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Centralize Lab Implementation on an Embedded Web Server using Cloud Computing

Neha S Rajurikar, Smita V Kulkarni(Assistant Professor)**, Prof. R. R. Patane**(Associate Professor)
Department of Electronics Engineering, Terna Engineering College, Nerul, Navi Mumbai, Maharashtra, India

Abstract— We are implementing a Wireless Remote Lab which will be used to perform complex Embedded experiments on it with Given limited resources using CoAP protocol [1] and Means Stack in RESTful interface [2] which can accessed and used over the web application over the cloud infrastructure .Now in experimental field where some time where nature is our laboratory , where our research takes us outdoor from our lab but we cannot physically present all the time at such location for the observation and data acquisition , but we need the data from our lab every moment for the assured result of our experiment, with such lab we also require a seamless connectivity so that no matter where we are we can access the lab from anywhere for best observation for our experiment . With increasing technology and research in IoT such labs and equipment's are coming to realization for the academic research and development. For such application we will implement an Embedded Server with CoAP protocol and, used with RESTful infrastructure we can such device form anywhere from the world. But still we want this device to work more efficiently so to increase efficiency we will implement virtual resource concept in our embedded server.

Keywords— Internet of Things (IOT), CoAP, RESTful, Arduino, Arduino UNO, Beagle black.

I. INTRODUCTION

To prove any hypothesis scientific community has to do lots of experiment on the given proposal before it is accepted , for such study's in major experiments scientist requires the equipment which will give them the required data from the analysis as per need of research. In many of this devices has the common structure, they have sensors and processors which will do the computation on the data then there is data acquisition for further analysis and historic database of such data in short an Embedded System. But such experiments not always done in confined room of the labs this experiment can be in real environments which are way distance from the civilization. And traditional embedded system cannot fulfill the modern experiments requirement on the basic design and implementation we will first observe the limitation of such embedded devices which are used in such scientific research.

This experiment location can be anywhere they might be far away from the civilization where daily physical presence of the human is not possible for such location, but still we require the data from the sensors in such case we require the seamless connectivity of the equipment. For such purpose we require the remote laboratory concept which can be accessed even from the far distance, just like the physical access. [3]

This laboratory are in actual open environment where natural parameters are highly variable day to day , so the device would require to be adapts as per the chaining enjoinment by using software change, or if research wants to change the behavior to change the experimental condition so this change can be done only by the physical presence. The availability of the real time data might be the high requirement for the experiment performance so that proper observation can be done at the research lab, also this research might also been done by multiple entity so the this data also be available to the other researchers at the same time, but all this requirements cannot be achieved with the simple embedded system we require more than basic system, to save time and resources which can be spent better on the research improvement. But only implementation of embedded device is not enough we have to make assure that this deceives can complete its experimental life time with given power so for that it should utilize its resources more efficiently.

What we require is a embedded device which will have multiple sensor which will generate the scientific data, this data can be accessed anytime from anywhere with minimum human interaction and management. And device software can be changed as per research requirement. And with all this it should have longer life expectancy.

This entire requirement can be achieved by implementing the Remote Lab with IoT concept.[4]

In IoT everything is seen as object, we can connect any embedded device to the internet .So in IoT a object with sensors which is in physical world and are connected to the Internet gives us the solution.

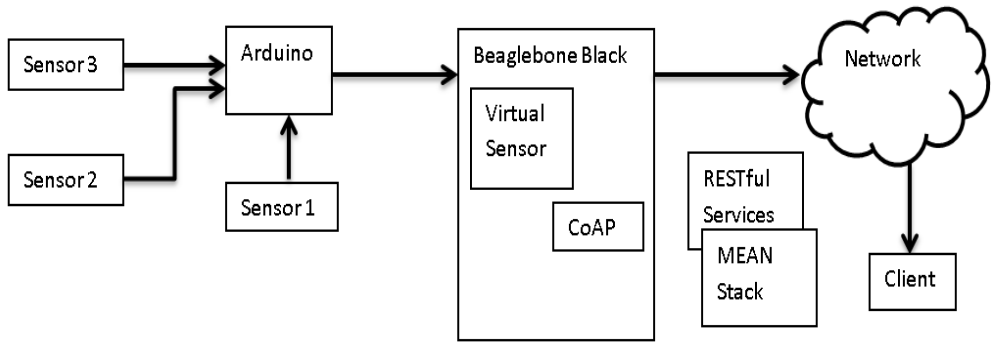
IoT will let us to develop our embedded system which will interact with Internet , with which we can access the embedded devices from any where we can observe the performance of the sensors by accessing the embedded server through web application which. This is how we can achieve accessibility solution for our remote lab [5]

With IoT we will able to create cloud based database on which we can upload the sensors data via embedded server , this embedded server will be interface with physical interacting hardware with the help of CoAP protocol and this server also use this protocol to interact with HTTP like applications interaction with net. This will help us to map our device into the RESTful interface.[1][2][6]

The Host can access our device through network using web application, with host also can access the cloud based data base for the use of data acquisition logs , with this host also can take the control of the embedded server for to make any changes in the software functionality of the physical interacting hardware.[7]

And all over this to improve the efficiency we will be implementing the virtual sensor [8], in this technique we will implement a software in Embedded server which will collect the all the information from the physical node and rather than taking decision on the basis of single sensor information the software which act as virtual sensor will first collect the information from all this this sensors and it will first process this all sensors information and according to the virtual sensor function it will take decision, rather than acting on single sensor information.

II. DESIGN



In our project Arduino is the end embedded device which will have the sensors which will interact with physical parameters and collect the information for the central computing which will be the beagle bone, this is the ARM based machine which will act as Embedded server for us which will do heavy lifting task like, Virtual sensor computation, handling CoAP protocol and communicating with the host over the network. It will also send the data over the cloud for the data acquisition. And host side can access the web application which will allow the host to control the end embedded device and also the cloud for the data.

III. HARDWARE DESIGN

A. Ardino UNO

Arduino is the embedded platform which consist of 8 bit microcontroller which is At mega 328 . With this microcontroller on this platform it also has onboard programmer to program the IC with the help of software IDE. This platform has 14 Input/output pins and microcontroller functions with 16 MHz crystal. It has dedicated PWM generating pins and this microcontroller also support standard protocol UART, SPI and I2C. It also has on board ADC (Analog to Digital convertor) , with which we can interface all different kinds of sensors to the Microcontroller.

B. Beagle boneblack

Beagle bone is low cost embedded AR based platform which can support Linux architecture and development environment. So it will act as Central processing unit in our design which will connect the network side with physical side of the design. We will be implementing the CoAP protocol on this device to interface our lab with RESTful architecture. The specification of this device is are 1GHz ARM Cortex™-A8 core , SGX530 graphics engine 32KB instruction buffer and 32KB data buffer , 256KB L2 cache with error-check code ,10/100M Ethernet (RJ45 connector) , 4GB 8-bit eMMC on-board flash storage, 512MB DDR3 SDRAM with such high end specification this device more suitable for our project.

IV. SOFTWARE TOOLS

Arduino program is developed with C language. The hex file for the Arduino is compiled with help of tool AVR gcc,so the required program file is send to Beagle Bone then it is compiled with the help AVR GCC this compiled Hex file is loaded on to the Arduino with the help of AVRDUDE and USBASP which are also open source tools.

Beagle Bone is installed with Linux Ubuntu distribution , with it we also have installed Server packages .With it also we have also installed all the supporting packages like Python ,PHP , Scripting tools We also installed CoAP support libraries in python CoA Python.

A. AVR GCC and AVR DUDE

AVR GCC is complier for the specific target of Atmel family microcontrollers. Because of AVR GCC we can develop the programs for the standard ANCI C programming language with ease. Due to such availability of library any

programmer can start with ease with AVR microcontroller with ease.AVR GCC support large number of AVR microcontrollers

We also install AVR DUDE for the burning the compiled hex into the AVR microcontroller. Using the AVR DUDE tool we can optimize our hex file compilation. Also we can modify the fuse bits of the AVR microcontrollers to change the internal behavior of the microcontroller related to the WATCHDOG timer , EEPROM , clock generation etc…Finally we dump the hex code into the Flash memory of the AVR using the AVR DUDE tool.

B. CoAP

Constrained Application protocol this protocol is developed to help the application for the embedded device to communicate with RESTful architecture just HTTP protocol but with constrained resources. It adapts to the same HTTP protocol which is based on simple request or response methods. Resources are identified by URIs and they can be retrieved and modified using standard methods like GET,PUT, POST to DELETE . This protocol is one of the latest protocol which is lead in research for IoT because of its energy saving concepts and very light on embedded development this protocol is available with multiple tool platforms for the application development , we will be using PyOT platform for the development of the application which is based on the Python language. PyOT has in build object which explicitly makes CoAP calls. We are going to implement virtual resource directory as CoAP server which are represented as CoAP resources.

C. Virtual Sensor

Virtual sensor is implemented on the embedded server with the help of the PyOT tools, this virtual sensor will fist collects the information from the arduino and this information first go through the defined algorithm for the Virtual resource according to the trigger point in virtual sensor then only Embedded server will forward the processed value from the virtual server to the cloud. This cloud information can be access by the valid user the web interface from client side.

D. Remote access of the Embedded Server

For client side we have made the web interface with PHP in which it will have first Login page, in which user will fist enter his/her credential and if the user is valid then only the user will get the access to the embedded server. After valid access user can upload a C file and this C file can be compiled on the embedded server and the hex output can be dumped on the Arduino for this dedicated button interface is created.

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