SMALL SPACE VIRTUALIZATION OF REGION UNDER MONITORING AND CONTROL

***Gitang Karnam, **Rohan Stanley**

**Computer Engineering*
Ramrao Adik Institute of Technology
Navi Mumbai, India.
***Electronics Engineering*
Ramrao Adik Institute of Technology
Navi Mumbai, India.

ABSTRACT

The semi-automatic world is fading and more autonomous systems are being developed to increase the convenience of mankind. The concept of IOT (internet of things) has gained plenty of attention in the technical world. This project is one such application of IOT which we named the HIVE. It enables you to monitor a particular area and control the appliances within that area from anywhere in the world. A web based GUI (graphical user interface) is used to login and gain access to the control page that gives the user an exact virtual visualization of the area. Environmental conditions like temperature and humidity is be monitored using a network of smart sensors (slave) that send data to the master. The project offers ease of access, process optimization, optimized resource consumption, sensor driven decision analytics, instantaneous control and response in complex autonomous situations etc. adding convenience to the way of life.

INTRODUCTION

The HIVE is a project that is based on internet of things (IOT). The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing internet infrastructure. Hive is a project that brings your workplace online. The project enables a person to control anything at his workplace from anywhere in the world i.e. automation over the internet. This project gives a person a complete access to his workplace so that he can monitor the activities going on and also control the systems. The authorized owner will have access to a control page that displays the layout of the

room and the systems available to be controlled. The control page is supported with a live video feed to monitor the activities as well.

PROPOSED METHODOLGY

Dealing with IoT systems, we can initially compare the proposed system with similar Adhoc architectures. The similar Adhoc systems designed for monitoring and control of a particular area have the most obvious demerit of being short of its control range. Whereas Hive is has no bounds in terms of control range as it is a purely IoT based system designed to stay connected to the user via internet.

Comparing with the existing IoT systems holding similar characteristics of control and monitoring we can point out some major modifications. These systems on a fully functional level exhibit some drawbacks on the application layer. The existing systems have on-screen switches/buttons as well as slider animations for control and onscreen LEDs , message display ports , graphical plots of real-time readings. These control elements available on the application layers of these systems have a wide scope of improvements which was taken into consideration while designing the application layer of HIVE.

HIVE has a more straight-forward user interface on its application layer thus making it different from older systems. It strives on delivering a more user friendly experience and that is possible due to its unique feature of 2D visualization of the control region.

The proposed methodology is dynamic enough to be serving a single client at once and with optimum steadiness. The client may enter the HIVE website using a web browser on a smartphone or a computer and login using pre-defined user ID and password. This website is hosted by the HIVE server on the same or remote network. After the authentication of the entered credentials the user/ client is directed to the control page hosted by hive control unit. The HIVE control unit now acts as the server and displays a 2D visualization of the region under monitoring and control. For example the region selected for the prototype of the system is a laboratory and the user can see a 2D top view layout of the room with all the control elements such as lights, air conditioner, lockers, doors, windows positioned exactly where they are placed in the real world. These control elements are actually active and can be toggled or processed in real-time. These control elements hold URL modifying attributes and as soon as the user clicks on these control elements, the corresponding url is read by the micro controller of the HIVE control unit and the respective changes are made. This control page also displays sensor values from server side at a 5 seconds refresh rate. These values include room temperature, humidity and ambient luminescence of the region under control. The Ethernet packets are received by the Ethernet chip in the device layer and decoded into valuable data by the microcontroller in the Hive control unit. The hive control unit also has a provision for controlling lights autonomously.

This is possible due to the motion sensor network which sends the real-time sensed data to the hive control unit (master) via the local sensor hub unit (slave). Using this data the hive control unit issues commands for switching of corresponding regional lights, these commands are sent to the appliance control hub (slave) which further takes care of switching the relays of the toggled appliance. On the control page layout of the room(region under control) we can also see the doors, lockers and windows along with their status (open or close) .Once the user toggles these elements from the client side the respected url is read by the hive control unit and the togglingg commands generated for opening or closing doors, lockers and windows is sent to the access lock hub(slave) which takes care of the solenoid switch states and servos used for optimum locking and unlocking of these physical control elements. If the user is in the same region and wants to control the things under that Hive then he or she can use the hive offline control unit. The sensor hub, appliance control hub, access lock hub as well as the offline control unit are wirelessly connected to the main hive control unit using IEEE 802.15.4 Zigbee protocol. This session continues till the user doesn't log out of the control page and once the session expires the user has to log into control page again.

BLOCK DIAGRAM

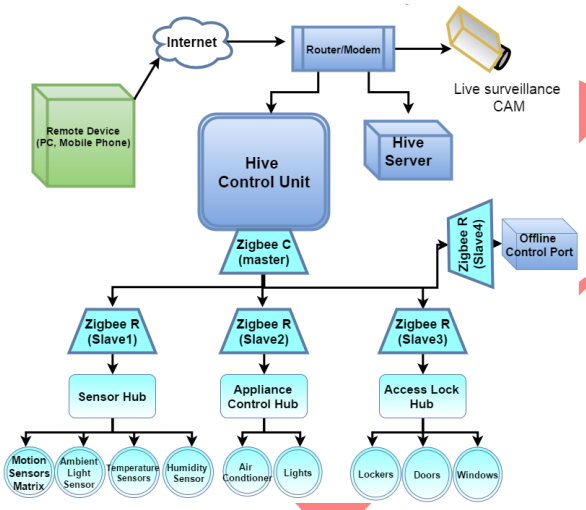

Fig 1-hive system block diagram

NETWORK LAYER

The network layer contains the following components

1. Web & Database server
2. Control page hosting server (Master microcontroller).
3. Router

In addition to the above components an IP camera is used for live video feed.

All the components are connected to the router. All the components are connected using Ethernet (IEEE 802.3). The web and the database server hosts the general web pages i.e. the user interfaces. When a login request is made and the login credentials are entered the server redirects the user to the control page hosting server. The IP of the control page hosting server is used to access the control page with proper authentication. Thus by assigning static IP addresses to the pages with pre-defined port numbers, we are able to control the navigation and flow of the entire website.

The router is responsible to connect both the servers locally so that the control page can be accessed faster. The live feed is accessed using the local IP address with port number of the camera. As both the servers and the camera are connected to the router an ad-hoc network (LAN) connection exists on one side.

DEVICE LAYER

The device layer of Hive consists of the hive control unit along with all the daughter hubs. At the heart of the hive control unit we have TM4C1294 chip by Texas Instruments based on the ARM Cortex-M4 architecture, interfaced with an Ethernet port. This unit is directly connected to the router. The Zigbee module interfaced with the hive control unit is configured as the coordinator (master) of the zigbee network mesh, while the zigbee modules in each of the daughter hubs, access lock hub, appliance control hub, sensor hub, offline control unit, are configured as routers of the same mesh holding the same PAN (Personal Area Network) Id as the coordinator zigbee module residing in the hive control unit. Each daughter hub is controlled by atmega328 chip by Atmel based on the AVR architecture.

The sensor hub consists of the microcontroller, temperature sensor, humidity sensor, light sensing unit, motion sensors. A mesh of 7 motion sensors is connected to the controller of sensor hub. Using a precise algorithm, the sensor hub finds out, in which exact region of the room, motion is detected. Using this information, the corresponding switching signal is sent to the hive control unit. Another feature of the same algorithm is that the sensor hub keeps track of the regions were no motion is detected for a pre-defined time and sends the turn-off signals to the hive control unit. The remaining sensor data is also sent to the HCU at a predefined refresh rate.

The appliance control hub consists of the microcontroller, relay unit and IR emitter matrix. The switching of relays is done on the basis of commands sent by HCU. The air conditioner is controlled using IR led matrix. The Power on/off, reference temperature level up/down IR codes are transmitted using IR led mesh. These AC control codes are also sent according to the commands sent by HCU.

Access lock hub also consists of the local microcontroller along with solenoid control unit and servo control unit used locking and unlocking of door and lockers. The window shields are also shut /open using an actuator. These controls are based on the commands sent by HCU.

The offline control unit of Hive consists of a microcontroller, OLED display, navigation and selection buttons, power management unit and Zigbee module. This unit also exhibits a user friendly menu based GUI. This unit is used to control the elements under control of Hive at a Adhoc level.

APPLICATION LAYER

The application is a web based application that is developed using HTML, PHP (Server-side scripting) and JavaScript (client-side scripting). The interface is developed using HTML and JavaScript and the backend processing is handled by PHP. A SQL (structured query language) database is used to maintain the user details like login credentials. The page navigation is guided by links and PHP headers wherever required that redirect to the requested pages. The entire control page developed using HTML.

As the user accesses the website he/she will be able to see as what the project is about and the details of the team that developed the project. The different pages of the website are navigated using the menu at the top of each page.

On the login page the user enters his login credentials and gains access to the main control page. On this control page is the 2D layout of the room he wishes to control. The status of the appliances changes on clicking the particular appliance. This page also helps to monitor temperature, Humidity and light intensity of the room and an additional panel is provided to access the video feed of the room.

RESULTS

The system has been connected online and tested on all levels of its functionality. The user is first directed to the hive homepage where a small abstract of the system is available. The user may then go to the login page to type in the correct username and password to gain access to the control page. The control page is shown in figure 5.

Fig 2-Hive homepage

Fig 3-About Hive page

Fig 4- Hive Login Page

Fig 5- Hive Control Page

CONCLUSION

The project enables us to control the various appliances and monitor the workplace completely. The features that are offered by the project go as follows:

Remote monitoring: The intelligently developed web interface allows you to monitor temperature humidity and the light intensity in the room. In addition, the supervisor can monitor which locker of the room has been opened. The Air conditioner settings can be monitored as well. On top of these factors a live video feed enables the supervisor to have a look on all the activities going on in the room.

Remote access: This feature is the core of the project that allows to have access and control all the systems within the room remotely. The project gives u access to control the air conditioner, lights, fans, etc. Thus the supervisor can restrict undesired activities remotely.

This IoT based project thus enables ease of access and allows monitoring and controlling by 2D virtualization of the room. Automation of the room is done for convenience and to save electricity using PIR sensors to detect motion and switch on the lights and fan for the user. Networking enables the different modules to communicate with each other smoothly.

ACKNOWLEDGEMENT

The Author's would like to thank the Electronics Engineering Department of Ramrao Adik Institute of Technology for their constant and valuable support and guidance.

REFERENCE

1] Francis daCosta , Rethinking the Internet of Things: A Scalable Approach to Connecting Everything , Apress, 1 edition , 30 December 2013.

2] Samuel Greengard, The Internet of Things (The MIT Press Essential Knowledge series), The MIT Press, 20 March 2015.

3] Jonathan W Valvano, Embedded Systems: Introduction to Arm(r) Cortex -M Microcontrollers, Createspace, 2nd edition, 26 May 2012.

4] Jonathan W Valvano , Embedded Systems: Real-Time Interfacing to Arm(r) Cortex -M Microcontrollers: Volume 2 , Createspace, 2nd edition, 10 November 2011.

5] Charles E. Spurgeon, Ethernet: The Definitive Guide , Shroff Publishers & Distributors Pvt Ltd, 2nd Edition, 1 July 2014.

6] Holger Karl, Protocols and Architectures for Wireless Sensor Networks, Wiley India Private Limited ,14 December 2011.

7] Tsang Kim-Fung , Tung Hoi-Yan , Lam Ka-Lun , ZigBee: From Basics to Designs and Applications, Pearson Education, First Edition, 20 October 2008.

8] Aaron Gustafson, Adaptive Web Design Foreword by Jeffrey Zeldman, Easy Readers, 1st edition, May 2011 .

9] Dan Cederholm, CSS3 for Web Designers, Jeffrey Zeldman, ,2nd edition, ISBN 978-0-9844425-2-2.

10] Dan Cederholm and Ethan, Handcrafted CSS: More Bulletproof Web Design, New riders, August 2009 .

11] Peter L. Dordal, An Introduction to Computer Networks, Loyola, 2014.