# Web Based Integrated Smarthome Applications: Control, Monitoring and Security

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# WEB BASED INTEGRATED SMARTHOME APPLICATIONS: CONTROL, MONITORING AND SECURITY

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## Abstract

*Smart home is a dwelling incorporating a communications network that connects the key electrical appliances and services, and allows them to be remotely controlled, monitored or accessed. Such systems can be a support for elder or handicapped people as well as can save energy and decrease pollution emission. The goal of this research is to utilize technology based on IP (Internet Protocol), using TCP / IP to connect all devices that using the same protocol, so it will facilitate communication between devices. The users who using this application can use mobile devices such as laptop, smartphone and tablet that connect to the Internet to access the home environment. The tests will be conducted on a prototype of a house made from acrylic that has three lights, one solenoid door lock to represent door equipped with lock, and two IP cameras. The application can control home appliances such as lights and door lock, and also can monitor the situation or home condition using IP Camera. The application also gives a warning when the door lock is opened by force.*

**Keywords:** *Smart Home, TCP / IP, Mobile Device.*

## 1. Introduction

Home environment management systems, also known as smart home systems, become more and more popular subject in recent days. Such systems can be a support for elder or handicapped people as well as can save energy and decrease pollution emission. Although dedicated systems have been already presented on the market they are rather expensive and require major interference in existing building infrastructure (Grabowski, 2009)

Smart home system infrastructure consists of a residential gateway network as it presented in **Figure 1**. The control network interconnects controllers, sensors and actuators for control and security information exchange, the media network is in charge of audio and video transmission, whilst the residential gateway is responsible for joining them to outer services like Internet.

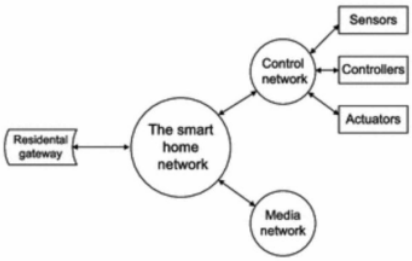


**Figure 1** *The Network Structure of Smart Home System* (Grabowski, 2009)

A smart home is one of the ideas that people devoted both money and time to reach the perfectly smart. A regular feature in a smart home is automation, which allows controlling and monitoring of all the devices in the house.

In any smart home, it is important to maintain the area secure. All doors may be remotely controlled using automatic and manual locks. Upon leaving the house, the system will notify the users about that event and all lights and devices that are switched ON. They can take action directly or leaving things up the system to deal with them

Security is another feature designed in our system. A fully connected IP camera system is intended to monitor the safety and security of the users. In case of any suspicios sign, the system will alert the users into their mobile devices.

In this paper discussed an integrated smart home system: control, monitoring and security using web based application. Any devices can use this application such as laptop, tablet or smartphone.

## 2. Theory

**TCP/IP Protocol Suite**

TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application. The first four layers provide physical standards, network interfaces, internetworking, and transport functions that correspond to the first four layers of the OSI model (Forouzan,2007).

*TCP/IP* is a hierarchical protocol made up of interactive modules, each of which provides a specific functionality; however, the modules are not necessarily interdependent. Whereas the OSI model specifies which functions belong to each of its layers, the layers of the *TCP/IP* protocol suite contain relatively independent protocols that can be mixed and matched depending on the needs of the system. The term *hierarchical* means that each upper-level protocol is supported by one or more lower-level protocols. **Figure 2** below shown the layers of TCP/IP Protocol Suite.

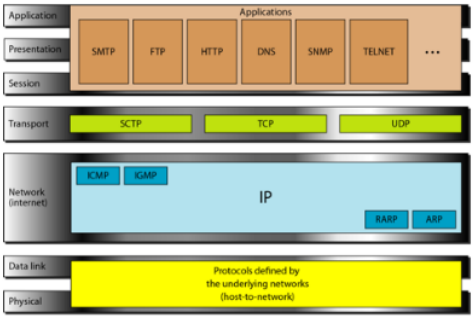


**Figure 2** *TCP/IP Protocol Suite*

**Arduino Uno**

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or powe it with a AC-to-DC adapter or battery to get started (www.arduino.com).

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means "One" in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards. Illustration of Arduino Uno is shown in **Figure 3.**

**Figure 3** *Arduino Uno*

**Arduino Relay Shield**

The Arduino Relay shield V2.1 is capable of controlling 4 relays. The max switching power is DC 90W or AC 360VA. It is possible to control the Relay shield through Arduino/DFRduino using digital IOs with external 7 to 12V supply. With the built in xbee socket, it can be wirelessly controlled via Xbee/bluetooth/WPM. This makes it an ideal solution for automation and robotics. (www.arduino.com). Illustration of Arduino Relay Shield is shown in **Figure 4.**

**Figure 4** *Arduino Relay Shield*

**Arduino Ethernet Shield**

The Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100 ethernet chip (datasheet). The Wiznet W5100 provides a network (IP) stack capable of both TCP and UDP. It supports up to four simultaneous socket connections. Use the Ethernet library to write sketches which connect to the internet using the shield. The ethernet shield connects to an Arduino board using long wire-wrap headers which extend through the shield. This keeps the pin layout intact and allows another shield to be stacked on top. (www.arduino.com). Illustration of Arduino Ethernet Shield is shown in **Figure 5.**

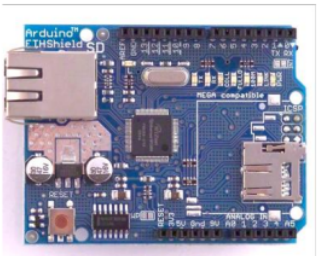

**Figure 5** *Arduino Ethernet Shield*

**Solenoid Door Lock**

A solenoid is basically an electromagnetic actuator which converts electrical energy into magnetic field. The basic working principle of the solenoids is the same as that of electromechanically relay and linear solenoids can be controlled by the help of transistors. Linear solenoids basically consist of an electrical coil that is wound in coils around a cylinder which consists of ferromagnetic coils and this cylinder can move freely in and out of the coil. (www.solenoidactuator.org). Illustration of *solenoid door lock* is shown in **Figure 6.**

**Figure 6** *Solenoid Door Lock*

**Motion Detection**

In video surveillance, motion detection refers to the capability of the surveillance system to detect motion and capture the events. Motion detection is usually a software-based monitoring algorithm which, when it detects motions will signal the surveillance camera to begin capturing the event. Also called activity detection. An advanced motion detection surveillance system can analyze the type of motion to see if it warrants an alarm. Illustration of *motion detection* is shown in **Figure 6.**

**Figure 7** *Motion Detection*

## 3. System Design

Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. **Figure 8** below shown the architectural design of smart home system.

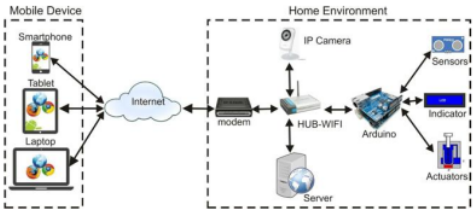


**Figure 8** *Architectural Design of Smart Home System*

Users are using their Mobile Devices to access the application. Mobile devices connected with Communication Links such as DSL Network or GSM Network. Mobile Devices using HTTP to connect with the server, while the server connected with Ethernet Shield at home network. **Figure 9** shown the block diagram of the system.

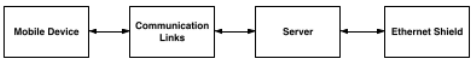


**Figure 9** *Block Diagram of User*

At home Environment the Ethernet Shield connected to Arduino Uno. Arduino Uno as a control Network Connect to Arduino Relay Shield.

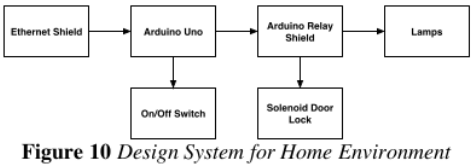


**Figure 10** *Design System for Home Environment*

## 4. Testing

Testing is a critical software development activity because it helps you improve the quality of your apps, ensure better user satisfaction, and reduce overall development time spent on fixing defects. Different parts of project were tested to finalize the study and show to what extent such a system can be trusted. **Figure 11** below is the login page where the user must log in first in order to used the application, where username and password are required.

**Figure 11** *Login Form Page*

- Username: Information that will need from Server. This is used to log on to smart home network. Server uses this to identify your account.
- Password: This is the Password used, in conjunction with the Username above, to log on to your smarthome network. This is used to verify the identity of your account.

If the users enter the correct username and password, the home page will open. From this page users can control and monitor the smart home system. Users can switch ON/OFF the electrical devices such as Lamps, LOCK/UNLOCK the door lock and see the video captured from IP Camera. **Figure 12** shown the home page interface.

**Figure 12** *Home Page*

Motion detection is the process of detecting a change in the position of an object relative to its surroundings or a change in the surroundings relative to an object.

Motion detection can be achieved by either mechanical or electronic methods. A simple algorithm for motion detection by a fixed camera compares the current image with a reference image and simply counts the number of different pixels. IP Camera D-Link DCS-5021L is supported with motion detection.

If the camera detecting a change in the position of an object, it will send notification to application. **Figure 13** shown the notification alert.

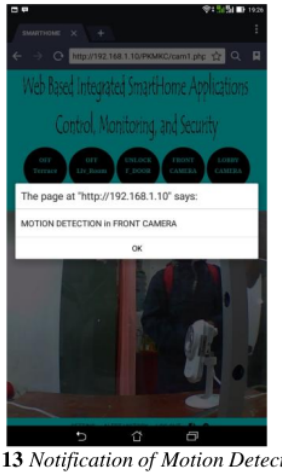


**Figure 13** *Notification of Motion Detection by IP Camera*

If the users wanted to add the number of electrical devices, the users can configure from the setting Page. The number of electrical devices depends on number of Relay at Arduino Relay Shield. **Figure 14** shown the interface of Setting Page Configuration.

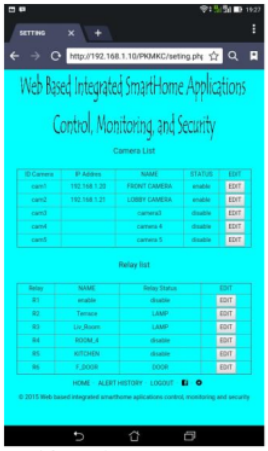


**Figure 14** *Configuration Setting Page*

The test is conduct on a prototype of a house made from acrylic. The protoype equipt with 3 (three) lights to represent electrical devices, 1 (one) solenoid door lock to represent door equipped with lock, and 2 (two) IP cameras. **Figure 15** below shown the prototype of the house.

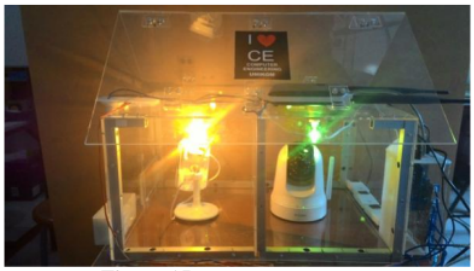

**Figure 15** *House Protoype*

The system also has a control network**. Figure 14** shown the control network.

**Fig. 1** *Control Network*

At the end of the testing scenario the system showed that the integrated smart home system is working properly. In the near future, we are planning to further develop the prototype, and it will perform more extensive and real life home experiments.

## 5. Conclusion

The conclusion of this paper are:

1. This Integrated Smarthome system has been able to control home appliances such as lights and lock the door, monitor the circumstances and conditions via IP Camera.
2. Applications has been able to give a warning when the door lock is opened by force and motion detected by IP camera.

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