Redback Operations

IoT Sensor Research and Development Team

By

Sharni Sujatha

(Leader of IoT Sensor Research and Development Team)

Cycling Prototype

Overview

This document discusses the development of a prototype of an IoT system with an exercise bike. This prototype is capable of collecting environment data such as temperature and humidity and movement data with an accelerometer and publish it over MQTT.

Hardware used

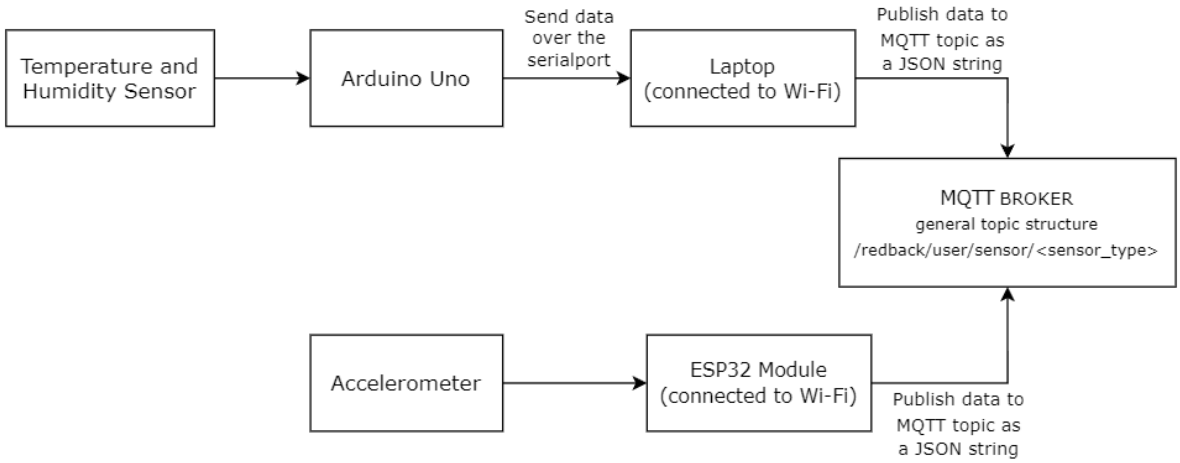
- Arduino Uno
  Arduino UNO is a microcontroller board based on the ATmega328P.

- DHT22 Sensor
  DHT22 is a basic digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and gives the humidity and temperature data.

- ESP32 Module
  ESP32 is a series of low-cost, low-power system on a chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth.

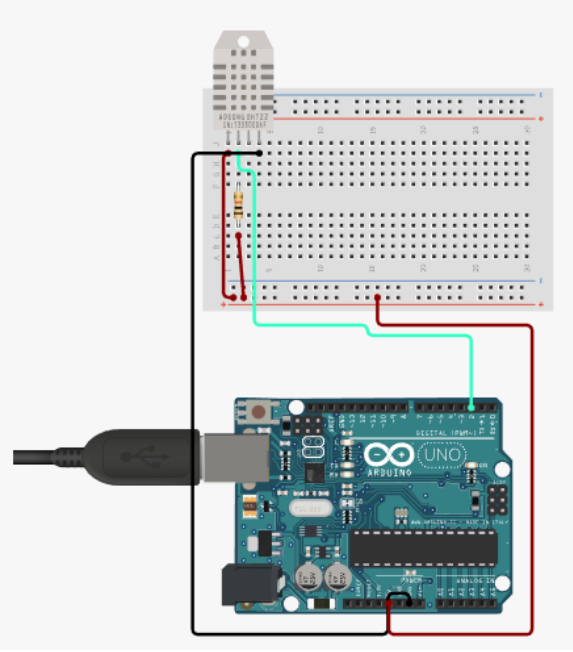
- LSM303
  LSM303 is a triple-axis Accelerometer and Magnetometer (Compass) board

System Architecture

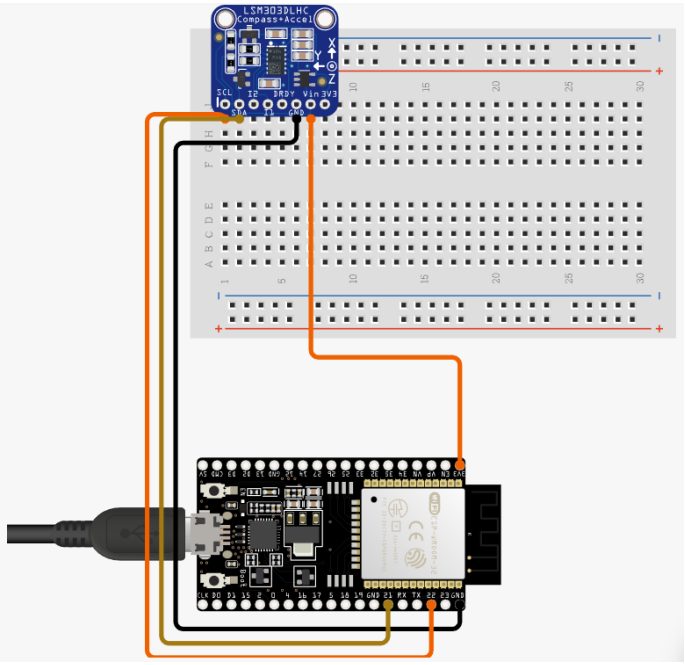


Prototype Simulation Diagrams

The below figure shows the simulation diagram of an Arduino Uno connected to a DHT22 sensor. This setup is used for measuring temperature and humidity.



The following figure shows the simulation diagram of an ESP32 module connected to an LSM303 triple axis accelerometer and magnetometer. This setup is used for measuring accelerometer.



System Design

The prototype consists of two subsystems as described below.

1. An Arduino Uno connected to a DHT22 sensor - The Arduino is connected to a laptop and sends the temperature and humidity data collected over the serial port in a JSON string format. We then have a Node.js program that reads this data, extracts the sensor details and sensor data, constructs the topic, adds the timestamp to the message containing sensor data and publishes it to the MQTT topic on a custom MQTT Broker setup on Google Cloud Platform.

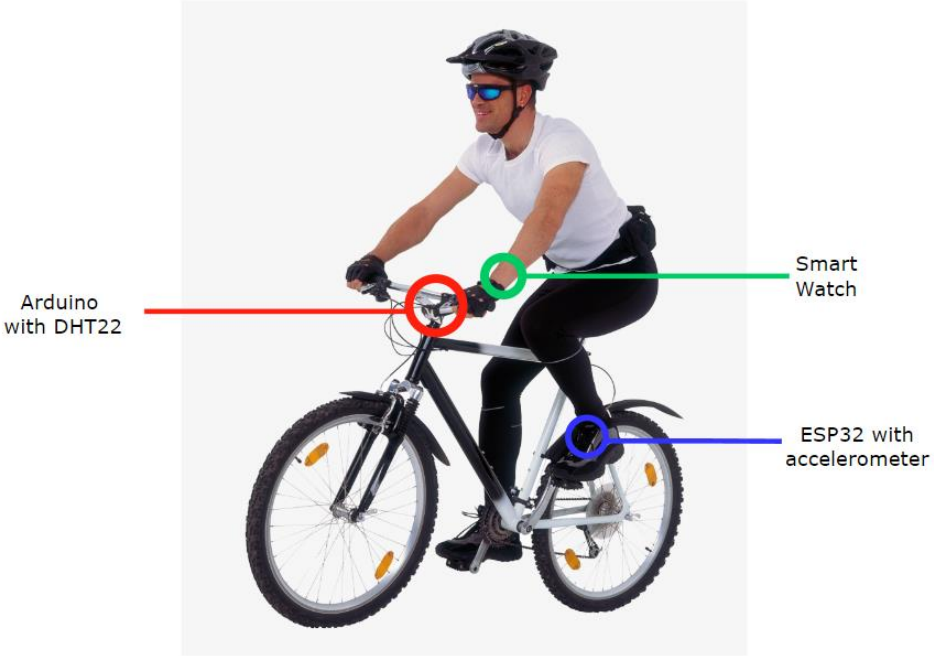
2. An ESP32 module connected to an LSM303 triple axis accelerometer and magnetometer. The ESP32 is connected to Wi-Fi and the accelerometer data collected is directly published to the MQTT topic with the time stamp.

The general structure of the MQTT topics is,

`/redback/{user}/sensor/{sensor_type}`

Sensor Placement

The following image shows where the sensors and devices are positioned on the user's and bike's frame.



Code

The code base is available at

https://github.com/redbackoperations/iot

Prototype Demo

The prototype demo video is available at

https://deakin365.sharepoint.com/:v:/s/RedbackOperations9-IoTSensorResearchandDevelopmentTeam/Eaci61Q3QqdJu4ride9wj2oBRTFSE4wJcpnpcACXuQz_ew

Conclusion

The prototype of this IoT system for cycling works fine. The demo was recorded with a normal bike and with the two subsystems (Arduino with DHT22 and ESP32 with

LSM303) attached to the user's body frame along with a Fitbit smart watch. A Fitbit smart watch was included to collect heart rate and other health data, but this was not implemented completely since the plan for the next trimester is to develop a smart wearable collecting health data from scratch. The initial idea was to make use multiple other sensors such as altimeter and pressure sensors for collecting environment data, heart rate, oximeter and body temperature sensors for health data, cadence and speed sensors for bike movement data. However, due to the unavailability of the devices this has been moved to the next trimester.