Smart Home-Control and Monitoring System Using Smart Phone

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Abstract. This paper presents a low cost and flexible home control and monitoring system using an embedded micro-web server, with IP connectivity for accessing and controlling devices and appliances remotely using Android based Smart phone app. The proposed system does not require a dedicated server PC with respect to similar systems and offers a novel communication protocol to monitor and control the home environment with more than just the switching functionality.

Keywords: Internet of things, smart home, remote controlled, home automation, Android smartphone, Arduino

1   Introduction

The Internet of Things (IoTs) can be described as connecting everyday objects like smart-phones, Internet TVs, sensors and actuators to the Internet where the devices are intelligently linked together enabling new forms of communication between things and people, and between things themselves [1]. Now anyone, from anytime and anywhere can have connectivity for anything and it is expected that these connections will extend and create an entirely advanced dynamic network of IoTs. IoTs technology can also be applied to create a new concept and wide development space for smart homes to provide intelligence, comfort and to improve the quality of life.

In this paper, we extend our previous work [2] and present a low cost and flexible home control and monitoring system using an embedded micro-web server, with IP connectivity for accessing and controlling devices and appliances remotely using Android based Smart phone app. The proposed system does not require a dedicated server PC with respect to similar systems and offers a novel communication protocol to monitor and control the home environment with more than just the switching functionality. We have utilized RESTful based Web services as an interoperable application layer that can be directly integrated into other application domains like e-health care services, utility, distribution, or even vehicular area networks (VAN).

2 Related Work

Home automation or smart homes (also known as domotic) can be described as introduction of technology within the home environment to provide convenience, comfort, security and energy efficiency to its occupants [3]. With the introduction of the Internet of Things, the research and implementation of home automation are getting more popular [4]. Various wireless technologies that can support some form of remote data transfer, sensing and control such as Bluetooth, Wi-Fi, RFID, and cellular networks have been utilized to embed various levels of intelligence in the home [5]. The studies in [2, 6] have presented Bluetooth based home automation systems using Android Smart phones without the Internet controllability. The devices are physically connected to a Bluetooth sub-controller which is then accessed and controlled by the Smart phone using built-in Bluetooth connectivity. Researchers have also attempted to provide network interoperability and remote access to control devices and appliances at home using home gateways. [7] proposed mobile IP based architecture and its potential applications in Smart homes security and automation without any actual deployment and testing. Lately few researchers have also presented use of Web services, simple object access protocol (SOAP) and representational state transfer (REST) as an interoperable application layer to remotely access home automation systems. [8] introduced a smart home management scheme over the Ethernet network based on XML SOAP standards. The drawback of using SOAP based Web a service is that it is complex and adds overhead to the client and server when parsing the message, resulting in slower operation and higher bandwidth.
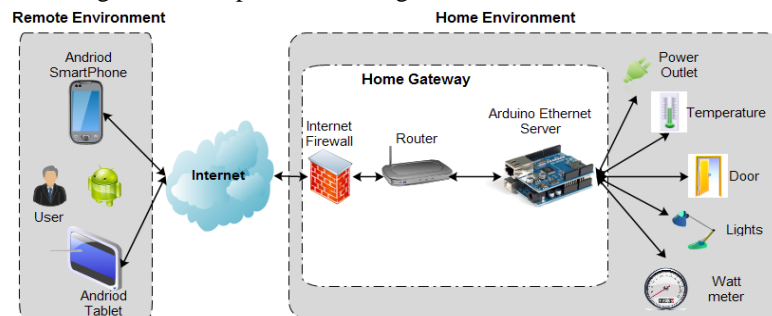

Fig. 1. Overview of conceptual architecture.

3 Proposed System and Architecture

In order to address the mentioned issues of flexibility and functionality in the literature survey, we designed and implemented a novel, standalone, flexible and low cost home controlling and monitoring system using RESTful based Web services. The system consists of a micro Web-server based on Arduino Ethernet, hardware interface modules and the Android compatible Smart phone app. The architecture presented in this work can be customized in different ways in order to accommodate different application scenarios with minimum recoding and design i.e. each time a new device is added to the micro Web-server, a new thread dedicated to the device is

automatically created in the smart phone app. The architecture is divided into three layers: home environment, home gateway and remote environment (see Fig. 1).

4 System Implementation

4.1 Software development for home gateway

Software of the proposed home automation system is divided into two parts: server application software and microcontroller firmware. The server application software is a library implementation of a micro Web-server running on Arduino Uno using the Ethernet shield. To successfully communicate between remote user and the Home Gateway, configuration stage and sensor/actuator control stage layers have been implemented on the Arduino. Fig. 2 shows the flowchart of connection establishment between the Arduino and the Internet.
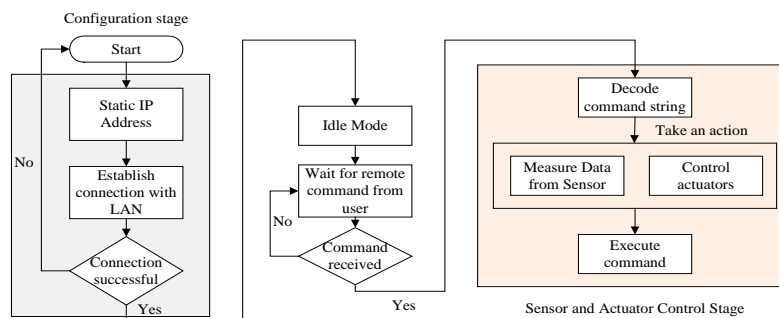

Fig. 2. Home Gateway flow chart for the connection establishment with the Internet.

4.2 Smartphone application and features

The Smart phone app for home control and monitoring applications provides the following functionalities to the user: 1) Remote connection to the Home Gateway. 2) Device control. 3) Device Monitoring. 4) Managing schedule. Fig. 3 shows the graphical user interface for controlling and managing the home environment using Smart phone.

5 Conclusion

In this paper, a novel architecture for low cost and flexible home control and monitoring system using Android based Smart phone is proposed and implemented. Any Android based Smart phone with built in support for Wi-Fi can be used to access and control the devices at home. When a Wi-Fi connection is not available, mobile cellular networks such as 3G or 4G can be used to access the system.
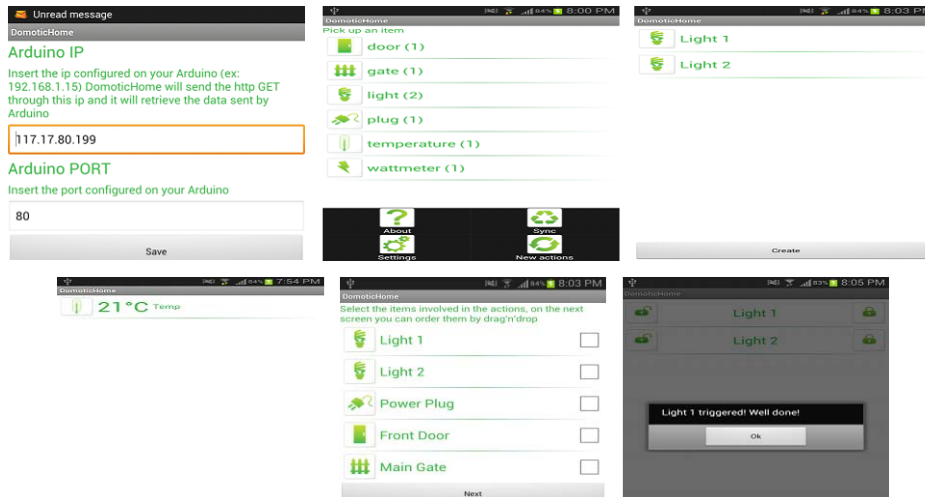
Fig. 3. Graphical user interface for the home control system.

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