Demo Abstract: A Smart Building System Integrated with An Edge Computing Algorithm and IoT Mesh Networks

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ABSTRACT

This poster presents a smart building system integrated with the emerging edge computing technology and IoT Mesh networks. More specifically, first we have established an IoT Mesh network with one IoT host/server and three devices. And the next step is to develop the data analysis algorithm at the network edge and to connect to the GoKit cloud service with a GizWits V3.0 board. The system will show an effective solution to smart home/building with proposing a cloud-edge-IoT system, and fundamentally extending the connection area to cover an entire farm or factory.

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1 INTRODUCTION

In recent years, cloud computing's certain limitation or capabilities has led us to the new so-called paradigm, edge computing or also as fogging, sometimes. There are so many Internet of Things(IoT) devices out there, increasing in tremendous amount, in ungovernable manner because of their prosperous usage. According to the research work of Cisco, there will be estimated 50 billion IoT devices producing around 600 ZB data by the 2020 [1]. It is tedious work to upload such gigantic data to cloud servers, and process and retrieve back by systems when requested. This is where edge computing comes into the picture. In edge computing, you do not need to send the whole data packet on cloud server, instead data can be computed at the edge where it is being produced which is better in terms of efficiency and performance [2].

Our vision is thus to create a smart building system as a case study, capable of sensoring our surrounding environment, and more important, directing different types of sensor data to the optimal place for analysis and making decisions autonomous at the proximity of the network edge.

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With such a system connectivity becomes primary issues. As far as communication is concerned, we have decided to use the IoT Mesh solution to establish an IoT network. Although the IoT Mesh technology is yet to standardize, we foreseen its abilities to be far than ever imagined or experienced in terms of power efficiency, connectivity and confidentiality [3]. We also anticipate that IoT Mesh would not be the only way of communication in future rather fusion of IoT Mesh with advanced standards such as Wi-Fi and Zigbee protocols to provide better quality of communication.

Another challenge is to deal with the large amounts of sensor data. In our work we presented a data analysis algorithm in order to filter data with different operational priorities. Generally speaking, the data will be sent to GoKit cloud servers using the GizWits V3.0 board or processed in the network, according to the time sensitivities of the data.

2 PROPOSED SYSTEM

2.1 System Architecture

In this poster, we present a smart building system as a case study. Fig. 1 shows the system architecture, which can be split into three stages.

In the IoT Mesh network, we have one host/server module which is wirelessly connected to three devices with IoT Mesh technology. The host/server module is also connected to the external GoKit cloud service through a development board – GizWits V3.0, which would keep data like sensor readings and feedback control the IoT network. In between there would be another computation method which is emerging as the day passes, called edge computing node.

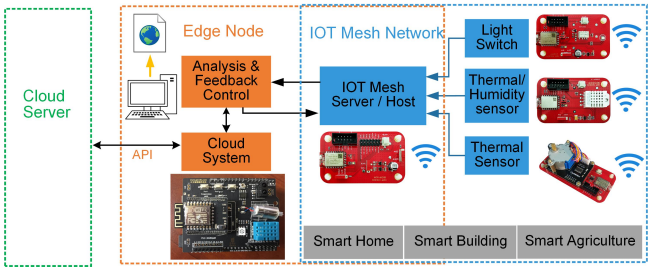

Figure 1: System Architecture.

Our previous work has already set up the IoT Mesh network and were able to communicate among host and devices using the CSRmesh protocol properly, as shown in Fig.2. In what follows, we propose a data analysis algorithm at the network edge in this

poster. By integrating the IoT host with the edge/fog server and GizWitz board, we could deploy the concept of edge computing on our proposed system.

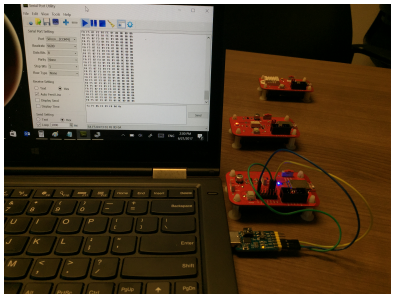

Figure 2: Test: IoT Mesh Network.

2.2 Analysis & Feedback Algorithm

Fig.3 shows the algorithm part of the system, typically it describes work flow of the algorithm.

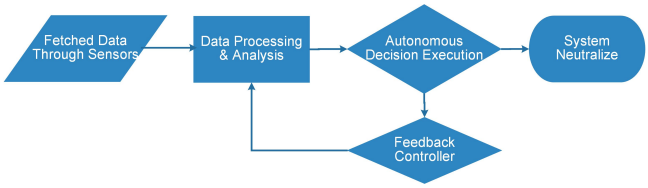

Figure 3: Flow diagram of the Algorithm.

2.2.1 Fetched data through sensors. In the proposed system, initial and primary step would be to gather all the information before any kind of analysis or process is done. First of all, sensors will collect all the data containing information about light, humidity, temperature readings. IoT Mesh host module will receive the data information, which works on the Bluetooth Low Energy (BLE) technology.

2.2.2 Data processing & Analysis. Once data assembling is initiated, analysis of data will be done. In this step, different measurement will be carefully observed such as frequent data fluctuation, steady data information, garbage values etc. Based on information database processing will be conducted. We have also planned to implement edge computing in this structure of system. Typically, data processing is the primary part where all the decisions are being thru which contemplated application of edge computing. Here, processes will be introduced to one of the three categories of the edge computing. They are created based on time sensitiveness of data.

1) Most time sensitive data are priority and will be executed first by all means.

2) 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.

3) 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, where it will be stored. In the case, when such data is required, it will be processed followed by restore the data to data server after completion of process.

2.2.3 Autonomous Decision Execution. In this phase of the system, as name suggests, data will be executed. When temperature sensor detects heat or temperature rise in the surrounding atmosphere, cooling system can be activated or cooling system's temperature will be decreased if system is already turned on. It will vise-versa too. If light is discovered through light sensor, LED will be turned off or in the dark LED will be turned on. All performance will be completely independent of human interruption.

2.2.4 Feedback Controller. Feedback controller contains the data after the execution of previous processes and will be transferred again to Data Processing & Analyzation phase to complete concurrent and iterative process.

2.2.5 System Neutralization. System neutralization will be done only when system no longer requires any kind of process execution. However, we do not put the whole system in hibernation, instead, data fetching and processing will always be done.

3 USE CASES AND FUTURE WORK

1) Smart Building - We plan to setup this prototype in our college campus building. A personal computer will be used as an edge server to connect with both the IoT host and the GizWits board. The IoT host module is in charge of the IoT network monitor and control, and the GizWits board is adopted to connect to the GoKit cloud. The main algorithm such as data filtering, analysis, and feedback control will be executed in the edge server. As an example, it can turn off and on the lights based on the light sensor data. Based on the temperature readings, cooling system of the building can be manipulated like fan or air condition system.

2) Smart Agriculture - Since system contains humidity, temperature, light sensors, agriculture filed can have the best out of it along with the algorithm. Which can let system work totally autonomous and take most efficient decisions. Suppose if the light measured is very low, system can automatic decision to provide external lights in the farm. If the humidity is low, system can increase the water supply and vice-versa. All the calculation and execution is done by system and there is no human interruption.

Above mentioned are briefly described couple of possible implementation of the system. Although, the potential of the system is far healthier then pronounced prior. To show our efforts, we also plan to develop a web page (sceweb.sce.uhcl.edu/xiaokun/FC) where valuable information will be visible and project demo will be visual too.

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