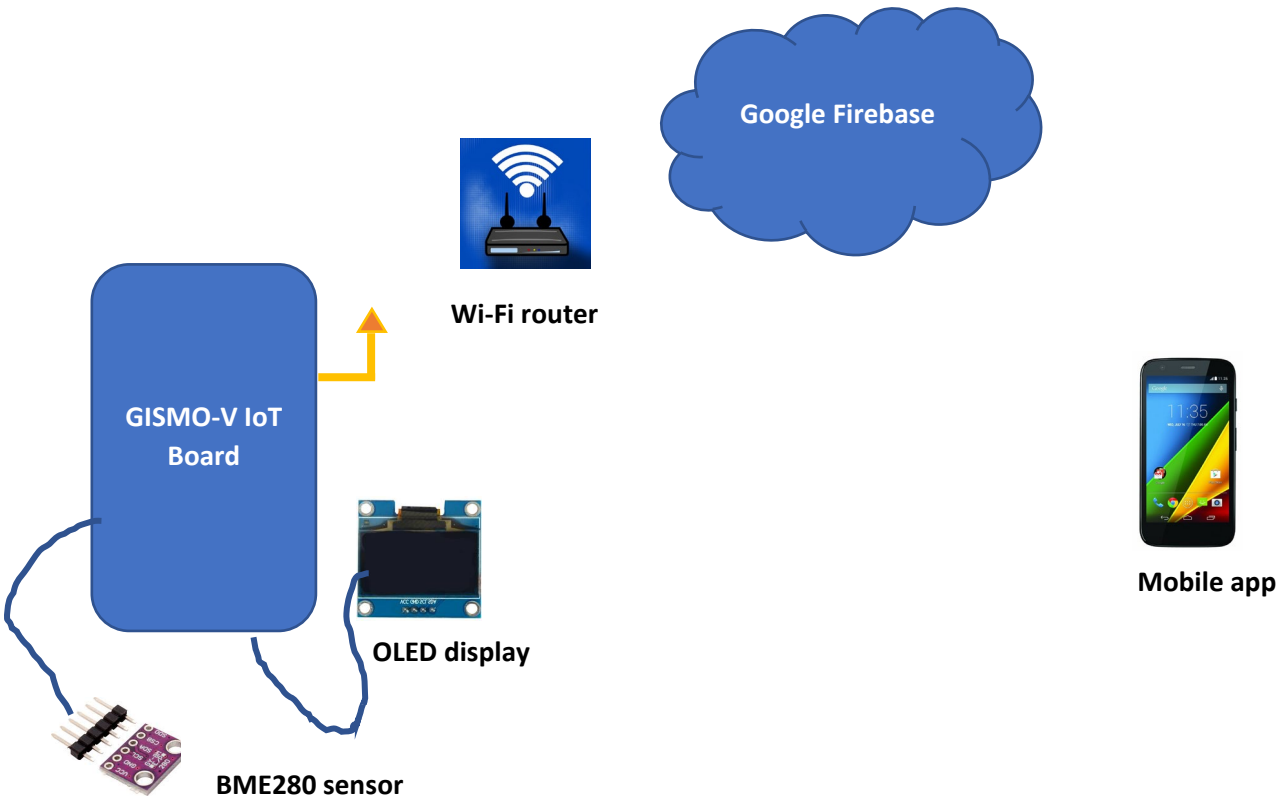
Description

The project aims to provide the following environment parameters:

- Temperature
- Humidity
- Atmospheric pressure
- Altitude

to the user in an app on his Android mobile phone. The update rate of the parameters will be twos seconds. The values will be read from BME280 sensor by an ESP32 controller. The ESP32 controller is a 32-bit dual core processor with Wi-Fi and Bluetooth capabilities built on-chip. The Wi-Fi capability is used to join a Wi-Fi network and connect to the Internet. The environment parameters are pushed to a cloud database – Google's Firebase which is created for the project. The database credentials – the host URL and the database authentication key are to be fed into the firmware. The Firebase database is a key-value based database and using the Firebase credentials and the key the values are accessed and displayed in the mobile app of the user.

The different components in the project are:



Hardware

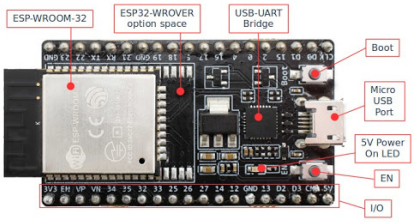
The hardware for the project consists of:

- GISMO-V board with:
    - ESP32 dual-core 32-bit processor with Wi-Fi and BLE
    - BME 280 Environment sensor from Bosch
    - 0.96” OLED display with 128x64 resolution

The BME280 is interfaced with the ESP32 using the I2C interface. The I2C interface has two signals – SCL and SDA. These pins on the BME280 are connected to I2C pins on ESP32 – GPIO22 and GPIO21. The BME280 works on 3.3V supply

The OLED display is a graphic display with I2C interface to the microcontroller. The SCL and SDA lines of the OLED display are connected to GPIO22 and GPIO21 pins of the ESP32. These are the I2C pins of the ESP32. The supply voltage for the OLED display is 3.3V

The ESP32 development board used is the ESP32 Dev Kit. The ESP32 board has a micro USB for programming, powering up and for transfer of data on serialline to and from the laptop. It has an on-board LED connected to GPIO2 which can be used for debugging purposes. It has a RESET and a BOOT button. The BOOT button needs to be kept pressed while downloading the program to the board. The Dev Kit also has 4 MB of external flash memory.



Firmware

The Arduino IDE is used to develop the firmware. The ESP32 board support package is downloaded and added to the existing boards in the IDE. The particular board to be selected is the ESP32 Dev Kit. The firmware can be divided into the following blocks:

- Sensor interface
- OLED display interface
- Internet connectivity
- Cloud database interface

Sensor interface:

The two libraries used for interfacing the BME280 sensor board are:

- Adafruit_Sensor.h
- Adafruit_BME280.h

The Adafruit BME library provides a class called Adafruit_BME280. An instance of the class is created. The class supports the following methods:

- begin(): It takes the I2C address of the BME sensor as a parameter. The I2C address is 0x76. The return value if true implies BME280 initialization is successful
- readTemperature(): Does not take any any parameters. Returns the temperature in degrees Centigrade as a float value
- readPressure():Does not take any parameters. Returns the atmospheric pressure in Pascals. This value divided by 100 gives the value in hPa (hectoPascals) which is equal to millibar pressure unit
- readAltitude(): Takes the SEALEVELPRESSURE_HPA as a parameter. Returns the altitude in meters.
- readHumidity(): Takes no parameters. Returns the relative humidity as a percentage float value

OLED display interface:

The two libraries used for the OLED display interface are:

Wire,h : For basic I2C interface

SSD1306.h: For display specific functions

The SSD1306 library provides a SSD1306 class. An object belonging to that class is created with the following initialization parameters:

- 7-bit I2C address of the display (0x3c)
- SCL pin of microcontroller (22)
- SDA pin of microcontroller (21)

The functions supported by the SSD1306 class are:

- init(): For initialization
- setFont(); Takes the font as a parameter. The font will decide the size of the text that will be displayed. The fonts supported are:
    - ArialMT_Plain_10
    - ArialMT_Plain_16
    - ArialMT_Plain_24
- clear(): For clearing the display
- drawSring(0,0,"fgfhgfhfhfh"): Takes three parameters – the x, y co-ordinates of the strat of the string and the string to be displayed
- display(): No parameters. The memory buffer is transferred to display

Internet connectivity

The in-built WiFi object is used to connect to the WiFi network. The WiFi object has the following functions:

- begin(): Takes two parameters:
    - SSID of the WiFi network to which we want to connect
    - Password of the WiFi network
- status(): Tells us whether the ESP32 is connected to the WiFi network or not.
- localIP(): The IP address dynamically assigned to the ESP32 by the access point (router)

Cloud database access

The cloud database used in the project is Google's Firebase. It is a No-SQL database in which data is stored as Key-Value pairs. The following are the credentials of the database required for access:

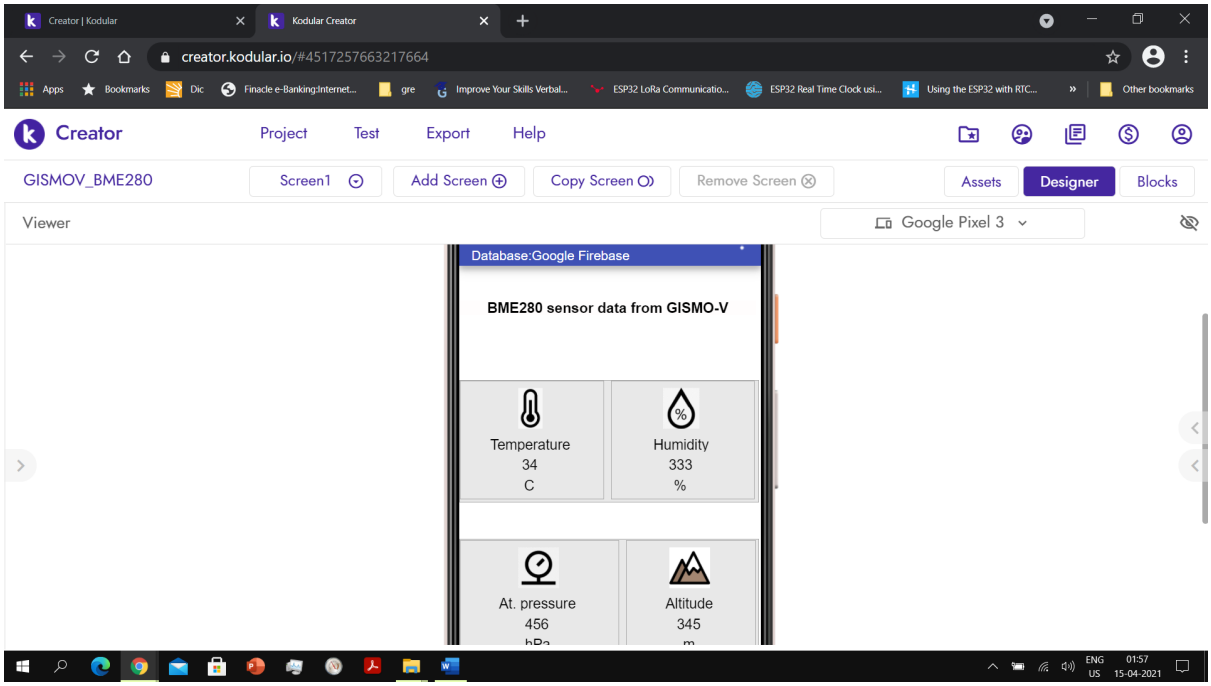
- Host URL
- Database authentication key

These credentials will be put in the ESP32 firmware to access the Google Firebase. The keys used to store the parameter values in the project are:

- IOTLAB/Environment_Monitor/Temperature
- IOTLAB/ Environment_Monitor /Humidity
- IOTLAB/Environment_Monitor/Pressure
- IOTLAB/Environment_Monitor/Altitude

Mobile App development

The Kodular rapid mobile app development utility is used for mobile app development. The utility has a Developer mode and a Blocks mode. In the Developer mode, there are different functional blocks available – User Interface, Sensors, Connectivity, Firebase, and so on. The UI gets defined in the Developer mode as under :



In the Blocks mode, a timer with timing set to 2 seconds will fetch the temperature and humidity values from the Firebase database and fill it in the appropriate place in the UI. To access the Firebase datase its credentials will be put in the Firebase component