Android Based Smart Home System with Control via Bluetooth and Internet Connectivity

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***Abstract*—Automation plays an important role in today's human life and people's life is gradually changing with smart living due to modern technology development and Android Smartphone. This paper presents a low-cost Smart Living System, which uses Android based User Interface for control of home appliances. Connection to the smart living system can be made from the designed app via Bluetooth or internet connection. It also integrates home security and alert system.**

Keywords—smart living; automation; android smart phone; Bluetooth; internet.

I. INTRODUCTION

The continuous growth of mobile devices in its recognition and functionality has lead to an increase in the demand for advanced ubiquitous mobile applications in people's daily lives. Smart phones are more than just phones in today's life having a broad range of applications, such as education, health care, and entertainment. Smart homes aim to provide enhanced convenience and comfort, energy efficiency, security and surveillance. It is claimed by market researchers that majority of homes will be outfitted with home automation systems in the very near future. Various smart home systems have been proposed where the control is via Bluetooth [1], internet [2, 3], short message service (SMS) based [4] while some researchers have proposed voice controlled smart home system based on Microsoft speech recognition [5] and microcontroller based voice activation (voice recognition module is used) [6].

II. THE PROPOSED SYSTEM ARCHITECTURE

A low-cost and flexible standalone smart home system is proposed and designed. The proposed system uses Bluetooth and REST ful based web services as the interoperable layer. It consists of an Android compatible smart home app, a micro web-server running on Arduino Ethernet as the main controller, and the hardware modules. The overview of the proposed architecture is shown in Fig. 1. The proposed smart home system has features such as user authentication, Bluetooth and internet connectivity, security and fire system with siren and email alerts and automated control of home appliances.

The master controller that has the Arduino Ethernet micro-web server running consists of Arduino Mega 2560 and Arduino Ethernet Shield with other hardware such as the siren, nRF24L01+ radio module, which is used to communicate and coordinate actions with the other sensor nodes within the home environment and the Bluetooth module. The system is designed to control more than the switching functionality, such as security and surveillance (incorporating door locks, gate control, fire detection, and intrusion detection with alarm and notifications), user authentication for accessing the smart home system, energy management, and automatic home environment control. Furthermore, the system also supports voice activation for switching functionalities.

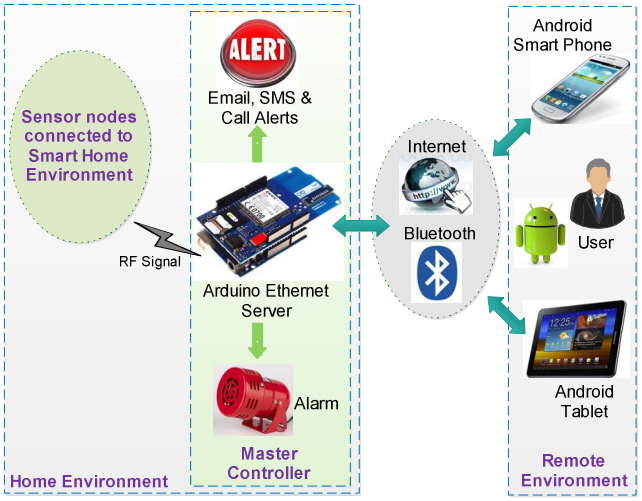

Fig. 1. Overview of the conceptual architecture of the proposed system.

III. PROPOSED SYSTEM IMPLEMENTATION

The Android based smart home app was designed using the Massachusetts Institute of Technology App Inventor that was originally provided by Google. The home screen and the main controls screen are shown in Fig. 2. Upon starting the smart home app, the user is given the option to select Bluetooth or internet connectivity for connecting to the smart home micro-web server. For internet connectivity, the user has to enter the IP address and a password whereas for Bluetooth connection selecting the device and entering a password is required. Access is only granted if the requested details are correct upon which the GUI statuses on the main controls page are updated to reflect the current statuses and the user can than perform the

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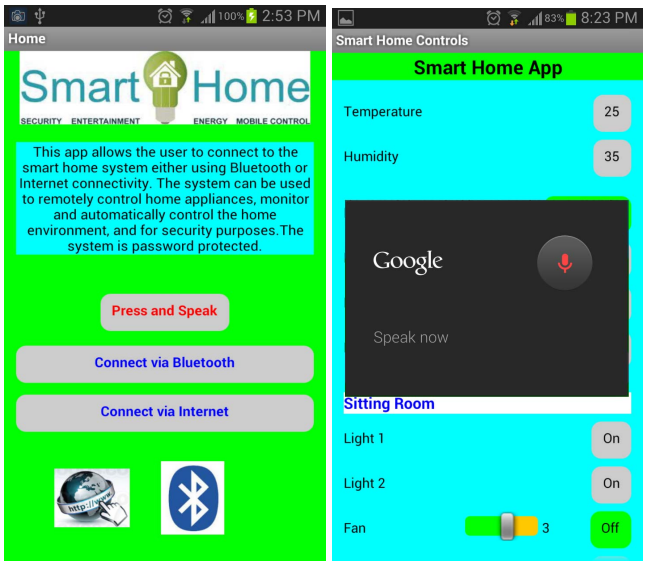
desired action using the GUI. However, if the entered details are incorrect or there is a connection problem appropriate messages are displayed on the user GUI of the app.



(a) (b)

Fig. 2. Graphical User Interface (GUI) screenshots of the smart home app: (a) Home screen (b) main controls screen.

The main controls page also has the option to change the current password. The default password is set to 1234. The packet layout of the commands sent from the app (in the form of a single string) to the smart home micro-web server is given in Fig. 3. The micro-web server is able to easily extract all the required action information from the command packet. Furthermore, the proposed smart home system also has features such as adjusting light intensity, fan speed, etc. For example, the command packet "1234Light1_On" will be sent for turning on light one and "1234FanSpeed_3" will be sent to adjust the fan speed to level 3. The smart home app also supports voice activation for all switching functionalities. For this purpose, the Google Speech Recognizer is used for obtaining the text from the speech. Fig. 2(b) shows the Google speech recognizer awaiting the user to speak the commands after the voice activation control button is pressed. Automatic mode can also be enabled where the user can either specify the time for certain appliances to be turned on/off or the home environment will be controlled automatically depending on the environment such as maintaining a certain temperature inside the house.

$	Password	$	Device	_	Action

Fig. 3. Smart home app's packet layout for the commands.

On the other hand, the sensor nodes deployed in the home environment monitor the status of the devices and if there is a change in the status or fire/intrusion is detected, it informs the master controller via the RF link. For reading sensor data, an interrupt is used so that in case of fire/intrusion a prompt action is taken. Once data is received, the status is updated by the micro-web server and if the data is that of fire or intrusion the siren will be turned on and an email notification will be sent to the user. For example, Fig. 4 shows an email alert that is received on the user's android smart phone when a fire is detected in the kitchen. The user can either switch off the siren from the smart home app or it will go off automatically after a certain period of time. When commands are sent by the user, the micro-web server extracts the action command and the master controller sends the signal to the respective sensor node, which performs the desired action.

The master controller of the smart home system supports both Bluetooth and internet connectivity. However, the Bluetooth connectivity is given priority over the internet connectivity. Therefore, only one type of connection is allowed at a time.

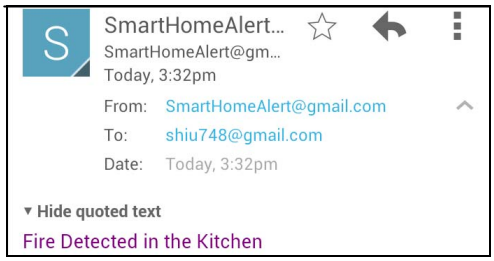


Fig. 4. Smart home email alert for Kitchen fire.

IV. CONCLUSION

The proposed smart home system and the smart home app has been successfully developed and tested. Devices such as light switches, temperature sensors, gas sensors, motion detection sensors and alarms have been integrated in the system to demonstrate its feasibility and effectiveness. Features such as low cost, user authentication, voice activation, security and surveillance, and automatic control make the proposed system unique.

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