SenseSmartHome:

Using Wireless Sensors,Mobile and Web via Bluetooth Network.

Mohammed Nadeem Bari, Ardah Khalid , Mohammad Naderozzaman and Reja Alam Talukdar
Computer Science, Electrical and Space Engineering
Luleå University of Technology
97187 –Luleå, Sweden
nadmoh-0@student.ltu.se, khaard-0@student.ltu.se, mohnad-0@student.ltu.se, mdrtal-0@student.ltu.se

***Abstract*—This paper is a description of a home automation system - SenseSmartHome - developed as an academic project. We believe a Home automation system can be afforded by all through the use of smart devices involving technology to run their home, office and outdoors. The architecture of the SenseSmartHome is detailed but we try to focus on a achievable, cost effective and simple system which can be implemented by any person with some technical expertise, knowledge of Java, SunSPOTS tool kit and web services. It also has the flexibility to expand and can be quite powerful if implemented in a bigger perspective. The architecture has been designed in such a way that each module controls multiple devices remotely or locally.**

Our objectives were to address a Smart home whose implementation is easy, can control a number of control points through blue tooth and web services through which the users can configure and adapt the system based on ones profile or preferences. To help support elderly and support disabled people. It can also cater to a rich set of integrated services in the cloud for multiple homes. In this paper we also focus on design, Installation and future implementations. We discuss and demo our lab experiment and challenges we faced.

Keywords-component;SenseSmartHome , Home automation System, Remote control, Bluetooth, SunSPOTS and System Architecture

I. INTRODUCTION

As we all know the future belong to things, rather than numbers, concepts or transactions [6], Hence our efforts to support this theory, we bundle circuits, sensors, smart phones and blue tooth devices in a network to monitor real-world activity with SenseSmartHome. The objective of this study is to enable pervasive technology in our daily lives and develop a remote control system over the Bluetooth home network in the home.

By fixing a blue tooth network, A low cost and simple to implement automation system which benefits like remote controlling and monitoring your appliances via web and through Android phone when indoors avoiding cables, reduce energy consumption and to reduce cost.

Few of the benefits of Smart home system is that it can increase comfort in the home, more safety and security and better energy management. This led to the development of SenseSmartHome, which has been used as a learning tool and as a test environment for new ideas and implementations.

In our project we made use of fewer features and lesser products with lower capabilities for the benefit of contributing to the awareness and easy implementation to any one in home automation.

1) Motivation behind SmartSenseHome .

a) To build a Smart and Pervasive Environment (buildings, homes, outdoors).

b) Proactive health management - both people and monitoring of things.

c) Reusability: Use of existing resources and timely access to better information-smart phones, wireless sensors, blue tooth technology.

d) Improve security and peace of mind: To any home who wants to be in smart environment or implement low cost SenseSmartHome.Selection: Highlight all author and affiliation lines.

2) What we did:

The capability of sensing just one physical phenomenon is not enough today's sophisticated applications, a device that provides several wireless sensors and transducers with programmable environment is limited only by imagination.

a) We Inter-networked available devices to Internet,

b) Embed a web server using code igniter to listen to SunSPOTS and Android Application.

c) Model resources as Uri's, Measurement of Light and temperature sensors,

d) Editing/updating Sensor values using RESTFull protocols,

e) Scan and Control Bluetooth devices from web and mobile app from outdoors.

3) What we used:

We made use of open source tools and technologies like Apache tomcat server, HttpRestServer, HttpRestClient, Android Client with Bluetooth API's and web services supporting REST services. JSON data format was used to send/receive data in a comma separated value way. The same is been shown in the figure below 5.0

a) REST: The main idea of rest is to blend with web and build web applications that can cater to any platform and provide functionality completely as a set of URI's and available over http to interact with them.

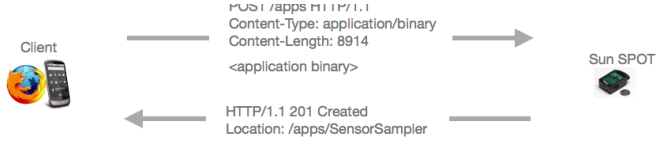

Figure (1) REST POST Request and Response.

b) Bluetooth: Bluetooth technology is capable of transmitting data and voice at half duplex[1] rates up-to 1 Mbps without the use of cable between portable and fixed electronic devices. Home automation is/can be one of the major applications of blue tooth technology. The core technology of home automation is communicating and controlling automatically with each device and sensor in a small home network.

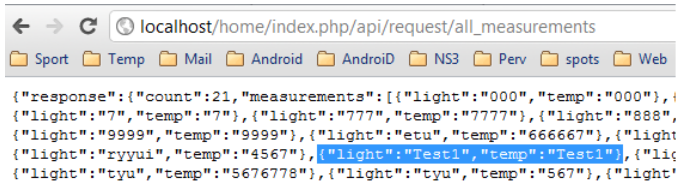

Figure (2) Json format Illustration and syntax.

It comprises of POST (Create), GET (Read), PUT (Update), DELETE (Destroy) requests and the response codes shown on Handheld or Web Application describes method success/failure. Please refer the picture of the Json format shown while making a GET request.

We needed one common language among diverse platforms; The Representations shown above in (XML, JSON) conceptually separate from resource and easy way to communicate over web.

c) Sunspot: a small WSN device, which integrates multiple sensors and transducers (sensors combined with actuator mechanisms) with programmable facilities and a radio [6]. By simplifying the development of wireless transducer applications, the sun SPOT systems introduce the potential use in wireless applications and its implementation into real world products.

Figure (4) Broadcast and Simulation of temperature values.

SunSPOTS has three layers:
Battery, Processor Board (BaseStation) and Sensor Board (2G/6G Accelerometer, one Temperature sensor, One Light sensor, Two 8-bit tri color LED's, 6 analog inputs, Two manual switches and I/O Pins

d) Bluetooth Devices: We made use of TellStick, which is USB-stick radio frequency transmitter that plugs into your computer and communicates to Bluetooth clients within 30meters distance[6]. It acts an interface between your computer and other wireless devices. It transmits signals at 433.92 MHz that turns on/off electricity on electronics and lights connected to wall plug socket receivers (Tested on NEXA units).

e) Bluetooth home network: This is capable of transmitting data and voice at half duplex rates without any interventions and cables between portable and fixed electronic devices. We don't compare other technologies over Bluetooth, as we don't attempt to provide any significant advantages over the other data transfer technologies such Zigbee, IrDA, RFID and Wireless LAN[2]. Since one of the objective of the experiment was to make use of existing devices available in the lab and build a network to combine this products to a desirable pervasive computing environment.

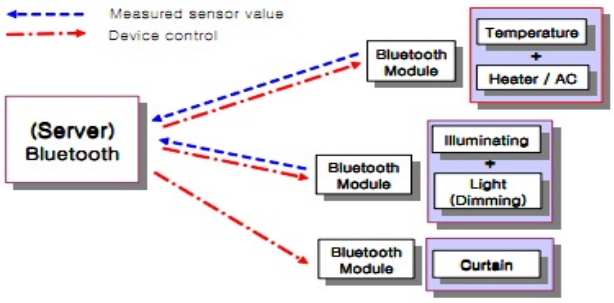

Figure (3) SenseSmartHome Server with other appliances [2].

As we all know blue tooth has its own limitation and was designed as a replacement technology for consumer electronic devices and data communication that uses short-range radio links to operate in the 2.4 GHz. But it was quite suitable for our project and for home wireless automation. We propose a system as shown in figure: 5 below.

II. SYSTEM ARCHITECTURE

a) Devices we used: SenseSmartHome architecture as shown in figure:5 is composed of various modules which are interconnected by a communication network that allow them to interact.

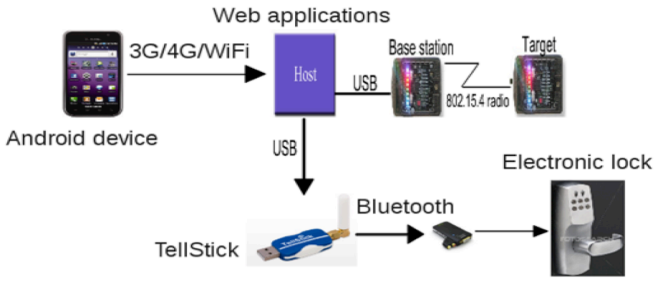

Figure (5) Internetwork of Devices and Technologies used

III. SOFTWARE DEVELOPMENT

- A variety of tools and languages used in the development of SenseSmartHome. We used a web server with PHP Framework called CodeIgniter for Backend REST Services.
- A Java programmed Clients for SunSPOTS, which acts as client and uses server sockets and http to communicate.
- A Java Based Client as Android app with API'S from TellStick.

a) TellStick Client and Server programming: Through this you can start a web server from your home computer, the TellStick server uses a web interface to control your environment, add available devices in a distance of 30m. We here make use of Tellstick API's to scan and add devices, Implement actions on them and send/receive messaged to the devices using REST protocol. The tell stick server runs over apache-tom cat server and it involves of using an android based client, TellStick USB and NEXA units.

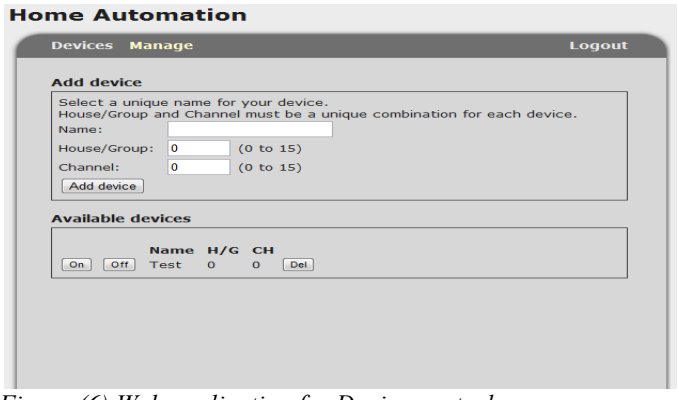

Figure (6) Web application for Device control

b) The Mobile Client: The Android app here is used to connect to the TellStick Server over Http and send /receive commands sent to the Server. Through this the goal was to use a wireless client when you're indoors, It is also easy to use, handy and requires an authentication before you use the application, It has the implementation for users and different accounts, The settings of a user is loaded based on the login credentials supplied to the server.

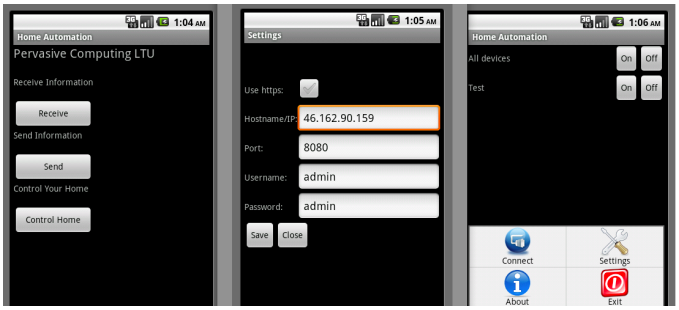

Figure (7) Mobile Interface and Functionalities.

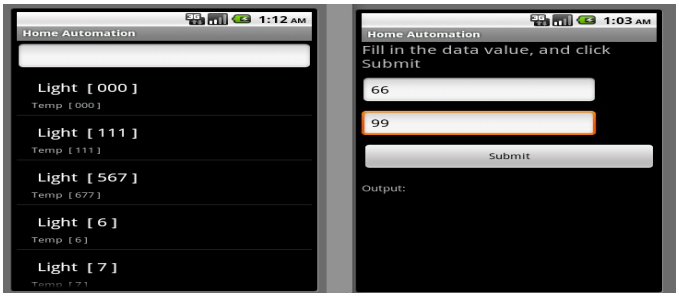

Figure (8) Light and Temperatures Interfaces.

c) SunSPOTS Client and Server: In this system, A sunspot client communicates sensor information (Temperature and Light Readings in a room) to a web application using REST protocols in SenseSmartHome server on your personal computer or laptop. There is a video and screen short shared in references[] on how a sunspot interacts to a web service over http with the data encapsulated in Json format. The data is being received to web services presently, which are mainly our Server set up at home, or lab environment and not a mobile application.

Once we have the sunspot temperature and light values, we would like to know the status of room temperature, light sensor values, We can analyze if we need to switch on the Air conditioner to low or high depending on the climate. It also indicates to us that there is something cooking at home. May be if he we have forgot to switch of the geyser or Electric stove resulting in high temperatures at home. Hence a user can control his devices or appliances through the Smart web services and switch of the devices. These results can also be used to trigger fire alarms and sending alert messages to neighbors or emergency services in advance.

IV. CASE STUDY

1) Experiment with Light Sensor:

Below is the picture, which shows the light sensor values are graphed against time; here the host application connects through the Base station radio to the Sun SPOT. The light sensor measured the range from darkness to lightness, Displays the raw light value from 0 to 1023.The value represents the intensity of detected light. We observed that as we covered the sunspot with our hands or made the room darker, the light level decreased level from 1000 to 200 and so on. In a complete dark room it showed 0. Similarly in well-lighted areas the values moved unto 800 and 1000 level. The demonstration and how to run this set up is shown in our Project website [9].

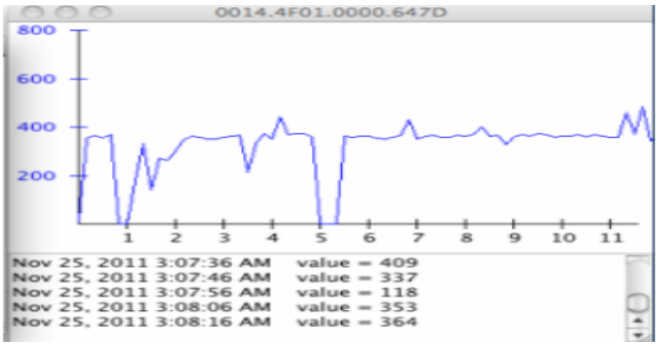

Figure (9) Visualization of Light Intensity in a client

TABLE I. LIGHT SENSOR INTENSITY VALUES

Name	**Table Column Head**		
	Under Darkness	***Well Lighted***	***With No light***
Light Sensor	200	1000	0

2) Experiment with Temperature Sensor:

As it is capable of sensing environment temperature, the raw value in the standard of Celsius or Fahrenheit is read from the free spot /Free node device. It is displayed in the web interface in a modal box or can be visualized on a graph.

3) Challenges or Points to watch out:

With respective to SunSPOTS: As SunSPOTS supports broadcasting, There are few instances where datagram's (packetized data) were lost during transmissions and we received a NoReplyException if the remote spot didn't receive a packet sent from Basestation. Because In the lab environment all devices must have same personal Network and the Mac address of the free node should be specified before Lab Experiments: Temperature measurements, changes and controlling of devices.

TellStick Devices can sometimes may not react to signals, which is based on the Appliances AC/DC VOLT (V) supply and distance to the server.

4) What we achieved:

a) A Demonstrated, functional , Affordable and Easy to implement SmartHomeSystem.

b) Simulated result between virtual SunSPOT and the Free Range SunSPOT for study and expansion.

c) Networking of devices and Communication of web, Mobile application, Blue tooth devices and Wireless sensors (SunSPOTS) to monitor real world activity.

d) Measuring Temperature, Lighting intensity using luminous intensity, Thereby reporting raw values and visualization.

V. ACKNOWLEDGMENT:

Apart from the authors of the research paper, forums of device manufacturers, We would also like to thank LTU University, course supervisor- 'Kare synnes.', and PhD students 'Basel kikhia.' and 'Juwel rana.' for their support and guidance.

VI. CONCLUSION:

In this paper a Home Automation systems based on Bluetooth and Smart devices is proposed, Efforts have been made to develop an efficient system, affordable and easy to get started by having these smart devices. We understood pervasive technology and its prospectus

Experiments and results have been shared based on our present architecture and the planned work- we assume
The system is ease of use and affordable.
Capable of using in any indoor environment
Be as non-intrusive as possible
Be reliable and, Provide instant corrective feedback.

REFERENCES

[1] Remote-controlled Home automation system via Bluetooth Home Network by Kwang yeol Lee, Jae Weon Choi, 2011 , Korea.

[2] DomoBus - A New Approach to Home Automation by Renato Jorge Caleira Nunes.

[3] Hamilton – Building Mobile sensor networsk using Smartphone and webservices.

[4] D. Valtchev, and I. Frankov, "Bluetooth Wireless Technology in the Home," Electronics and Communication Engineering Journal

[5] "http://api.telldus.com/documentation/account",Documentation

[6] http://sunspotworld.com/, Documentation.

[7] Open source API's forum for TellStick. "http://developer.telldus.se/".

[8] http://java.net/projects/spots/pages/Home," Documentation.

[9] http://pervasiveteam-ltu.yolasite.com/videos.php