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Research Paper

Sensor Network Accessing Cloud Services for Data Collection and Sharing Using Arduino Yun

Engineering

KEYWORDS : Internet of things (IOT), Data logging, Arduino Yun, pushing Notifications.

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ABSTRACT

Internet of Things (IOT) mainly involves in integrating the data generating objects called as sensors which show continuous stream of data and are capable of using Internet as a main communication for data processing which acts as a database as a service. There are three IoT components namely hardware - made up of sensors, actuators and installed correspondence equipment, middleware - on demand storage and tools for data analytics and presentation - visualization and tools which can be broadly used on diverse platforms and which can be intended for diverse applications which can be simply phrased as how things can be connected to internet. One of the most important point in discussing the IOT is data logging which means storing the data or pushing the data to server either for storing purpose or processing the raw sensor data for pushing notifications for real time use cases. In this paper we implement a model in which sensor data is stored in Google cloud data store by using app engine.

1. INTRODUCTION

The Internet of Things (IOT) is emerging technology in present world. It is basically connecting many hardware objects called as things in our perspective. There are many outstanding home automation projects where we can integrate sensors like temperature sensor, motion detection sensor, gas monitoring sensor to microcontroller like Arduino in which after deploying the program on to the microcontroller in which to collect the sensor data where the design should be in a way like it should warn the user when there is an abnormal sensor readings. Some of the similar applications are smart watches, smart rings, smart switches, energy monitoring systems etc. For developing these types of projects many prototype platforms boards are available in market namely raspberry pi, Arduino which are famous and ia also an open source. There are many global Industry giants like Google, Samsung, Apple, amazon etc. who are constantly making new inventions in IOT.

Figure 1 –Basic Architecture of Connected Things

In this paper we utilize Arduino platform to make embedded projects. The IOT-platform is constantly been updated with new available resources where in which even big players like IBM, Google are researching all possibilities to make great contribution. Undoubtedly, creating applications for IoT has dependably been truly complex and obliges a ton of skill in both equipment and web applications development. On the other hand, we are going to see why utilizing the Arduino Yun can make the methodology much simpler.

In this paper we have implemented using Arduino Yun board which makes use of Bridge library that permits us to call commands of the Linux machine from the common Arduino microcontroller that additionally displays on the board. Thus, one can utilize these Linux commands form Arduino board using process library (Arduino library) which is inbuilt in development environment provided by Arduino open source. For instance, one can compose entire projects in high-level languages, for example, Python, and call them from an Arduino sketch.

Another more important point to be considered is data logging and data visualizations. By using this Arduino Yun we can connect to cloud platforms for data logging. For example when we use Temboo cloud service provider[12] which is an IOT cloud platform we can deploy the sketch for the sensors; deploy it on a board with different API's provided by the service provider and can be called as in code. The provider will provide the API key which should be included in Arduino sketch and we can post the data to Temboo service provider. When we consider data logging we should discuss about the backend protocol which is HTTP to post the data into external server.

0.1 Protocols

For sending the data we use HTTP protocol which sends to cloud data store where the default data from Arduino will be sent as a string data after which the cloud server will consume the data from Arduino and it will convert into reqired datatypes. Hence the main issue to be considered is pushing the data using internet communication by using HTTP protocol.

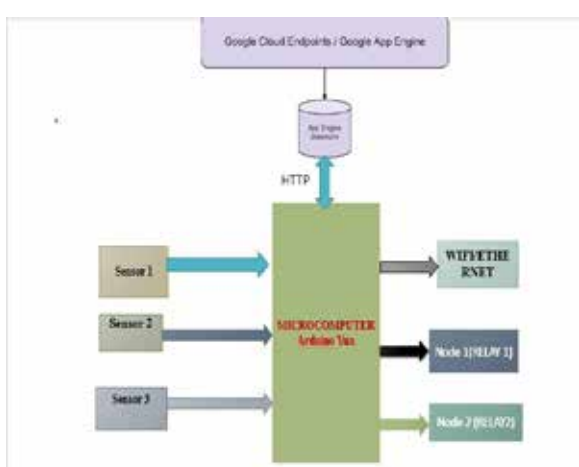

Figure 2: Architecture of Connecting Sensors And Pushing to Data Store Via App Engine

MQTT – Considering MQTT it is Message Queue Telemetry Transport (MQTT) protocol which is a lightweight publish/subscribe protocol flowing over TCP/IP for remote sensors and control devices through low bandwidth, unreliable or intermittent

communications. This is more advantageous than HTTP because it is a lightweight protocol developed by IBM and presently they are using it in IBM Blue-mix IOT foundation. This protocol is very light weight protocol where there will be three main modules publisher, subscriber and broker which act as a middleware. This protocol is emerging in IOT platform where every other cloud platform in coming future migrates for better light weight protocol like MQTT.

However in this paper we will be using HTTP protocol to push the data to Google cloud data-store.

2. EXISTING SYSTEMS

These types of integrated system can be used in many applications like sensor integration, manufacturing, health sector, education, etc. There are a few application spaces which will be impacted by the rising Internet of Things. The applications can be characterized taking into account the kind of network availability, scope, scale, heterogeneity, repetition and user involvement.

We classify the applications into three spaces:

- Home Automation
- Manufacturing
- Utilities based

These spaces communicates to Personal and Home IoT at the size of a single person alternately home, Enterprise IoT at the size of a group and Utility IoT at a national or provincial scale. There is an enormous hybrid in applications and the utilization of information between spaces. For example, the Personal and Home IoT produces power utilization information in the house and makes it accessible to the power utility organization which can thus enhance the supply and demand Internet empowers offering of information between diverse administrations suppliers in a consistent way making numerous business opportunities.

2.1 PERSONAL AND HOME

The sensor information which was collected by the sensors in personal area should be capable of working in private networks and must be able to authenticate authorized users and these should be acted as actuators. Many ubiquitous healthcare system which are in use are still limited because lack of centralization of storage of these type of systems which must be capable of getting the readings from human body and send the data to server where smartphone can be acted as an interface and at backend they will be storing the data. So far there are several mobile applications which are deployed in IOS, Android and several other mobile platforms. However as mentioned they are lacking centralized server.

2.2 CONTROLLING HOME EQUIPMENT

Home automation is the industry where IOT is making its evolution very rapidly. Many implementations like smart switches allow control of the electronic devices from anywhere in the world which is called as actuators. Even other devices like smart lights where we can check the status of lights in our house, these devices are even capable of using the social networking websites where they are being capable of posting in Facebook as well as in twitter by using twitter of things (tweetOT). However the disadvantage is how to provide security.

2.3 ENTERPRISE

Referring to the Network of Things inside a work domain as an enterprise based application. Data gathered from such networks are utilized just by the owners and the information may be utilized specifically. Environmental checking is to start with normal application which is actualized to keep a track of the quantity of inhabitants and deal with the utilities inside the building

2.4 RADIO FREQUENCY IDENTIFICATION (RFID)

RFID innovation is a noteworthy leap forward in the embedded communication standard which empowers outline of microchips for remote data communication. They help in programmed distinguishing proof of anything they are connected to going about as an electronic scanner tag. RFID has brought about numerous applications especially in retail and supply chain management. The applications can be found in transportation and access control applications also. The latent labels are presently being utilized as a part of numerous bank cards and toll cards which is among the first worldwide arrangements. Dynamic RFIDs have their own particular battery supply and can instantiate the communication. Of the few applications, the primary utilization of dynamic RFID labels is in port compartments for monitoring purpose.

Sensors in traditional system have always connected with physical wires where erosion is in high proximity this can be replaced with wireless devices giving flexibility to install where ever we need in our premises where with the IoT subnet we can install them many microcontroller devices like Arduino, raspberry pi which are prototype boards can be deployed by connecting many sensor where they are capable of connecting to wireless network.

2.5 UTILITIES

The data from the systems in this application space are typically for service optimization as opposed to consumer utilization. It is as of now being utilized by service organizations (smart meter by electricity supply organizations) for asset administration keeping in mind the end goal to enhance cost versus benefit. These are comprised of exceptionally far reaching systems (generally laid out by huge association on territorial and national scale) for observing discriminating utilities and proficient asset administration. The network may differentiate finally

Electricity producers for better quality of service on load balancing introduced smart metering and smart grids which are at still implementation stage due to security reasons the main utility using these smart systems the can get know the reading of each and individual house as well area so that based on time they deploy necessary power to the following these type of smart consumption will decrease the cost of maintenance.

Introduction of IOT with video base is a bit complex where machine learning comes into play where it integrates image processing, vision, networking frameworks which is till at research stage where intersection of image and audio with perfect network should integrates surveillance is widely used application where each and every step is important to detect as well to identify the intruder.

Another major application comes under water conservation where identifying the quality drinking water using IOT approach. Sensors measuring critical water thresholds where they can be installed at different places and integrate them to ensure to knew high supply quality to avoid contamination of water by sewage and other means of source of disposal even there are sensors to monitor the soil fertility this can be helpful to choose the crop based on fertility of soil

3. PROPOSED ARCHITECTURE

The disadvantage of above mentioned systems some examples will not be providing the data if so the data which is produced will not be logged for future perspective. Apart from it there is other disadvantage that is even after data logging there is limited functionality on server side. Hence we propose a model of using Google cloud services by using app engine in which when Arduino sends the data to Google cloud the server side program will consume the data and post to web interface. The following

next steps will brief about the implementation of the proposed model.

This work is an embedded project where hardware components of the following are needed

1. Arduino Yun
2. DHT11 sensor (temperature and humidity)
3. PIR motion sensor (passive infrared sensor)

Arduino Yun is microcontroller where Atmega-32 processor is embedded into it and it can even communicate to Linux commands onboard where one can execute the commands to send the sensor data to any server by using cUrl command where it is in process library of Arduino and it has development environment where code can be deployed on to the board where sensors are connected to it. Here we used 4 types of sensors DHT11 sensor is a sensor which generate humidity and temperature with defined delay time this has library DHT which can deployed into environment to get the real time values. PIR motion sensor is an infrared motion detection sensor where when there is abnormality generated in the infrared rays it will detect it as a movement and will generate the alert at the point of time it is generated.

Figure 3: Arduino Yun **Figure 4: DHT11**

Figure 5: PIR motion sensor

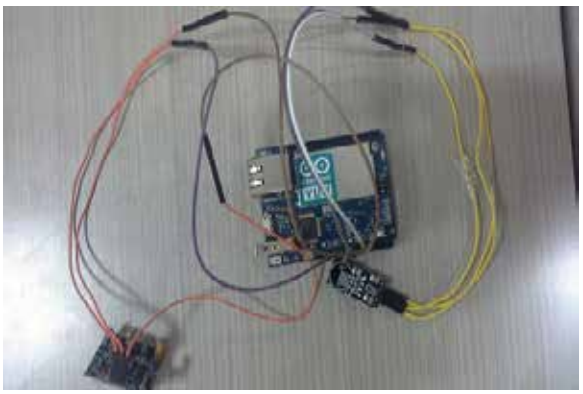

Figure 6: Sensors connected to board

3.1 TESTING THE HARDWARE SIDE PROGRAMING

The program is written in 'c' where we should include following libraries namely 'bridge' library and 'process' library for connecting to Google cloud using app engine ID, DHT library for getting the real time temperature and humidity values we should use YunClient and YunServer for describing client and server modules. There are two modules in code usually called as sketch setup and loop in addition to its many function can be called the setup function is used to check the first time connection of board and loop will continuously send the data to outside network database if we defined. The following is code snippet:

```
#include <dht.h>
//library of dht sensor
// the below the header or libraries are used from making connection with server either it is external or internal
#include<YunClient.h>
#include<Bridge.h>
#include<YunServer.h>
#include<HttpClient.h>
#include<Process.h>
#include<Console.h>
#define dht_dpin A0 //Assigning  A0 pin to dht_dpin
YunClient client;
YunServer server;
 dht DHT;
void setup() {
// Initialize Bridge
Bridge.begin();
// Initialize Serial
Serial.begin(9600);
// Wait until a Serial Monitor is connected.
Serial.println("in setup after cnct or ncnct");
DHT.read11(dht_dpin);
server.noListenOnLocalhost();//this header is to connect to external server
delay(5000);
  // run various example processes
}
void loop() {
DHT.read11(dht_dpin);
runCurl(DHT.temperature,DHT.humidity);
   Serial.println("printed");
   delay(5000);
}
void runCurl(int temp,int humidity) {
Process p;
Serial.println(temp);
Serial.println(humidity);
String cmd = "curl  --data \"temp=";
cmd +=temp;
  cmd +="&humidity=";
```

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```
cmd +=humidity;
cmd = cmd +"\" http://arduinoproje.appspot.com/arduino_post";
      app engine id
Serial.println("after gae");
if(p.runShellCommand(cmd))
Serial.println("exe");
else
Serial.println("not exe");
Console.println(cmd);
  p.close();
}
```

We use Curl command to call the app engine id where we used python code to grab the temperature readings from arduino. The next section describes about app engine.

Google App Engine (GAE) is cloud based platform to deploy web application we can write the backend of the application as well as the front end. It support 4 languages python, go, php and java. So the server side which is written in python will grab the data from the Arduino and sends the data to the app engine where it stores it in Google cloud data store using library "data-store.db". Webapp2 is library in python google app engine where its main functionality is we can use webapp2 request handler to consume by using get and post in web interface using post method.

4. RESULTS AND TESTING

Figure 7: Arduino data in Google cloud console

Figure 8: The temperature and humidity values are shown in Google cloud console

Figure 9: calling app engine id for displaying the data in web dashboard

5. CONCLUSION AND FUTURE ENHANCEMENT

The end result of the data is able to store the data in Google cloud data store as specified by server side programming but even the logged data is scattered and irregular which is difficult for analysis ultimately this will effect to generate the alerts and other advantage is this Arduino Yun board is capable of using the wi-fi in which it can send the data to outside network where ever it is placed of provided network connectivity, coming to future enhancement the data here is sending to Google cloud using http protocol but there is a protocol which is lightweight known as MQTT where latency can be overcome so implementing this is future enhancement. And also providing real time notifications and alerts is another challenging task in IOT platform.

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