A Wide Area IoT Mesh Network With Edge Computing

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Background

- Fabrication:
  - First and foremost, all the boards displayed are self-fabricated boards. Below, you can see some images of chip, sensor, led and motor.

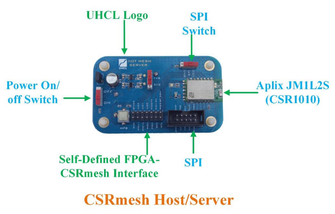
(a) CAplix BLM mesh Model: JM1L2S

(b) AN2302 Sensor

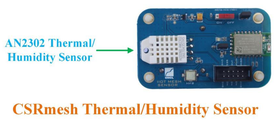
(c) High Torque Stepper Motor-24BYJ48)

(d) Optical Power LED

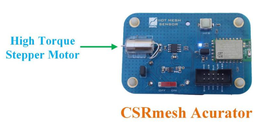
- A wide area IoT Mesh network :
  - We have established an IoT Mesh network using this fabricated boards. Such system consists one host/server module and three other boards which are humidity/thermal sensor, actuator, LED.
  - For IoT Mesh network, we have used Bluetooth Low Energy (BLE) protocol. The protocol hasn't been standardized yet, which is the primary reason behind using this protocol.



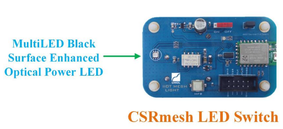
(e) CSRmesh Host/Server



(f) Humidity/Thermal Sensor



(g) Motor Board



(h) LED Switch

A Glance on The Smart Algorithm

- Smart algorithm is implemented at the edge node :
  - As shown in Fig. 1, smart algorithm is processing data. Here, the IoT Mesh network is connect to the laptop and laptop is connected to the internet. Note that, laptop is edge node in the system.

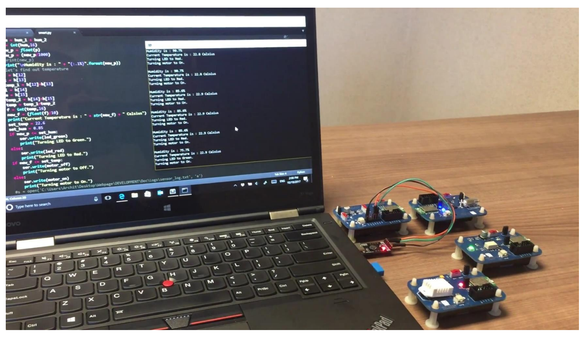


Fig. 1 IoT Mesh Network with Edge Computing

- Fig. 2, shows the flow of the algorithm working on edge node:

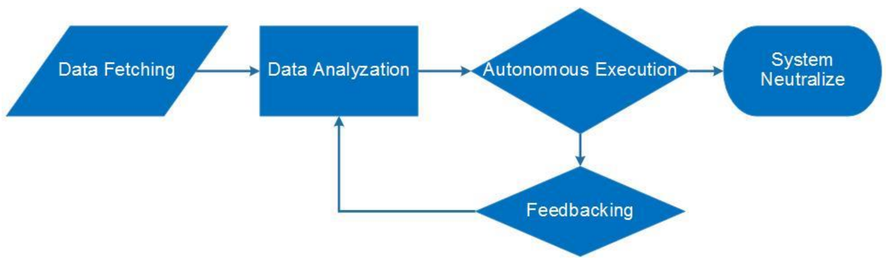


Fig. 2 Flow of Smart Algorithm

- Categorization during Data Analyzation:
  - Most time sensitive data are priority and will be executed first by all means.
  - A bit less sensitive data which can wait a bit and will be communicated to edge computation part and rest of the process will be handled over there.
  - The last category will be the one where data does not require to be processed immediately, which can wait for some time, will be sent to data server. In the case, when such data is required, it will be processed followed by restore the data to data server after completion of process.

An Overview of System Architecture

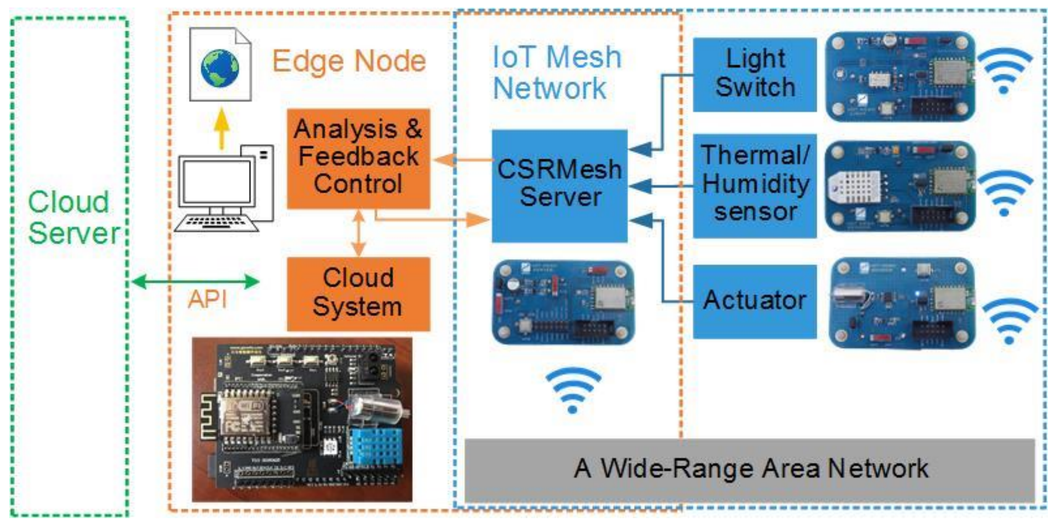


Fig. 4 Cloud-Edge-IoT System Architecture

- The System Architecture can be split into three stages.
  - **IoT Mesh Network –** One host / server is wirelessly connected with three devices using the Bluetooth Low Energy (BLE) protocol.
  - **Edge Node –** Edge node is situated, virtually, between cloud and IoT mesh network. It also has smart algorithm running in background.
  - **Cloud Server –** Cloud server is connected to system with internet.

Working and Application

- Currently, our system provides two types of decision making and controlling support which are edge and cloud computing. Which can be described as:
  - **Edge Computing –** In this type, we don't want to send all data to cloud instead, we complete all computation at edge node (like shown in Fig. 1) and then send only those data to cloud which are actually helpful.
  - **Cloud Computing –** For this, we can actually control our system from anywhere through internet (as shown in Fig. 5) but we may have to deal with the latency though.

- Due to liberty of the wide area communication, this system has a great potential to be proved as productive. It has many applications like smart building, smart agriculture, smart home etc.

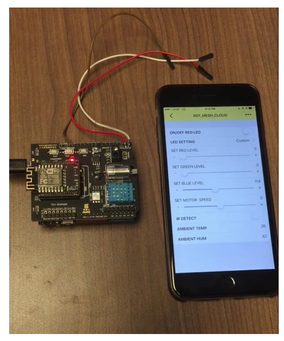


Fig. 5 Cloud Computing

- Fig. 6 is screenshot of the test results, also how only important data is stored on the cloud.

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Wed, 12:05:39 on Sep 27, 2017 (Central Daylight Time) -- Humidity : 99.9% & Temperature : 25.9 Celsius
Current Temperature : 25.9 & Set Temperature : 26 --> LED: Green

Wed, 12:05:40 on Sep 27, 2017 (Central Daylight Time) -- Humidity : 99.9% & Temperature : 25.9 Celsius
Current Temperature : 25.9 & Set Temperature : 26 --> LED: Green

Wed, 12:05:41 on Sep 27, 2017 (Central Daylight Time) -- Humidity : 99.9% & Temperature : 26.2 Celsius
Current Temperature : 26.2 & Set Temperature : 26 --> LED: Red
```

Fig. 6 Test Result

Closure and Glimpse at Interesting Extensions

- The system delivers, typically, two types of solutions 1) a wide area network using Bluetooth Low Area (BLE) protocol and Mesh Technology, 2) to speed up the system processes and reduce the latency by implementing, evolving edge computing conventions.

- We have planned to integrate FPGA to our system, specifically, at the edge node, since FPGA has very high potential to speed up the algorithm process and to decrease the latency in traffic.

- More detailed information and interesting demos available at:
  - http://sceweb.sce.uhcl.edu/xiaokun/ → FC