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Implementing Anti-theft Systems for ATM and Vehicles

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Abstract: Anti-theft technology can be implemented on many systems such as ATM, automobiles, mobiles etc. In ATM security we use silent indicate systems, integrated video surveillance cameras, etc. which are all implemented with help of M2M communication technologies. M2M needs new system architecture so we implement a low cost embedded web server based on ARM11 processor and Linux operating system using Raspberry Pi. It has modules such as web enabled control, sensors, shutter lock and camera control. Anti-theft in vehicles can be implemented using GSM and GPS or Bluetooth technologies. In GSM and GPS we install a tracking system and fingerprint verification. This is implemented by single board embedded system equipped with GSM (Global system for mobile) and GPS (Global positioning system). In Bluetooth low energy module we use Arduino board which functions in the master mode and reading of MAC address is done by the BLE slave device. There are several methods used in Anti-theft systems but in this paper we have concentrated more on the following methods.

Keywords -Raspberry Pi; M2M; RF Communication; Embedded System; Fingerprint; GSM; GPS; Bluetooth low energy; RFID.

I. INTRODUCTION

Theft is taking of a person's objects without his consent illegally. Idea of anti-theft arises to prevent the act of thieving. In today's modern world as the technology is increasing linearly theft has increased side by side. These problems have led to invention of anti-theft systems. Till date many anti-theft systems have been invented but in this paper we will mainly discuss three anti-theft systems in detail. They are: Anti-theft ATM machine using Embedded Systems; Anti-theft protection using Fingerprint verification of vehicles with help of GSM and GPS; Anti-theft system for motorcycles using Bluetooth low energy 4.0;

II. ANTI THEFT ATM MACHINE USING EMBEDDED SYSTEMS

Automated Teller Machines (ATM) have made the life easier for many people but it is difficult for the managed service providers (MSPs). The factors like purchasing, maintaining the machine, money filling, security and the passive assets are responsible for keeping the ATM Active. These assets include Air conditioners, UPS, light bulbs, security camera and light collection boards. The assets and security is managed manually so it shrinks the gross margin of ATM operators. Therefore they are looking for a more reliable source to maintain ATMs.

The main aim of the Anti-theft ATM security is to provide protection against physical and electronic thieving. This is achieved by using M2M communication technology which is abbreviation for Machine-to-Machine. It provides no human intervention and provides a real time monitoring control. M2M architecture needs a new system architecture which is implemented using an Embedded Web Server (EWS) based on ARM11 processor and Linux operating system using Raspberry Pi. Each of this is discussed further in detail.

Machine to machine (M2M) describes any technology that enables networked devices to communicate without any assistance from the humans. M2M communication is usually used for remote monitoring. Example: in product restocking. It forms the basis for a concept known as the Internet of Things (IoT). It has many applications in areas like warehouse management, remote control, health defense, robotics, traffic control, and industrial automation, Smart grid for cities, logistic services, supply chain management, fleet management and telemedicine.

Architecture of M2M includes a device like sensor or meter which observes parameters like temperature or inventory level. This information is sent through a network which may be wireless, wired or hybrid. The information is associated with some application (software program) and required steps are taken later. Remote network of machines send information back to a central hub for analysis, which later is rerouted into a system like a personal computer. Sensor based network has been extensively used in monitoring and controlling purposes in ATM [1]

The presence of an object is recorded using radio signals; this technology is called as Radio-frequency identification (RFID). It finds its use in inventory control or timing sporting events.

RFID reader is separate from the main controller unit. It is placed on the outside of the shutter. Serial data is received from the controller from reader and it controls the shutter to lock or unlock. The card is brought near to the RFID module and it reads the data in the card. Later it also displays on the LCD.

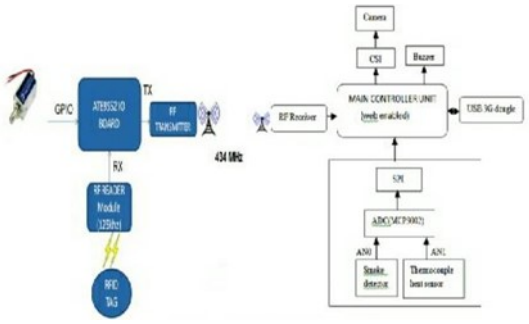


Fig 1. Functional Diagram

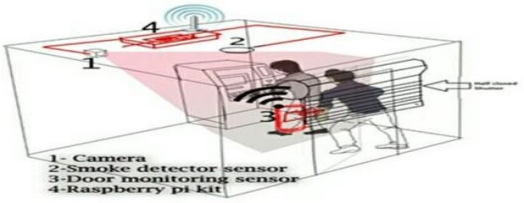


Fig 2. Proposed Module

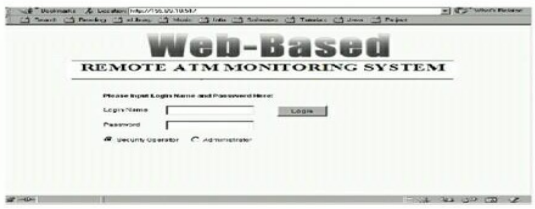


Fig 3. Sample Login Page

Authorized or unauthorized message is displayed after the data in the card is compared with the data in the program memory. For a licensed person the door opens and for unauthorized person the door closes.

RF module is a device used to transmit or receive signals between two devices. Wireless communications can be achieved with help of this. A signal is transmitted from RFID module when it reads information from RFID card. The main control unit receives and prepares to require snap and transfer to server RF Modules square measure used wireless transfer information. For short range wireless control applications, an ASK RF Transmitter-Receiver Module of frequency 315 MHz or 433 MHz is most fitted [2]

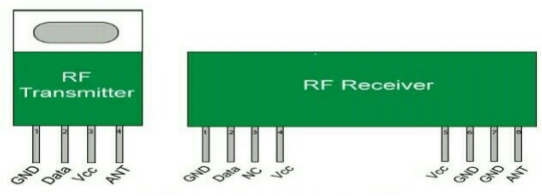


Fig 4. RF Module devices [3]

RASPBERRY PI WEB SERVER: ARM processor based web servers, do not use computer directly. This helps a lot in cost reduction. Our aim is to implement an Embedded Web Server (EWS) based on ARM11 processor and Linux operating system using Raspberry Pi.

It provides a wide range of application over the internet. Embedded system is used to run the web server. Many types of software can be used to implement the embedded web server, and a few examples are- Linux–operating system, Apache–web server (http)software , MySQL – database server, PHP or Perl – programming languages, etc.

a) RASPBERRY PI CAMERA: There's is no hardware limitation in the Raspberry Pi itself. It's quite capable of handling these high frame rate modes, but it does require a certain amount of effort to work out these new 'modes' inside the camera software. [4]

The Raspberry Pi camera board consists of a five Megapixel device which connects via a ribbon cable to the CSI connective on the Raspberry Pi. For the same price we get better video and still image quality than a USB webcam. OpenCV (Open Source Computer Vision) is nothing but a library of programming functions which aims at real-time computer vision. Python is used for OpenCV to apply face recognition to the captured image. When raspistill -o image.jpg is entered at the command prompt, the preview appears on the screen for a few seconds.

b) SMOKE DETECTOR AND FLAME DETECTION: A smoke detector is a device which senses smoke, which indicates the fire. Smoke detectors usually use either optical detection (photoelectric) or physical method (ionization)

The alarms used are sensitive to smoke. Some smoke alarms use a carbonic acid gas detector or carbon monoxide gas detector to observe characteristic merchandise of combustion [5]

c) M2M Driven ATM Sites: M2M technology provides solution to security problems. Safety of clients is most important in banks. So we implement remote observance resolution across their ATM sites to resolve security problems. Handiness, security, cut back field service visits, minimize system downtimes and minimize operative prices are possible if M2M is put in ATMs. If a haul happens, the operators are alerted and they will be able to resolve the threats from a distant location. If breaking, drilling, or cutting of the safe area unit dispensed or any other physical attacks takes place, vibration sensors put within the machine alerts the operator.

If ATM closes anonymous or if there is any physical attack then the alarm alerts general public and also the closest police headquarters.

M2M also assists the operators in energy management, fault management, rising operative prices and news. Smart ATMs add location intelligence and

enhances observance visually by desegregation Google map. It allows integrating Google Maps and placing the sites on the maps in step with the geographic distribution. The site status of a site can be viewed during a popup by clicking on the positioning balloons on the Google Map [6].

Furthermore the site location on this popup redirects to site exposure page containing sensing element standing, power supply, power consumption pattern, etc., The operators/IT directors get a comprehensive understanding of however distributed the site/device extremely is[6]. With this graphical read alert notifications and alarm count of web sites in multiple geographical locations across the world can be viewed as shown in Fig 5. Thus, it empowers IT directors to pinpoint problems and resolve the problems in numerous web sites across the world with an additional visual bit.

Fig 5. Google map integrate ATM site Manager

The hosted website on raspberry pi can be accessed by the client[7]. The client has to type the WAN IP address of website in address bar of any web browser. Client can see the webpage.

III. ANTI-THEFT PROTECTION USING FINGERPRINT VERIFICATION OF VEHICLES WITH HELP OF GSM AND GPS

A stolen vehicle can be retrieved easily if a tracking system is installed in it. To track the vehicle location an electrical device is installed in vehicle. This helps the owner to keep the track of vehicle location. Location of the vehicle can be determined by GSM and GPS module along with this finger print recognition is also used. Each individual has unique fingerprint image. This feature of human anatomy is used to identify the owner and thus preventing theft. Biometric protection system is used to verify match between two human fingerprints. Before starting the vehicle driver must give his verified fingerprint image. Only then he will be able to move the vehicle. This is normal condition. The abnormal condition is when the fingerprint is not verified but the vehicle is changed, in this condition the owner will receive an smallest which includes the URL of "Google map" with the current location of the vehicle with interval of 10 second. The current location of vehicle is updated. Any time the owner wants to know the location of the vehicle he can give a missed call after which he will receive a SMS.

We determine the vehicle location with help of satellites and GPS receiver. In figure 6 GPS receiver receives the message from satellite. It will determine the position of satellite. A, B, C are components of satellite position and time sent are designated as [Ai, Bi, Ci, Xi] where i=123….n .message reception time indicated by a board receiver clock is ~ti, the true reception time ti=~ti-Xi where X is receiver clock bias. The message transit time ~ti-X-si, si is satellite time. As the message at the speed of light c, the distance is (~ti-X-si)c. For n satellite, the equation is given by [8]

$$(A-Ai)^2+(B-Bi)^2+(C-Ci)^2=[(\sim ti-X-si)c]$$

i=1, 2, 3….., n

In Terms of pseudo ranges, pi=(~ti-si)c

$$\sqrt{[(A-Ai)^2+(B-Bi)^2+(C-Ci)^2]}+XC=pi$$

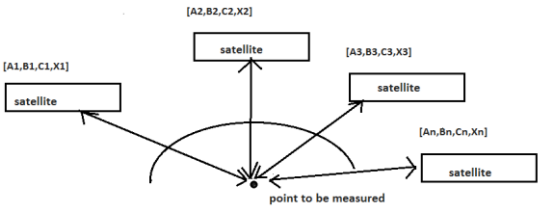


Fig 6. GPS system with satellite

Biometric verification uses the fingerprint sensor technology. Amongst many sensor technologies present we are using optical sensor technology. The finger image is captured digitally processed and stored as a template in the memory. Before starting the vehicle, fingerprint of driver is taken and compared with previously taken image using fingerprint matching algorithm. If the verification goes wrong, then GPS engine will collect and send the location through SMS to the owner's cell phone number.

After initialization of GPS receiver, it get coordinate, time and several information in NEMA format [9].every second information is updated. After starting, microprocessor gets 1st coordinate from GPS receiver. If loni and lonf are the initial and final longitude and lati and latf are the initial and final latitude then from haversine formula [16] we can get distance, D. [reference paper]

dlon= lonf-loni

dlat= latf-lati

$$a=(\sin(dlat/2))^2+\cos(lati)*\cos(latf)*(\sin(dlon/2))^2$$

$$C=2*\operatorname{atan2}(\sqrt{a}, \sqrt{(1-a)})$$

D=R*C

R=>radius of earth

By giving missed call, the owner can also get the location of the vehicle flow [8] chart is given in figure 7

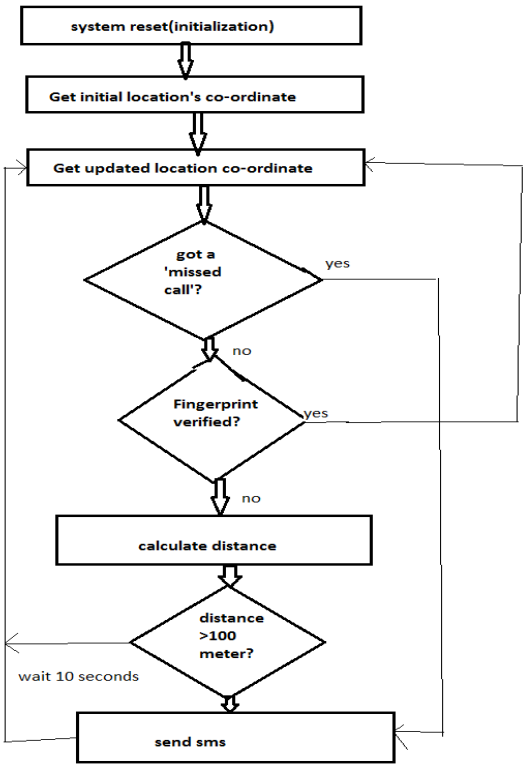


Fig 7. Flowchart of sending SMS and security check

Design: An Arduino mega 2560 microcontroller is interfaced with GSM and GPS receiver. SIM 980[11] is also used. GT-511C1R [12] is used as fingerprint device. This figure 8 shows the block diagram of vehicle tracking system with fingerprint verification [8].

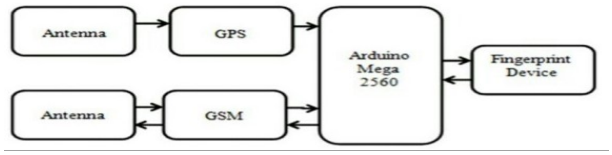


Fig 8. Block diagram of vehicle tracking system

A. *Arduino MEGA-2560 microcontroller [13]*

The Arduino mega 2560 is a microcontroller based on the ATmega2560. It has 54 digital i/o pins, 16 analog input pins, 4 UART, a 16MHZ crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. simply connect it to a computer with a USB cable with a AC-to-DC adapter or battery to get started[13].

B. *GPS/GPRS/GSM(SIM908)[14]*

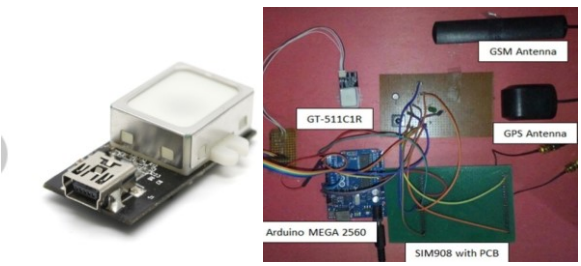
SIM908 module is a complete quad band GSM/GPS module which combines GPS technology for satellite navigation. General features are quad band 850/900/1800 1900MHZ, GPRS multi slot class10, GPRS mobile station class B, supply voltage range-GPRS: 3.2~4.8. GPRS: 3.0~4.5 V. [14]

C. *GSM AND GPS antenna [8]*

In this paper GSM antenna is a passive and GPS antenna is active type.

D. *Fingerprint Module (GT-511C1R) [15]*

The GT-511C1R FPS (fingerprint scanner) is a small embedded module which consists of an optional sensor mounted on a small circuit board. The optical sensor scans a fingerprint. The microcontroller and software provides the module functionality which automatically processes the scanned fingerprint [15].This module can only store up to 20 different fingerprints but is capable of 360° fingerprint recognition and download and upload templates using serial interface.



IV. ANTI-THEFT SYSTEM FOR MOTORCYCLES USING BLUETOOTH LOW ENERGY 4.0

To detect the purloining condition, couple of RFID tags is installed on motorcycles. The information stored on a tag which is attached to object is read and captured by RFID using radio waves. Two UHF RFID passive tags are used. First tag is positioned on the body of motorbike hidden from seeing called as bike tag. Other one is connected with the key called key tag. The RFID tags cannot be hung flexibly. The drawback is if the RFID reader is unable to scan the key tags, unlocking of motorcycles become easier and so is the theft. Installation of key tags completely on motorcycle is not possible in real life because the RFID tags are scanned only when key tags are installed in front of bikes. Passive RFID tags positioned more than 9 meters leads to inaccuracy.

To overcome the drawbacks of RFID,BLE 4.0 is used which is advanced version of motorcycle anti-theft system (MATS).Here we mainly improve the accuracy of key tag and BLE tag readers are implemented. BLE tags work on two modes, Slave mode which is installed on key. Master mode consisting of Arduino board and HM11 BLE 4.0 module.MAC address (ID) of BLE slave devices are read by the master mode. BLE slave's ID can be detected by the master with maximum distance of 18 meters. BLE 4.0 method is flexible compared to RFID as the key can be hung freely only if bike's speed is below 80 km/hr. And this method is effective, has better accuracy than the previous version and consumption of power is less.

A. Improving MATS

The fig 9, represents the flowchart of improving MATS. This includes BLE tags which have the capability to read the BLE's ID of a key tag.BLE tags work in slave mode and the reader operates on master mode. As the detection accuracy of RFID is good they are not changed. The ID's of both the key tags must be detected simultaneously, but in case of stolen bikes only RFID's ID can be detected. This is referred as normal condition. In both conditions i.e. in normal condition and abnormal condition the information such as time and license plate number is saved on the database. But in abnormal condition the alarm is notified.

To detect the bike tags and key tags, which are positioned on motorcycle and it's key respectively the RFID reader and the BLE reader must be installed at the beside the road. The FTTx (Fiber to the x) is used for data communication between the pole and centre (as in previous section) [1].

B. BLE tags and its reader

Bluetooth low energy reader tags: The ID of BLE tags are obtained by placing some devices on pole and the received TCP/IP protocol is send to the processing unit at a center. Improving of MATS does not affect the software at the command center. But this software has to determine the abnormal condition with the help of ID's of key tags and bike tag and has to save the data on a database. With the fixed RFID reader the bike tags ID is obtained and BLE technology replaces the ID of key tags.

Fig 10 represents the improvisation MATS block diagram. Here BLE reader is used to detect the ID rather than the RFID reader that is used in the previous section.BLE tag reader has BLE 4.0 module HM10,Arduino UNO R3,Ethernet shield W5100,DC adaptor 5V 3A and 5V DC fan.[1]

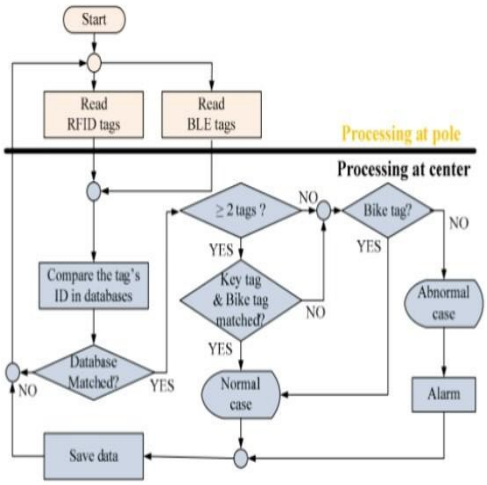


Fig 9. flowchart of improving MATS [1]

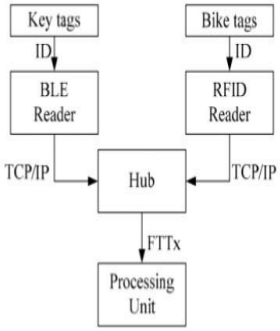


Fig 10. block of improving MATS[16]

With the help of AT command communication of data is possible using HM10 module which is attached to Arduino board and RS-232 protocol.

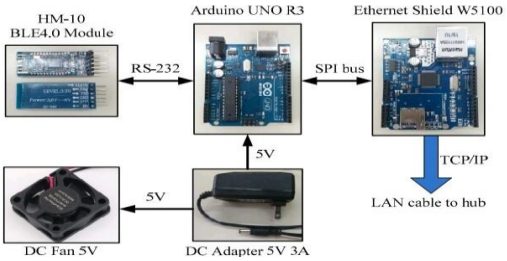


Fig 11. Block diagram of BLE tags and reader [16]

The Arduino makes use of 3.3V low power. To detect 6 maximum ID of slave simultaneously in datasheet the HM10 is set to master role. For far away processing Arduino alone cannot send the tag's ID so it employs an Ethernet shield W5100 which connects Arduino to the command center using TCP/IP protocol. After successful processing of Arduino, the shield immediately sends the BLE tags ID to the command center. Communication of shield and Arduino is possible by SPI bus on digital pin 10-13 of UNO. The usage of SD card is not preferred as it shares the SPI bus and the processing cable by LAN cable is easier with RJ-45 and BLE reader connection. As BLE tags are connected at pole, there is a necessity for fan connection to reduce temperature. And the fan is placed based on the desired supply current. DC adaptor 5V 3A makes all devices to work more efficiently even though shield offers Power Over Ethernet(POE).

Bluetooth low energy tags: The BLE tags in fig 11, operates in the slave mode.GS- BKF01 is the model designed by Shenzhen Gotrich technology, China. The Power consumption of this is only 0.4 microampere and 0.079mA in normal mode. Specification of BLE tags are mentioned in the table.BLE tags are preferred than RFID as its performance is good.

Fig 12. Anti-theft lost device work as BLE tags.[16]

V. CONCLUSION

In Anti-theft ATM systems the use of M2M communications and implementing it with help of Raspberry Pi web server has made ATMs a lot safer than before. The additional modules like shutter lock and web enabled cameras has made it secure but there are a few disadvantages also. There is no software integrity control, no antivirus solutions and no authentication of an app that sends commands to the cash dispenser. The pc part of ATM is also easily accessible. The software security measures must also be taken with hardware measures.

In Anti-Theft system using GSM and GPS the exact location of the stolen vehicle is sent to the owner so it is easy to retrieve the vehicle. The system is cost efficient and provides greater security. The fingerprint verification technology also ensures that only the owner is able to access the vehicle but during emergency if the owner is injured or is unable to drive the vehicle it causes inconvenience. The GPS system is not always correct and due to network issues the owner may receive the message much after the vehicle is stolen.

The Anti-theft Bluetooth low energy system provides more flexibility and can be freely hung when the bike speed is below 80 km/ hr. this method is more efficient and the power consumption is also less. The few disadvantages of this technology are data speed is slow, poor data security and shortened battery life.

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