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SECURED SMART HOME ENERGY MONITORING SYSTEM (SSHEMS) USING RASPBERRY PI

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ABSTRACT

This paper deals with the design and implementation of Secure Home Automation using Raspberry Pi for mobile devices that leverage mobile technology to provide essential security to our homes and associated control operations. The proposed home security solution hinges on our novel integration of cameras and motion detectors into web application. Raspberry Pi operates and controls motion detectors and video cameras for remote sensing and surveillance, streams live video and records it for future playback, and finally manages operations on home appliances, such as turning ON/OFF a television or microwave. For instance, when motion is detected, the cameras automatically initiate recording and the Raspberry Pi device alerts the homeowner of the possible intrusion. Raspberry Pi has two main components interacting with each other: the Web application that executes on the mobile device's browser and server-side scripts that run in a cloud which will be operated by the Raspberry Pi hardware tool component

Keywords: *Buffer, Home automation , Motion detectors.PIR sensor ,Raspberry Pi, Relay*

1. INTRODUCTION

Security over household always pays a high price which a middle class person cannot afford for such a price. Hence this paper leverages a security progression over the household in a very cheap cost and which he can itself provide a security which could also be said that 'he can be the ironman of his house'. Our Project, SHARP provides a greater benefit to any person who can afford a cheap product which could provide home automation features to any device carrying a browser. The home automation system works by using the internet as the master and Raspberry pi as hardware tool.

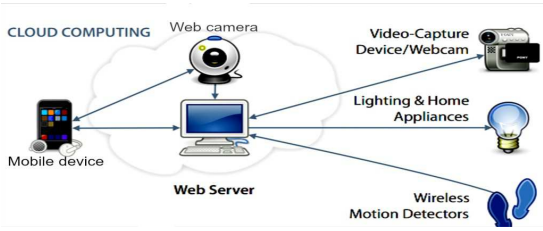

Figure 1.3: Expression Tree

A custom-made Raspberry Pi will be fitted at each power points or switch boards. It will act as the control for all electrical appliances (lighting, fans, air conditioners etc). There will be no work for the user regarding his/her appliance. One has to initialize the required settings at the time of setting up of the system. After that the system will be individual and self sustained. The custom Raspberry Pi will have relays fixed on, which will control all lighting and fans or any other electrical appliances. This board will have a Wireless connection that connects to an Internet hub. This Internet hub will be connected to the internet via LAN or Wi-Fi (Depends upon the choice of the user). As mentioned earlier the internet acts as a master since the entire control process is taken care of by an online server-side program (ASP or PHP modules). The user just has to login in to the specified webpage during the time of initialization and in case there is a need to change the automation settings. The web-page will be coded in such a way that it provides complete control to the user over the automation process such as timing and conditions for the automation process.

Specifically, Raspberry Pi makes the following contribution (a) operates the cameras and motion sensors, which is also used for security purpose (b) operation of home appliances (c) calculates the electricity bill, which bring efficiency for the user

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(d) storage is done over cloud and also in server using external hard disk

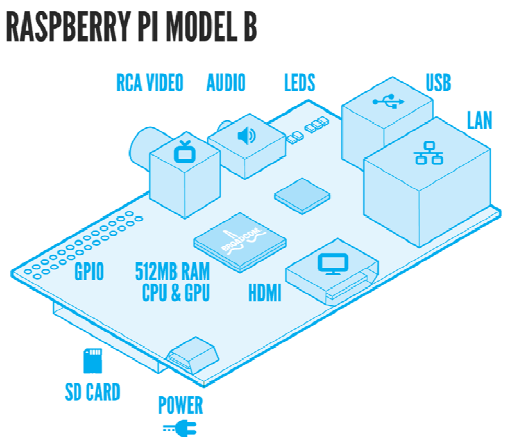

Figure 1.3: Raspberry PI Model

1.1 HARDWARE TOOL - RASPBERRY PI

The Raspberry Pi manipulates and controls the camera (RECORD/STOP) in real time. It can playback video recordings listed in the order of their timestamps, turn ON/OFF small appliances. Raspberry Pi can also detect motion through PIR sensors. Once the motion is detected, it begins to automatically record and then sends an alert to the user's mobile device. The user can view a live video feed from the cameras and remotely control any device that is integrated with the Raspberry pi. For instance, when an intruder is detected, the user can decide to record several minutes of video from a camera for identification of the intruder and thus turn on lights and stereo to detect him.Raspberry Pi incorporates several devices; user interfaces the cloud and mobile software. It uses sensors for motion detection, cameras for remote viewing and recording, a server for data storage and intermediary interface. All external devices, such as cameras, lights, PIR sensors, are connected to the server directly or through the control protocol by the web application from a mobile device. This paper is organized as follows. Section II describes about related work. Section III provides the system overview of Raspberry pi. Section III and IV respectively describes the server and client components, their specific functionalities and related challenges. The performance evaluation is presented in Section V. Concluding remarks are offered in Section VII

2. LITERATURE SURVEY

The security of one's belongings when a person leaves his/her house is always a concern with increasing number of incidents of theft, robbery etc. Many automated systems has been developed which informs the owner in a remote location about any intrusion or attempt to intrude in the house. . However, this paper looks into the development of an ANDROID application which interprets the message a mobiledevice receives on possible intrusion and subsequently a reply SMS which triggers an alarm/buzzer in the remote house making others aware of the possible intrusion[1].
They can provide several useful services such as support for the elderly and disabled people, access control, environmental monitoring, and home automation. Furthermore, with the widespread diffusion of mobile devicesand their integration with new auto-identification technologies, the need to control and manage the smarthome through these devices is increasing. In this context, the main goal of this work is to develop and validate an architecture, both hardware and software, able to monitorand manage a KNX-based home automation system through an Android mobile device in an efficient and safe way[2]. With the rapid development of mobile devices and Internet services, managing home security with these devices and services is gaining popularity. To expand the range of usability of conventional home surveillance cameras, we propose the UPnP-based Surveillance Camera System (USCS), which employs UPnP technology to search, control, and manage IP-based cameras. With UPnP, interconnected equipment and the control network inside the home can be accessed for data sharing, communication, and entertainment. However, the current UPnP was originally designed for local networks. Therefore, we integrated the UPnP control module into the Open Service Gateway Initiative (OSGi) framework to access UPnP services from a remote network. The control point is an external network that can access the UPnP device, which is hosted in a homearea network via USCS. Our system showed improved searching, management, discovery, and manipulation of IP-based cameras in a home network using our system, compared to a conventional system. Users can use a mobile device to monitor the home security status in real time by a remote access function provided by OSGi. Hence, users can monitor their homes more efficiently and instantly, ensuring the safety of

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house members and the property[3]. The next paper is aimed to present a new idea of using the embedded system on FPGA platform with the microprocessor MicroBlaze and the real time operating system FreeRTOS to control and to monitor household appliances through GPRS and using the PIR sensor to carry out monitoring break-in. Due to the strict requirements of the time constraints, theuse of resources and the importance of scheduling, real-time operating system (TRTOS) plays a very important role in the development of embedded systems[4]. The use of wireless technology in home and industrial automation systems is on the rise due to several advantages such as cost reduction, easy placement and installation, easy extension, comfort benefits, and mobile device connectivity. This paper provides a comparative study of different wireless protocols such as ZigBee and Bluetooth for the selection of appropriate technology for Load Control. It also describes a project model for remote controlling and monitoring of various loads/appliances and a means of efficient power utilization through real-time power level indicator with the help of a PC-based GUI application. Further the analysis of various performance parameters such as Latency, Received Signal Strength Indicator (RSSI) value, Round-Trip Delay time , Network coexistence of the ZigBee technology are evaluated for the implemented system[5]. Photovoltaic System of the renewable energy industry is regarded as an important alternative. Recently, the trend is to improve Photovoltaic System Applying Ubiquitous-computing because the advent of Ubiquitous-computing concept and the smart phones is has propagated. Due to the advent of Cloud technology into the home has saved computing resources that is the personal and the household making or spending. Public-Cloud combines and shares resource when necessary. Using external server Private-Cloud's method that combine Public-Cloud, Hybrid-Cloud has been put to practical use. In this paper, Mobile's photovoltaic monitoring system that is based Web-service is implemented. Web application framework that has emerged in recent years has been implemented based Sencha-Touch framework. And, the unique benefits of the Sencha-Touch framework, introducing the concept of ubiquitous computing, user convenience-oriented monitoring is possible on smart phone or tablet PC. In addition, Reports were implemented without restrictions on different kinds of device or OS because the mounting Highcharts was written in pure JavaScript. Lastly, Use of Cloud middleware based Web services, because the future is more easily scalable photovoltaic system monitoring, and When combining the Bluetooth, wireless network and 4G LTE device will be helpful in the new monitoring technology development[6]. As experimental collaborations become larger and more international, there is a growing need for webbased tools that can allow collaborators to securely and reliably monitor and control their respective systems both on-site and remotely from their home institutes. Increased adoption of mobile devices such as smart phones and tablets also opens new possibilities for system monitoring, including push technologies to send notifications about important events or error conditions. We present a system based on state-of-the-art clients implemented in HTML5. These thin clients have high performance capacities due to modern technologies like web workers for multithreading and websockets, a protocol with extremely small overhead. The client is adaptable to different platforms and requires no installation whatsoever. The client can provide highly complex functionality and offers a large number of controls and information channels through a simple-to-use gui, while major computation is handled by middleware. Beyond basic controls such as disabling/masking problem nodes or restarting processes, our system is also capable of processing data volumes and presenting live graphs and histograms on the client. If necessary, users can be alerted with text messages (sms) for rapid reaction to special events or error conditions. In these messages a uri is included that brings up the client in a browser with the data and the controls necessary to begin dealing with the event. All transactions such as control signals are handled reliably through use of enterprise integration patterns. Security is based on industrial strength proven protocols including SSL. We share our experiences implementing and testing these new tools in realistic experimental environments, including projects in which our group is involved[7]. Home automation refers to a system that is used to control devices around the home. These devices can include doors, lights, surveillance systems, and consumer electronics. A user can control a variety of home devices with the help of a home automation system. To provide mobility, a mobile phone-based home automation has been developed. As another approach toward home automation, an Internet-based home automation system has been proposed, providing a graphic user interface. However, these system slack user friendliness and are neither

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intuitive nor realistic. To improve the user-friendliness of the interface, a 3D view interface was designed. However, its level of realism was low. In this study, to provide a more realistic interface, a 3D virtual world is adopted as the user interface for a home automation system. Additionally, a home server is used as a controller for home devices. As an information exchange format between the virtual and the real world, a control protocol that works under a standardization process is introduced. With the help of a 3D virtual world, a user can control and monitor home devices via a user-friendly interface that works both intuitively and realistically anywhere and anytime through the Internet[8]. Smart Home monitoring services have attracted much attention from both academia and industry. However, in the conventional monitoring mechanism the remote camera cannot be accessed for remote monitoring anywhere and anytime. Besides, traditional approaches might have the limitation in local storage due to lack of device elasticity. In this paper, we proposed a Cloud-based monitoring framework to implement the remote monitoring services of Smart Home. The main technical issues considered include Data-Cloud storage, Local-Cache mechanism, Media device control, NAT traversal, etc. The implementation shows three use scenarios: (a) operating and controlling video cameras for remote monitoring through mobile devices or sound sensors; (b) streaming live video from cameras and sending captured image to mobile devices; (c) recording videos and images on a cloud computing platform for future playback. This system framework could be extended to other applications of Smart Home[9]. the next study, a home monitoring healthcare system for elderly and chronic patients has been proposed. The system was developed for three types of users: assisted person, doctor and guardian. It analyzes the collected information and in case of detection of dangerous events informs physician and guardian. A mobile device has a key role in the system. It allows exchange and visualization of data to the users. This work describes the design and implementation of a tablet in the home monitoring healthcare system, with specially developed data exchange protocol Additionally special security features to protect data exchange were introduced. Software part of the system was made using modern technologies such as JavaFX for central unit and Android for mobile devices[10]. The ubiquitous solution for providing a secure access for monitoring and controlling of a smart homeby using a mobile device. It describes an end-to-end solution for an user friendly house and facility monitoring and control system. The solution enables the ubiquitous control of various house and facility automation devices by using amobile smart phone and mobile internet access. The paper describes the overall system design, the used components, the implementation, the security features, as well as the testing and evaluation of the corresponding service access times[11]. Significant developments in the recent times have led to an increasing use of mobile devices such as smart phones in accessing Internet services and applications over wireless networks. security architecture for counteracting denial of service attacks in Beyond 3G (B3G) network architecture with mobile nodes. We describe the system architecture and discuss the different cases of attack scenarios involving the mobility of the attacking and victim nodes. Our proposed solution takes into account practical issues such as limited resources of the mobile nodes. It has distinct advantages such as monitoring of the traffic to the victim node and the attack traffic being dropped before reaching the victim, the ability to trace back the attacking node and prevent the attack at the home agent or foreign agent that is closer to the attacking node, and the ability to deal with dynamic changes in attack traffic patterns. We also present an analysis of our proposed architecture as well as simulation results [12]. WLAN device-free passive indoor localization is an emerging technology enabling the localization of entities that neither carry any devices nor participate actively in the localization process using the already installed wireless infrastructure. This technology can be promising for a variety of applications, where special hardware might not be applicable such as intrusion detection and smart homes. We present a demonstration of RASID, a system capable of detecting passive human motion using the already installed wireless networks. RASID uses statistical anomaly detection techniques to detect motion inside indoor environments. Thesystem also is capable of adapting to the environment changes for enhancing its accuracy[13]. First, it exploits the benefits of Augmented Reality for visual identification of network devices during performing network management tasks. Second, it encapsulates technical jargons into common, day-to-day phrases. TIARA strength lies in its architecture that is loosely coupled and able to be implemented beyond home network. Built on an Android smart

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phone, TIARA provides a unified UI and portability for seamless operations. Our experiments have shown that TIARA yields only a fraction (of up to 15.1%) of the traditional method in completing basic management tasks. In addition, TIARA receives high scores in ease of use, satisfaction level and importance of TIARA in home network management[14]. The use of smart phones has lately grown by leaps and bounds and the role of a smart phone as a portable computer has been conspicuous. The application programs of smart phones are used in diverse areas such as business planning, banking, blogging, GPS, medical application, andhome security. The diversity of such application is seen to be one of factors of the expansion of smart phone users, and to that extent, the demand of security is increasing. In particular, safety issue is more important in the controlapplicationof home security for home safety. It aims to control methods in the access of home securitysystem which monitors andcontrol s security devices, installed around houses by using smart phones. In particular, we suggest the way of dynamic delegation of authority for allowing outsiders like housekeeper to have access to
the security system temporarily[15].Security surveil lance partakes in significant number of home automation systems, deploying digital cameras and sensors to monitor and report intrusion events and thereby reducing damages caused by burglary. In this paper, we present the design, implementation and operation of a cloud connected adhoc wireless home automation system with en suite intrusion detection and burglary prevention stratagems. Along with an improved infrared camera, each node of our home automation system has devised intelligent algorithms for intrusion detection and subsequently reports any event to a location-aware cloud service in real-time. In case of an intrusion event, another cloud service alerts the user with a SMS conversation. The user can then monitor the intrusion from anywhere, on any Internet enable device by accessing the cloud's web interface. If the intrusion is genuine, the user is provided with options to stealthily alert neighbors (who are using our home automation system), play alarm sounds or even report to the police. Using these techniques, burglary can be evaded effectively [16].

3. SYSTEM MODEL

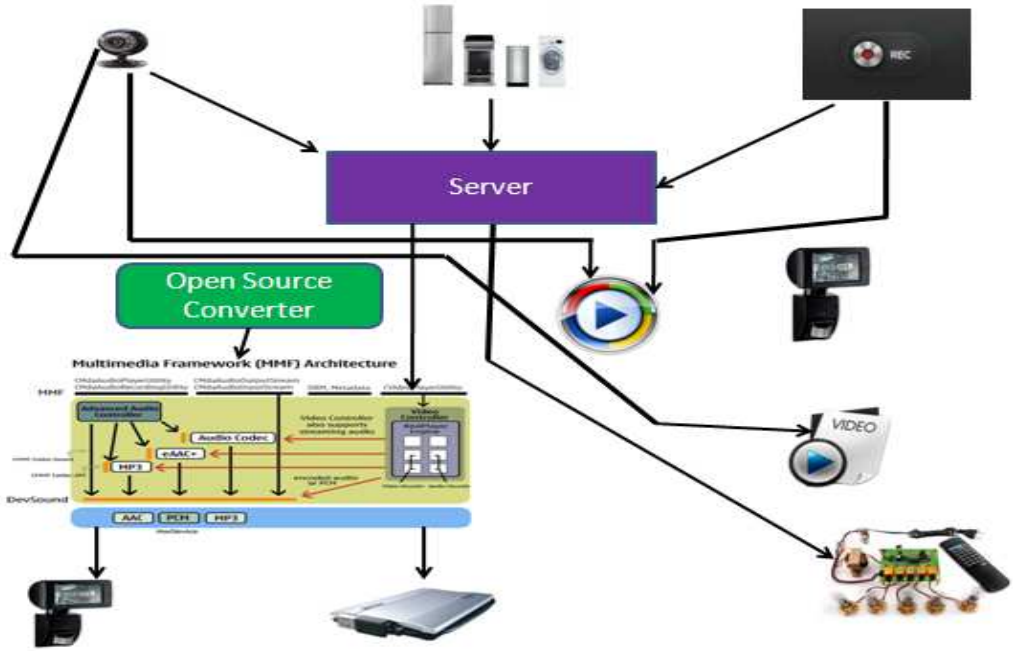

Figure .3.1: System Model

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The Design of Raspberry Architecture, while it displays the hardware components and implementation, including the communication between the server and the client. We divide the architecture into four layers : Application, web server, programs and data storage. Each of them is further broken down into smaller entities with unidirectional or bidirectional communication links. We set up an Apache HTTP server with open-source PHP web server package on our web application.

Raspberry follows the client-server architecture model. Video is streamed from the server to the client, while commands and controls are sent from the client to the server. When necessary, alerts are sent from the server to the client.

3.1 Experiemtnal Setup

A complete controllability to the user such as customization of electrical appliances in the home, monitoring rooms, security to the home with cameras and also as a media center. users in the home are given a smart interface where they can login in a browser/application to control and customize the operations done moreover if 'this' then 'that' kind of commands are also possible from the user dashboard

3.2 Control Of Camera

Since Raspberry Pi provides the user the flexibility to choose any type of video-capture devices (e.g, webcams lined either internally or externally to the server, or IP cameras in the cloud), we had to account for each of their distinct design details and adapt a solution that would seamlessly integrate them into one cohesive application, Of the two types, generic webcams were more difficult to implement since they presented a unique challenge to allow the user to simultaneously view and record live video. We coded and video capture program in C++ that responds to RECROD/STOP commands using API. It records video to an AVI file, which is then converted to a playable MP4 file with FFmpeg's open source multimedia convertor.

3.3 Data Storage And Retrieval

Recorded videos are stored on the web server with timestamps as the filenames. Display the list of recordings in our application, the PHP script for recordings reads the contents of the names of MP4 files and places them into a hyperlinked list. The storage is also done over an external hard disk which provides the retrieval of the timestamps also without network..

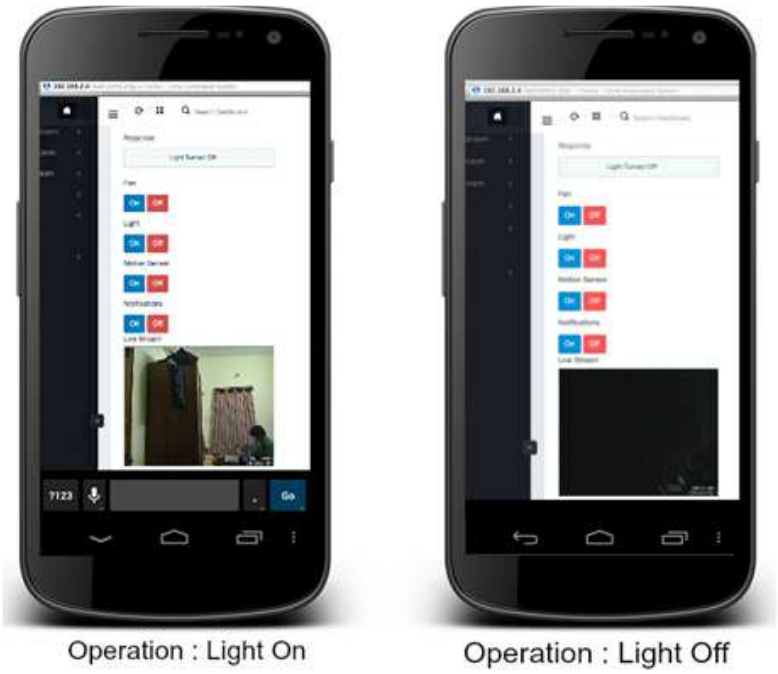

Figure 3.1: Light Switch ON/OFF Mode

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3.4 Electricity Efficiency

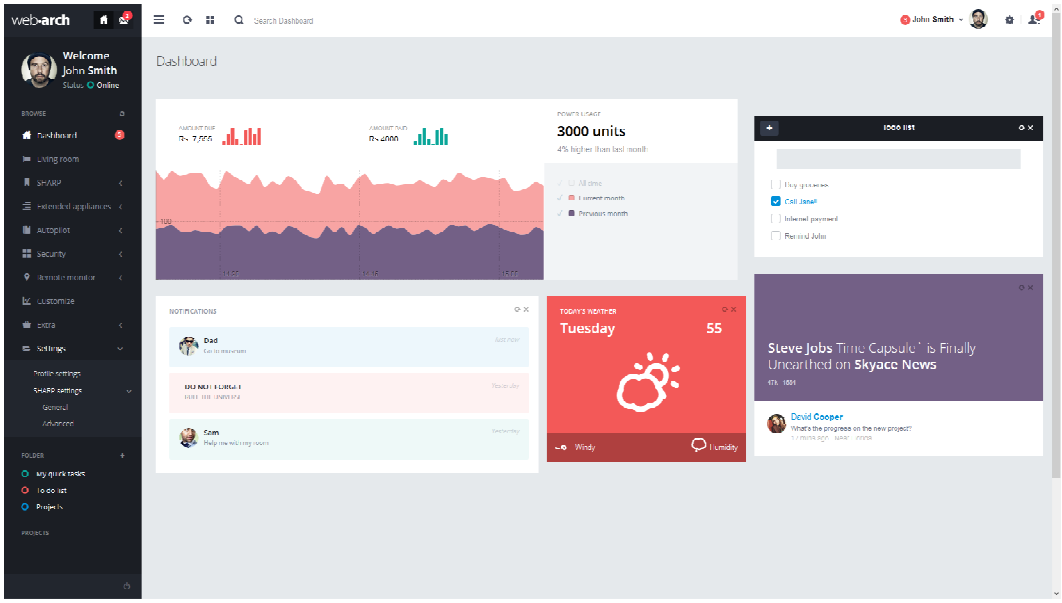

Figure 3.4: Efficiency Graph Details

Automatic switching ON/OFF the lights when the user enters the room and the duration for which the lights are ON. Powering up of the fans and their duration (if needed).If there is no motion detected for more than a specific amount of time (which can also be controlled by the user) all the electrical appliances in the room can be set to power down there by saving power .To avoid powering down of appliances during sleep, a separate set of coding can be added which will modify the automation process as required, For example, during sleep, even if there is no movement, appliances like AC and fans should be ON. The user can set the AC to switch ON and OFF at specific times and the temperature to be maintained. To reduce power consumption, options like after the required temperature has been reached the AC will be turned OFF and fans can be turned ON till the temperature reaches a upper threshold. The powering up of the AC will be carried out by an IR transmitter fitted on the board. This transmitter has to be programmed with the remote of the AC during the initialization process with the help of an on-board IR receiver. The possibilities are endless. Options for power monitoring can be set up, that is the web page will also display the amount of power used based on the unit ratings. The average power used per day, per month and charts of it! Since the process is controlled by a server, a dedicated e mail can be set up to which all the power bills and phone bills can be forwarded. A notification will be displayed to the user for the same. Voice control options can also be provided to the system of Raspberry Pi and hence get the efficiency details.

3.5 Home Security

We chose to combine home automation and home security into one application because of the user friendliness and ease of use that it enables. Additionally, this integration allows for the customization of the final product as both components strengthen each other. Since we implement that PIR sensors and Cameras will notify the user. For example, when an intruder arrives at the room, the PIR sensors detects the motion and switches ON the lights and camera records the footage which would send the user a live feed of the video to see who/what was intruding. We have also provided an external storage and email facilities which would be helpful for the user to view later which in case provides a better facility for the user to retrieve. The user's devices act as the home security system that can be enabled or disabled in the web application.

4. PERFORMANCE ANALYSIS

We conducted experiments to first measure the latency of streaming video from a remote location for two cases and then expanded the scope of our evaluation to include other tests as well. These

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results were recorded for 6 successive latency measurements 20 seconds apart and then averaged them. We repeated each experiments 10 times. For the first scenario on Figure 4.1, we used high resolution of 640x480 pixels i.e., 7.5 Frames per second (fps).We tested on a webcam and as expected the results for the individual streams (approximately 1-3 seconds). Even the high-quality video performed well.

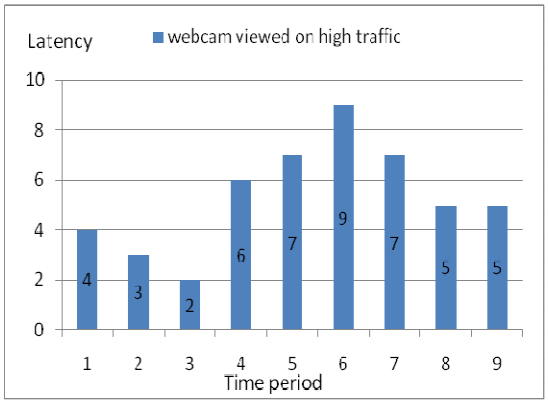

Figure 4.1: Latency of streaming video

For the second scenario, we used worst case or stress test. In this scenario, we used high traffic network.

We did this for three resolutions: high (640x480 pixels, 7.5 fps). As expected, the reduction in delay is proportional to the quality of the video streams. However, even in the worst case scenario the delay is never greater than 10 Seconds. We experimented in different streaming qualities

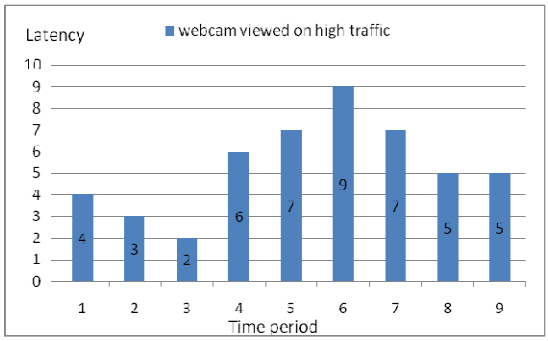

Figure 4.2: Latency of streaming video

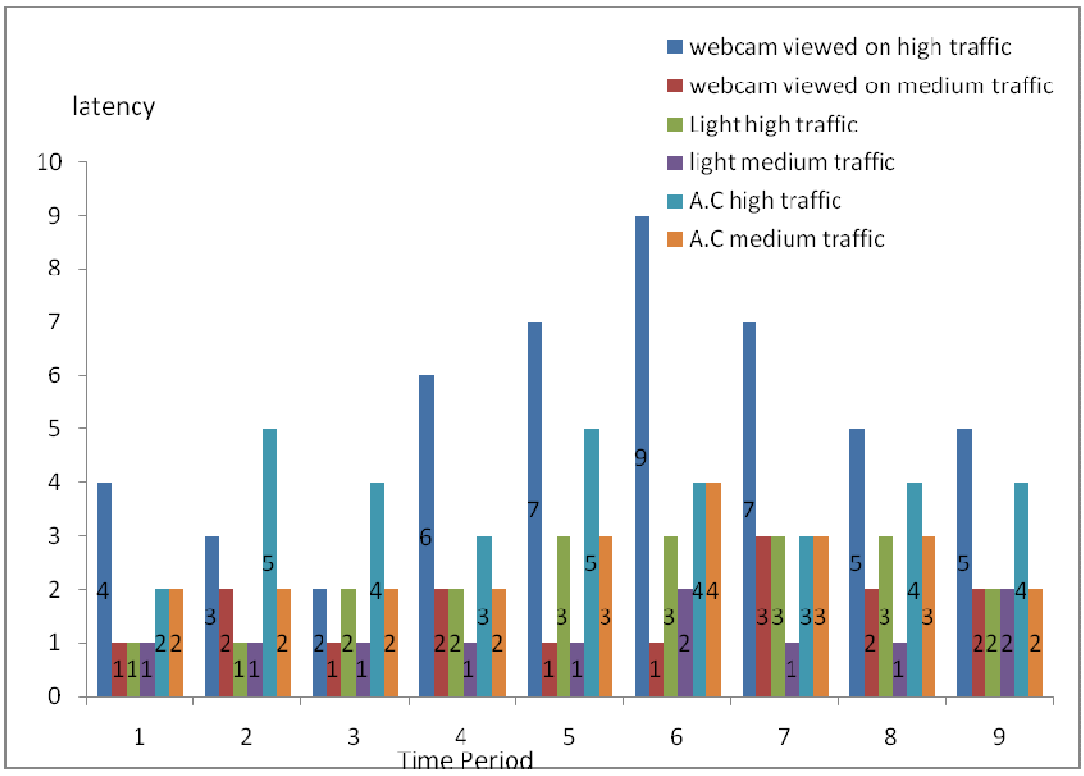

Figure 5.2: Latency of streaming video with different traffic

Journal of Theoretical and Applied Information Technology
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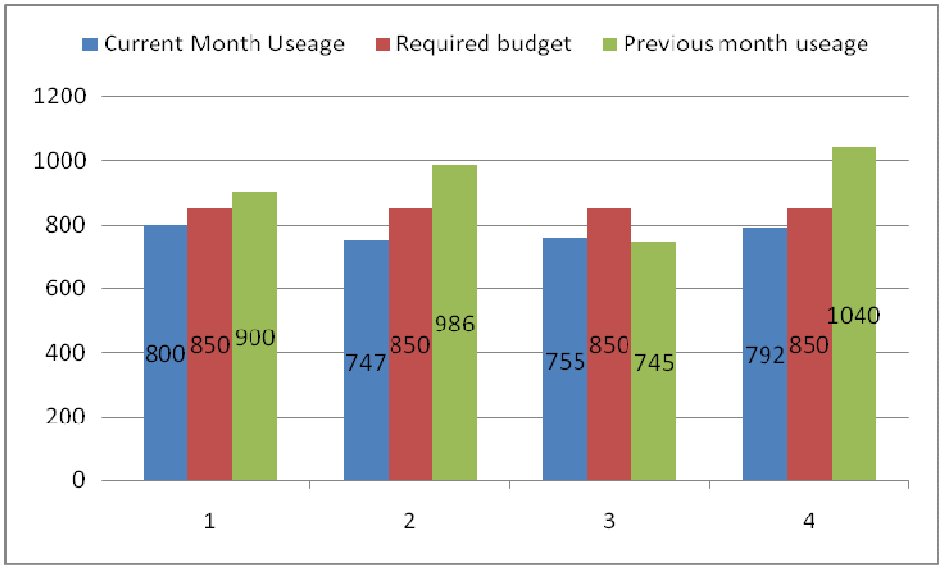

Figure 5.2: Weekly usage: Current Efficiency

Table 1: Comparison Between Proposed System And Existing System With Reference To Functionality

Functionality	Proposed System	Existing Systems		
	SSHEMS	Revolv	Vivint	Smart Things
Ease of Use	√	X	X	X
Energy Efficient	√	X	X	X
Remote Access	√	√	√	√
Programmable	√	√	√	√
Randomized Programs	√	X	√	√
Wireless System	√	√	√	√
Wired System	√	√	X	X
Security Monitoring Service	√	X	√	X

For the third scenario on figure 4.3, tests were run using different networks that represent a user being at home and viewing the video streams from inside a local network a user viewing the stream from a medium-traffic network outside the home, and a user viewing the stream from a high traffic outside network. As expected the high traffic network experienced significant delays when compared to the others. We also tested latencies for home automation processes such as turning ON/OFF appliances. The actions were carried out in 1-2.5 second range. The comparison between the proposed system and existing system with reference to the functionality is illustrated in table 1.

5. CONCLUSION AND FUTURE WORK

We developed a comprehensive solution that provides a user friendly home automation and security application for homes. We accomplished this through the integration of cheap, off-the-shelf, widely available devices, interfaces and software coupled with a user friendly interface. This work provides users with an easy to use mobile application for which they can remotely access and control their home appliances and security. In future we intend to provide a wireless relay connection and wireless sensors which can be movable and can be operated and which can be used in company and instates for Security to the whole building with one single system. This provides a full security support for homes.

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