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# An Internet of Things Approach for Motion Detection using Raspberry Pi

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**Abstract:** The Existing system had low end microcontroller, motion detection sensor, RFID reader and Zigbee transceiver. In the present world where we live there are already devices, which are connected to each other and help in day to day aspects, for example wearable fitness devices, sensors which help in automatic garages, RFIDs in ID cards used in Universities and Industries to gain and lock access. However, imagine this after a few years where billions of devices will be connected to each other including cars, phones, jet planes, appliances, wearable gear etc. Internet of Things (IoT) is a going development of the Internet by which everyday 'things' objects have communication capabilities which allow them to send and receive data. It is expected to connect systems, devices, sensors which can communicate without the need of machine-to-machine communication. IoT refers to an enormous variety of devices such as sensors that assist fire fighters in rescue and search operations, heart beat and blood pressure measuring devices, bio-chips that are implanted in farm animals. It is expected that by 2020, 20 billion devices will be connected with the Internet. The IoT has its own challenges, which need to be addressed. Every device will require an IP address to communicate; The Internet of things presently is being used in the fields of automobiles, agriculture, security surveillance, building management, smart-homes, and health care. The IoT expects to use low-cost computing devices where there is less energy consumption and limited impact to the environment. The next challenge would be data storage, as billions of devices are connecting the data would need to be stored for which massive storage space is required. After the data have been collected we need to make sure that the security policies are in place as more and more personal information will be collected from devices which not get breached and the data should not get in the hands of hackers. Privacy would also be a great challenge as after the recent hacks people are becoming more concerned about their privacy. Hence these challenges need to be taken in careful consideration before planning any project related to the lot. In this project of motion detection these security challenges have been considered after which a successful implementation.

**Keywords:** Internet of Things, Motion Detection.

## I. INTRODUCTION

The design objective is to build an intelligent remote control and monitoring with embedded Web server. The goal of a low-cost, easy to use, and scalable solution for Web-enabled measurement and control systems can be achieved by using the following key technologies.

1. Component-based architecture
2. True embedded networking
3. Standard Internet technologies

The Embedded technology is software or hardware that is hidden-embedded-in a large device or system. Embedded systems, in contrast to general purpose computers such as a desktop, contain processors, software, input sensors and output actuators all of which are dedicated to the control of a specific device. The EWT was developed during the 20th century by members of NASA Lewis Research Center, flight software engineering branch of the engineering design and analysis division of the engineering and technical services directorate. It was modified in 2002. The EWT is the marriage of embedded systems and the World Wide Web. EWT is the merging of Embedded Systems with the World Wide Web. EWT decreases the cost of developing and maintaining the user interface by allowing the user to interface to the embedded system through a Web browser running on a standard personal computer. EWT can also be used to simplify an Embedded System's internal network. The Embedded Web Server Technology is most evolving technology for Internet Devices. There are many application areas including internet devices, telecommunication devices, measuring instruments and lots of consumer electronics.

WEB-enabled systems have offered great promise to education and science, businesses, and consumers. Their benefits are well known.

- Reduction of operating and maintenance costs due to remote monitoring, diagnostics, debugging, and upgrading firmware.
- Virtual educational laboratories for distance learning that provide flexible schedules and create new educational opportunities at a limited cost.
- Convenience and safety that comes with the ability to monitor the status of a smart house and to control Internet appliances when away from home.

- Remote monitoring of residential and industrial properties, notification of emergency services in case of fire, theft, and a leak of liquid or gas.

Traditional Web servers are designed to serve static Web pages from high-end workstations with plentiful CPU and memory resources. Embedded Web servers have different requirements for which traditional technologies are unsuitable.

- Protocol Considerations
- Embedded Software Considerations

The server is the repository for the Web pages, and it handles requests and passes data back to the browser. The browser does the more difficult work of presenting the text, displaying graphics, generating sound or video and running Java applets.

## II. BLOCK DIAGRAM AND MODULES DESCRIPTION

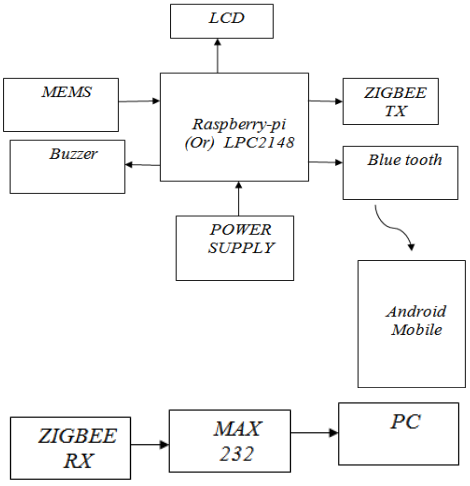


**Fig.1. Block Diagram.**

### A. Modules and Description

The project consists of ARM based Microcontroller (LPC2148/Rasperi-pi), Zigbee transceiver, Bluetooth module, LCD, MEMS, Buzzer, PC and power supply. By using power supply we can provide +3.3v to the LPC2148 and +5v to the rest of all modules. MEMS are the advanced sensor which gives the signal to the microcontroller. When motion may happen then MEMS can give different values to the microcontroller then the microcontroller compares with internal program, if the values matches then it will give the alarm sound and the data will send to Android mobile through blue tooth and data can send to the server through Zigbee transceiver.

1. Micro Controller (RASPBERRY-PI)
2. Power Supply
3. Zigbee modules
4. LCD
5. MAX 232
6. Blue tooth
7. Buzzer
8. MEMS

### 1. LPC2148 Microcontroller

LPC2148 microcontroller board is based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontrollers with embedded high-speed flash memory ranging from 32 KB to 512 KB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty. The meaning of LPC is Low Power Low Cost microcontroller. This is 32 bit microcontroller manufactured by Philips semiconductors (NXP). Due to their tiny size and low power consumption, LPC2148 is ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale.

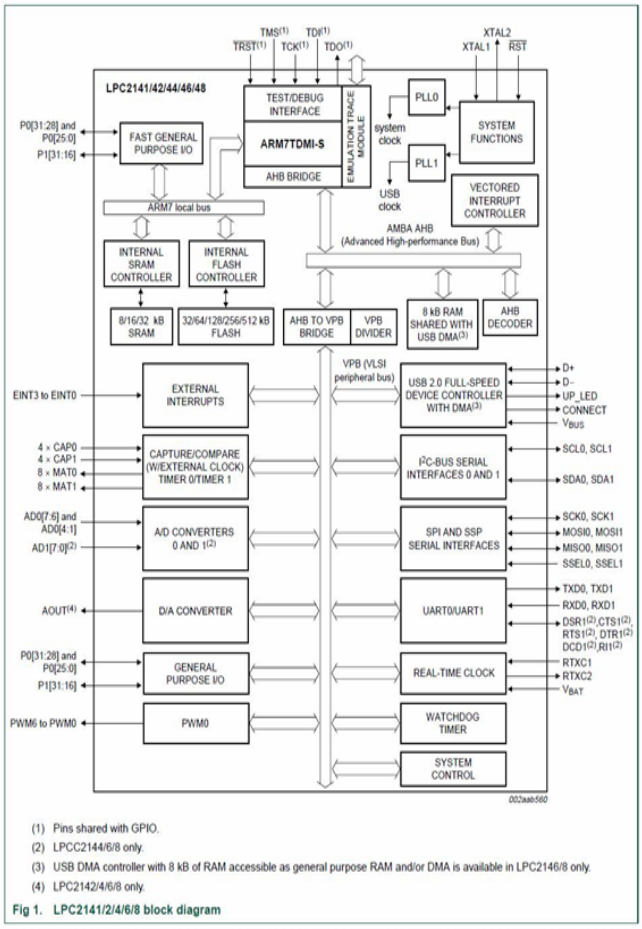


**Fig.2. LPC Block Diagram.**

**Features of LPC2148 Microcontroller:**

- 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 8 KB to 40 KB of on-chip static RAM and 32 KB to 512 KB of on-chip flash memory; 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- USB 2.0 Full-speed compliant device controller with 2 KB of endpoint RAM. In addition, the LPC2148 provides 8 KB of on-chip RAM accessible to USB by DMA.

- One or two (LPC2141/42 Vs, LPC2144/46/48) 10-bit ADCs provide a total of 6/14 analog inputs, with conversion times as low as 2.44 ms per channel.
- Single 10-bit DAC provides variable analog output (LPC2148 only)
- Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog.
- Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input

**Raspberry Pi:**

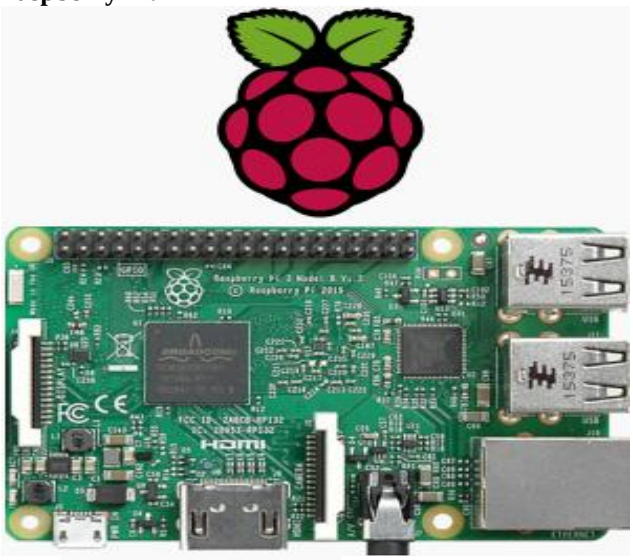

**Fig.3. Raspberry Pi 3 model B**

The **Raspberry Pi** is a series of credit card-sized single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and developing countries. The original Raspberry Pi and Raspberry Pi 2 are manufactured in several board configurations through licensed manufacturing agreements with Newark element 14 (Premier Farnell), RS Components and Egoman. The hardware is the same across all manufacturers. The default firmware is closed source, while an unofficial open source is available. Several generations of Raspberry Pis have been released. The first generation (Pi 1) was released in February 2012 in basic model A and a higher specification model B. A+ and B+ models were released a year later. Raspberry Pi 2 model B was released in February 2015 and Raspberry Pi 3 model B in February 2016. The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support. This block diagram depicts models *A*, *B*, *A*+, and *B*+. Model *A*, *A*+, and *Zero* lack the Ethernet and USB hub components. The Ethernet adapter is internally connected to an additional USB port. In model *A*, *A*+, and *Zero* the USB port is connected directly to the system on a chip (SoC). On model *B*+ and later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while model *B* only provides two. On the model *Zero*, the USB port is also connected directly to the SoC, but it uses a micro USB (OTG) port.

**2. Power Supply**

All electronic circuits works only in low DC voltage, so we need a power supply unit to provide the appropriate voltage supply for their proper functioning .This unit consists of transformer, rectifier, filter & regulator. AC voltage of typically 230volts rms is connected to a transformer voltage down to the level to the desired ac voltage. A diode rectifier that provides the full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation . A regulator circuit can use this dc input to provide dc voltage that not only has much less ripple voltage but also remains the same dc value even the dc voltage varies somewhat, or the load connected to the output dc voltages changes.

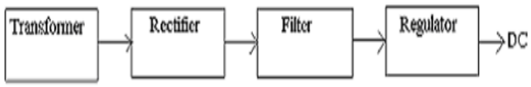


**Fig.4. General Block of Power Supply Unit**

**Transformer:** A transformer is a static piece of which electric power in one circuit is transformed into electric power of same frequency in another circuit. It can raise or lower the voltage in the circuit, but with a corresponding decrease or increase in current. It works with the principle of mutual induction. In our project we are using a step down transformer to providing a necessary supply for the electronic circuits. Here we step down a 230volts ac into 12volts ac.

**Rectifier:** A dc level obtained from a sinusoidal input can be improved 100% using a process called full wave rectification. Here in our project for full wave rectification we use bridge rectifier. From the basic bridge configuration we see that two diodes(say D2 & D3) are conducting while the other two diodes (D1 & D4) are in off state during the period t = 0 to T/2.Accordingly for the negative cycle of the input the conducting diodes are D1 & D4 .Thus the polarity across the load is the same. In the bridge rectifier the diodes may be of variable types like 1N4001, 1N4003, 1N4004, 1N4005, IN4007 etc… can be used. But here we use 1N4007, because it can withstand up to 1000v.

**Filters:** In order to obtain a dc voltage of 0 Hz, we have to use a low pass filter. So that a capacitive filter circuit is used where a capacitor is connected at the rectifier output& a dc is obtained across it. The filtered waveform is essentially a dc voltage with negligible ripples & it is ultimately fed to the load.

**Regulators:** The output voltage from the capacitor is more filtered & finally regulated. The voltage regulator is a device, which maintains the output voltage constant irrespective of the change in supply variations, load variations & temperature changes. Here we use fixed voltage

regulator namely LM7805.The IC LM7805 is a +5v regulator which is used for microcontroller.

**C. Zigbee Technology**

Overview or tutorial of the Zigbee standard and Zigbee technology used for remote sensor, data collecting applications. Zigbee is a wireless networking standard that is aimed at remote control and sensor applications which is suitable for operation in harsh radio environments and in isolated locations. Zigbee technology builds on IEEE standard 802.15.4 which defines the physical and MAC layers. Above this, Zigbee defines the application and security layer specifications enabling interoperability between products from different manufacturers. In this way Zigbee is a superset of the 802.15.4 specification. With the applications for remote wireless sensing and control growing rapidly it is estimated that the market size could reach hundreds of millions of dollars as early as 2007. This makes Zigbee technology a very attractive proposition for many applications.


**Fig.5. Zigbee**

**D. LCD Display**

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. One each polarisers are pasted outside the two glass panels. This polarizer's would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters.

The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD does don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.

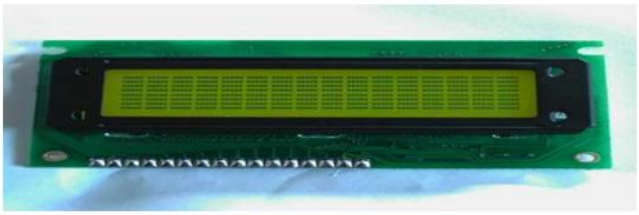

**Fig.6.LCD Display.**

**5. MAX 232**

The MAX232 is an IC, first created by Maxim Integrated Products, that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5V) from a single + 5V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0V to + 5V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 VTTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V.

**6. Bluetooth Module**


**Fig.7**

Bluetooth File Transfer for the PC is a file transfer utility and client which makes it extremely easy to share files between devices with a better laid out user interface than

Windows' built-in file transfer program. The included file and folder manager gives you the ability to browse your computer or remote device. It comes with full support for Android and Apple devices and basically any type of device with Bluetooth capabilities. From within the Bluetooth File Transfer explorer itself, you're able to upload and download files, perform file management operations such as deleting, renaming, copy paste files and more. Bluetooth File Transfer cans also playback multimedia files, open text files and browse images. Although the program might be a little bit slow finding devices, that isn't really a fault of the program but more of Bluetooth protocols. This software certainly makes it a less daunting task of dealing with Bluetooth devices and file management.

**Bluetooth File Transfer (PC) features and highlights:**

- Easy to use and simple user-interface
- View your files using Large Icons, Small Icons, Tiles, List or Details mode
- High-speed transfer rate achievable
- Adaptive Medieval Cache System for a folder navigation in turbo mode
- Fully supported Drag & Drop to and from the Windows operating system
- Cool background transfers for very large files, a tray icon will be displayed on bottom-right
- Intuitive options system using a drop-down button and quick item explanation
- Information about connected device are stored in a quick "Device History" menu system
- Very useful folder navigation system using a cool drop-down button
- Unique licensing system using ultra-secure online SSL transactions
- Detailed raw log generation system of any device connection
- Built-in error report system for quick bug reporting
- Automatic online version check and update

**7. Buzzer**

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or electronic. Typical uses of buzzers and beepers include alarms, timers and confirmation of user input such as a mouse click or keystroke.

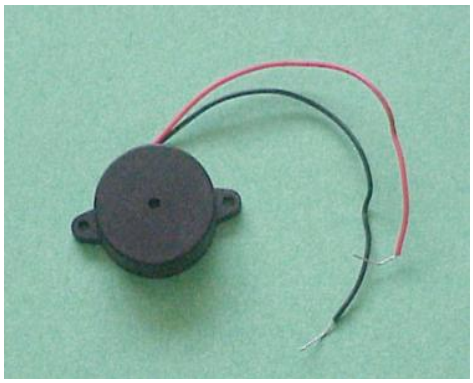

**Fig.8.Audio signaling Device(Buzzer).**

**8. MEMS**

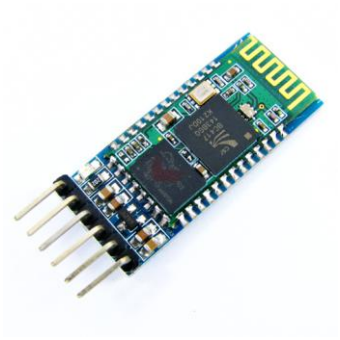

**Fig.9. MEMS**

## III. PROJECT IMPLEMENTATION

While developing any project it is important to decide the architecture of the project and the capacity and capabilities of the hardware being used. In this project we have used a Raspberry Pi Model B to connect the web camera to capture the footage and the RJ45 to connect to the Internet for sending and receiving data. Raspberry Pi executes the processing of all the data and after the data is analyzed then the set actions are triggered for example sending an email on detection of motion and uploading images and videos to the ftp server. The python script matches the last frame and the present frame of the live video, if there is any difference then the motion flag is set, triggering all the events.

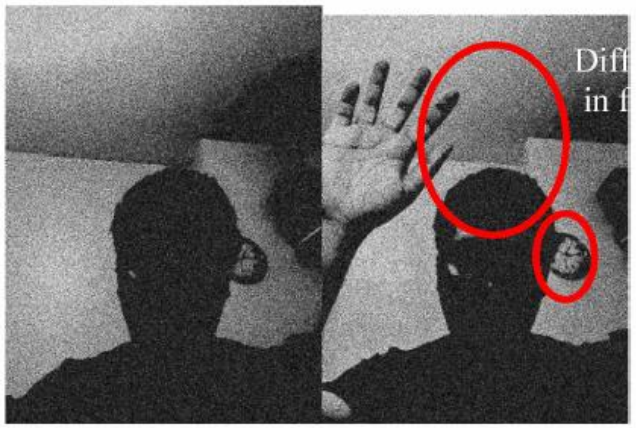

**Fig.10. Frame I (Left) and Frame 2(Right)**

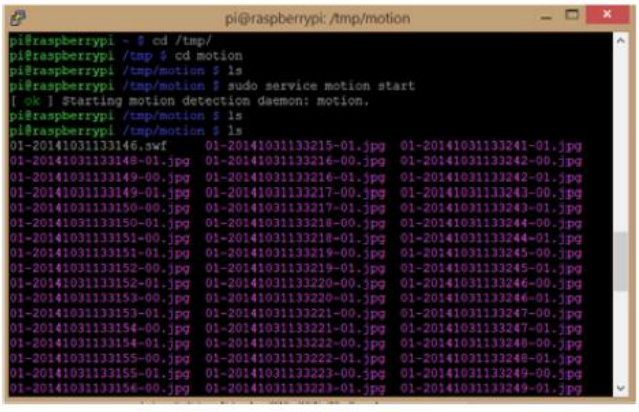


**Fig.11. Images saved locally on Raspberry Pi**

The python script executes and takes continuous snapshots from the camera till the motion is detected; it also starts to make a video of the same from the start till the end, 133 continuous photos are uploaded to the external server, as there could be a chance that the person would attempt to damage the device itself. As the user would also get a notification of the motion detection they can login remotely to the Raspberry Pi and check live output from the camera, which would verify the reason for the detection of motion.

## IV. CONCLUSION

Henceforth, by enhancing the capabilities of these technologies and integrating them, we hope to introduce the 'Motion Detection' system and to contribute to the current security system. This system would be an alternative for expensive security systems being used in the present day.

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