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Sticker Control for Internet of Things and Home Automation

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Abstract: **The rapid development of "Mobility" and its involvement in personal and professional life of humans have made it a necessity. However its utilization is constrained with regards to security, accessibility, and multi-tenancy. That is mobile phones are single tenant devices and hence could be insecure and difficult to handle under certain situations. Also with the verge of Internet Of things, the use of traditional point to point connection between home or industrial appliances and wall mounted switches seems redundant. We propose to design and develop a sticker based input technology for controlling mobile phones and home appliances. The sticker contains built in Wi-Fi capabilities for wireless communication with mobile phones or remote servers over internet and controlling them. The sticker thus acts as a portable and customizable replacement for traditional wall mounted switches and also provides hands free access to mobile phones.**

***Index Terms*— android application, esp8266, home automation, internet of things.**

I. INTRODUCTION

Various kinds of input devices are currently present to control electronic devices used on a daily basis. The sizes of these devices are shrinking beyond the conventional limits and the need to control everything with just a click or touch of button is ever increasing. Although handheld devices like PDAs, tablets, smart phones etc. do exist, it's the need of the hour to make a customizable, portable and user-friendly input device to ubiquitously control electronic devices. The conventional point to point connection between wall mounted switches and home or industrial appliances seems superfluous in the age of internet. Hence the need of wireless, portable and customizable switches is eminent. The second problem of usage of mobile devices in scenarios such as driving, attending a meeting, etc. could be inconvenient and at times, threat to life.

The proposed system consists of a sticker based input device which provides the necessary ease of access, customizable actions and portability. This new input technology could also be stretchable, visually customizable and be made to stick to different surfaces from human skin to walls. Unlike the modern techniques of using mobile for home automation, this system allows multiple users to use the same sticker without compromising privacy and security. The most suitable type of wireless data transmission for the proposed system will be through a Wi-Fi module and internet thus expanding its range and scope. Another important feature of the proposed system is its integration with modern technology called Internet of Things.

Gartner defines Internet of Things as "The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment". IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS) and the Internet.

The IoT is all about connecting things to the Internet Devices that are (directly) connected to the Internet and must use the IP suite to be able to exchange data with devices and servers over the Internet. [1]
A protocol is required which would enable the connected devices to communicate when required. Most of these devices have constrained resources and they should be able to communicate with various other heterogeneous devices. **MQ Telemetry Transport (MQTT)** protocol complements these necessities of IoT. It is a lightweight protocol and uses a publish/subscribe architecture.

II. LITERATURE SURVEY

A. Related Work

1. The Things in the Internet of Things

The paper "The Things in the Internet of Things" published by Stephan Haller, SAP Research Centre Zurich, tries to bring clarity by describing the most important terms like things, devices, entities of interest, resources, addressing, identity and, more importantly, the relationships between them as well as identification, addressing, resolution and discovery. It has been shown in particular regarding the distinction between the entity of interest and the device that an absolute, clear-cut

categorization is not always possible. Rather, it depends on the perspective from which one looks at a particular thing. [4]

2. Bluetooth, ZigBee, and Wibree: A Comparison of WPAN Technologies

In the paper "Bluetooth, ZigBee and Wibree: A Comparison of WPAN Technologies" published by John Kooker in 2008, analysis and comparison of the three wireless technologies has been made. Hence, one can make intelligent decisions about which to use in particular applications. Wibree is already being targeted toward watches, as low-data, low-battery- drain accessories to mobile phones. Meanwhile, industrial automation tasks—like adding lighting control to an existing building requires the resilience of mesh networking, making ZigBee a strong choice. For applications requiring high bit rates over short distances, like wireless stereo headphones, Bluetooth remains the best technology of the three. [10]

B. Existing System

1. iSkin sticker

The experimental system published in CHI '15 Proceeding of the 33rd Annual ACM Conference on Human Factors in Computing Systems allows users to control mobile devices using flexible, stretchable stickers that adhere to their skin. The silicone iSkin stickers contain capacitive and resistive sensors that respond to being touched. They can be made in a wide variety of shapes and sizes, and temporarily applied almost anywhere on the body via a medical -grade adhesive. Should one of them only be needed intermittently, it can be removed, rolled up and put away when not in use. They're capable of multi - touch functionality, and also recognize gestures such as swiping. ISkin patches are made of layers of thin, flexible silicone—the same squishy material used in everyday products from window sealants to cookware. The silicone is breathable and can be manipulated into any shape on any part of the body without damaging the patch, which means it can venture to challenge body parts like the back of the ear or the side of a finger. To receive and transmit tactile input, the iSkin houses electrodes sandwiched between the silicone layers. A black carbon powder connects the electrodes to one another, allowing them to be situated into any design. The electrodes all link back to a computer chip, which connects the iSkin to a mobile device with various cables. The biggest drawback of the system is the sensor stickers are connected via cable to a computer system. [8]

Fig 1: iSkin Sticker

2. IoT for Environmental Condition Monitoring in Homes

The paper published in IEEE Sensors Journal, Vol.13, No.10, October 2013 demonstrates a system which is an effective low-cost and flexible solution for condition monitoring and energy management in home. The basic operations remote management and control of domestic devices such as electric lamp; water heater etc., unobtrusive monitoring of domestic utilizations and providing ambient intelligence to reduce the energy consumption through IoT technology are the key functions of the developed system. This will support and reschedule the inhabitant operating time according to the energy demand and supply. The novelty of the system is the internetworking mechanisms, which are practicable to integrate with modules like intelligent home monitoring systems for wellness determination of inhabitants. [2]

III. SYSTEM REQUIREMENTS

A. Minimum Hardware Requirements

- Esp8266 Wi-Fi module
- Embedded buttons
- Server Machine
- Power Module
- Relay Circuit
- Electric bulb
- Android smart phone

B. Minimum Software Requirements

- Java
- MQTT Protocol
- Android application-Android Studio
- Wi-Fi module programming – Embedded C++
- Web Socket – HTML, CSS, Java Script, PHP, AJAX & JSON

IV. PROPOSED SYSTEM

The proposed system essentially consists of three parts:

1) Things

The things consist of any electronic device capable of connecting to internet and needs to be

controlled by the sticker. The proposed system will consist of things such as an electric bulb and an android application. The stickers will be programmed to turn on /off the electric bulb or control a music player application in android.

2) IOT Server

The server consists of two components:

- Websocket – The server stores real time system information and is responsible for re-routing of control messages to the appropriate things.
- MQTT Broker – MQTT (Message Queuing Telemetry Transport is a light weight protocol designed for "Internet of Things") Broker provides capabilities such as session management, message queuing, and QoS delivery throughout the system. It is responsible for receiving all the messages, filtering them; decide who is interested in it and then sending the message to all intended clients (electric bulb or android application). [9]

3) Sticker

The sticker acts as an input device having a circuit with embedded buttons. The sticker contains processing and WiFi capabilities which it utilizes for communication with MQTT Broker. The sticker is the input interface having embedded buttons.

V. SYSTEM DESIGN

A. Block Diagram

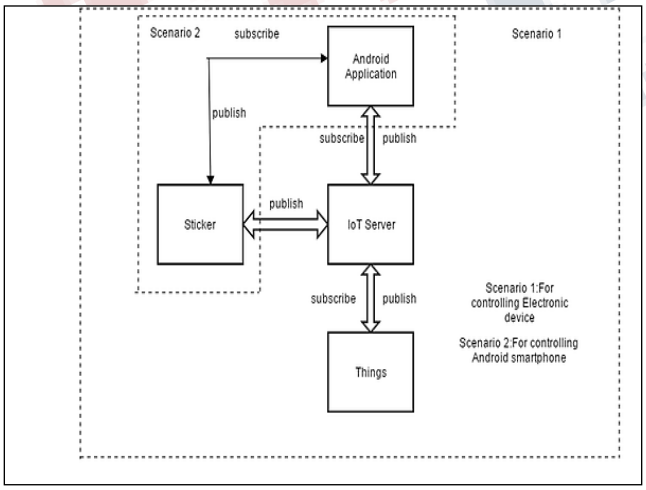

Fig 2: Block Diagram

The figure 2 signifies the block diagram that shows all the modules in the system and the flow of information between them.

Module 1 – Sticker

The sticker contains microcontroller with built in WiFi adapter (ESP8266 – 12) and embedded buttons. It first establishes internet connection either with the home router or mobile hotspot depending on the scenario and then sends out control information to IoT Server or android application when the button is pressed.

Module 2 – IoT Server

The IoT Server receives the messages published by the sticker. It later determines the intended recipient based on the received message and re-routes the message to it. The server contains a database which stores the information of registered users, device information and mapping of stickers and corresponding things.

Module 3 – Things

A – Electric Bulb

This module consists of electric bulb (Thing) which is equipped with relay system, microcontroller and WiFi Adapter which are used to turn the bulb on / off as per the control message received from IoT Server.

B – Android Application

The android application provides user with notification system by providing real time status of all the devices within the system. It also contains various functions for volume up, volume down, play or pause a music, etc. which the user can access through the sticker and thus control the android device. It also allows new user to register to the system.

B. Working

The methodology contains various phases. They are as follows-

a) Configuration

- The user first registers itself by providing login credentials of an active email account. This information is stored in database on the IoT Server.
- The ESP8266 Wi-Fi module initially acts as a Wi-Fi hotspot having a fixed SSID and Password. This id and password is used to connect an android device to the WiFi module only for the first time.
- Once connection is established a new SSID and Password is generated by the android application for future connection of ESP8266 WiFi module to the internet.
- This new SSID and Password is fed in the ESP8266 WiFi module using its "Over The Air (OTA)" firmware update capabilities.
- Multiple SSIDs can be fed in the Wi-Fi module so that during Connection to Server phase the WiFi will automatically connect to WiFi Access Point

bearing new SSID and Password.

b) *Initialization*

- This phase takes care of assigning functions to the corresponding sticker.
- Data of all available stickers and things within a user system is retrieved from the database and displayed to the user for mapping.
- User then assigns functions to each button on the sticker based on the retrieved data and stores the mapping information on the database.

c) *Connection to Server*

- The ESP8266 WiFi Module then starts connecting to the new SSID and password uploaded in it. It can either connect to user's home wireless router or to mobile's WiFi hotspot depending upon the signal availability.
- Once WiFi connection is established, it attempts to connect to MQTT Broker.
- The sticker automatically performs reconnection in case of connection drop or failure.
- The Wi-Fi module now searches for the Wi-Fi network with the new SSID and Password fed in it during the Configuration phase. In this phase this new SSID is of the Home/Office Access Point.

d) *Control from sticker*

Scenario 1:

- When the user presses a button on sticker, microcontroller determines the pressed button based on the interrupts and then publishes the corresponding message to MQTT Broker.
- The MQTT Broker will filter the messages according to the topics and forwards the message to all subscribed clients.
- Since the Websocket also acts as a client in MQTT infrastructure, it receives the forwarded messages from MQTT Broker.
- The websocket retrieves mapping information from the database and accordingly re-routes the messages back to MQTT Broker.
- The MQTT Broker then forwards the messages to intended things.

Scenario 2:

- When the sticker is connected to Mobile's WiFi Hotspot and a button is pressed, a message is directly sent to the android application.

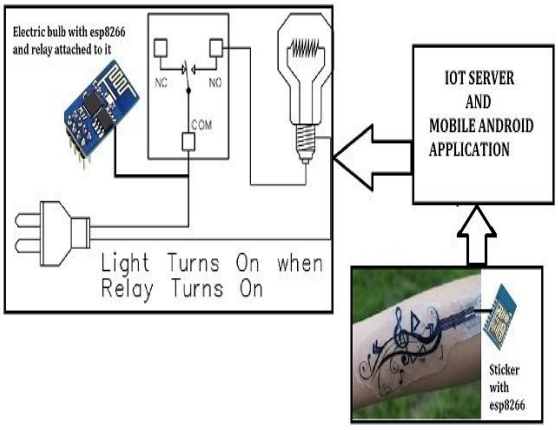

Fig 3: Working

e) *Actuator Operations*

Scenario 1:

- As and when the things receive the messages from IoT Server, the attached microcontroller analyses the messages and sends out signals to appropriate actuators (Relay for Lights, Motor for Fans, etc.)
- The things sends acknowledgement message for successful execution of operation back to IoT Server

Scenario 2:

- If the Thing is an android application, it retrieves the mapping information from the database or local storage and calls the appropriate function (such as volume up, volume down, etc.)

VI. RESET

Every sticker will have a reset button, that when pressed will reset all the states. It is used to restart the sticker after initial configuration and resume normal operation after an unexpected failure.

A. *Advantages*

The portability feature of sticker allows it to be quickly accessible to the user by placing it at his place of interest. It provides a replacement to the traditional wall mounted switches for smart cities, homes, and industries. Also, since the system is connected to Internet of Things technology, any device registered in the system and connected to the internet can be controlled by the sticker from anywhere and anytime thus giving the power of ubiquitous control to the user.

It provides a unique feature of multi tenancy i.e. multiple users could use the same sticker without compromising the security of the system.

The system uses cheap yet efficient components hence making the system cost effective.

B. Disadvantages

The desired compactness of the sticker puts a limitation to the area of access. Thus, only specific types of input tasks can be performed through the sticker like controlling the things only by the push of the button.

Also, since the system is linked with Internet Of Things technology, internet access is an essential requirement thus rendering the system inactive without connection to the internet at all the times. However, control of the android phone from the sticker can be performed without the internet connection.

VII. CONCLUSION

To support the emergence of technologies such as Internet of Things, Home Automation, Smart Cities, etc. the need for pioneering techniques to flourish over orthodoxical methods is a necessity. This system not only aims at replacing the conventional point to point wiring architecture for control of electronic appliances with modern & efficient techniques; but also provides firm foundation for the technological advances.

The proposed system is also designed with a purpose to make existing "iSkin" system wireless & link it to Internet of Things thus widening its scope and making it apt for controlling mobile devices. The standard implementation for all things could provide a stepping stone for ubiquitous machine to machine communication.

REFERENCES

1. http://www.gartner.com/it-glossary/internet-of-things.
2. "Towards the Implementation of IoT for Environmental Condition Monitoring in Homes" by Sean Dieter Tebje Kelly, NagenderKumar Suryadevara, SubhasChandra Mukhopadhyay published in IEEE Sensors Journal, Vol.13, No.10, October 2013.
3. "Internet of Things: Ubiquitous Home Control and Monitoring System using Android based Smart Phone" by Rajeev Piyare Department of Information Electronics Engineering, Mokpo National University, published in International Journal of Internet of Things 2013.
4. "The Things in the Internet of Things" by Stephan Haller SAP Research Center Zurich.
5. "Wireless Home Automation Networks:A Survey of Architectures and Technologies" by Carles Gomez and Josep Paradells, Technical University of Catalonia, published in IEEE Communications Magazine , June 2010.
6. http://iot-ph.com
7. http://phys.org/news/2015-03-flexible-sensors-skin-touchsensitive-interaction.html
8. http://blog.atmel.com/2015/03/11/iskin-stickers-could-turn-your-body-into-a-touchscreen/
9. http://www.hivemq.com/blog/mqtt-essentials-part-1-introducing-mqtt
10. Bluetooth, ZigBee, and Wibree: A Comparison of WPAN Technologies-John Kooker, CSE 237A, November 20, 2008