Metal Detecting Cubical at Security Screenings

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Abstract: Metal detectors are used for security screening at the access points in metro stations, airports, courthouses, malls, and prison airports to detect concealed metal weapons on person's body. These human operated metal detectors often cause discomfort to people. Hence there is a need to screen people without the intervention of human which also automates the device using Internet of Things. This paper demonstrates an efficient way of screening people in short time using pulse induction metal detecting sensor. This serves as an alternative method for the existing metal detection methods employed at the various screenings. If a weaponized intruder is found, the method locks the screening unit to prohibit escaping of the intruder, captures his/her image and sends an alert to the security division for further action.

Index Terms **– Metal, sense, intruder, detect, security, Raspberry, Pi camera, Pulse induction.**

I. INTRODUCTION

The necessity of security screening is imperative. In case of security screenings, as the queue piles up, it becomes difficult to monitor and this may lead to several consequences, one among them is a person with a weapon enters without getting checked. Hence manual way of detecting weapons at the security screenings is less efficient and time consuming. In addition, the existing metal detectors can detect the object when it is at a distance of millimeters and it doesn't specify the region of object. Thus, there is a need to develop a sensor which can work at centimeter/meter scale and also specify the object location. This prototype helps to detect metals and indicate its location in the body, using pulse induction metal detector in a cubical structure. Pulse induction metal detector circuits can detect metal targets approaching the detector, without making a physical contact with the target. The electromagnetic field is made use of, to penetrate through the target. Once the metal is detected the prototype designed captures the image, stores it and sends it to the nearest security in-charge personnel using the concept of Internet of Things (IoT).

II. LITERATURE SURVEY

Mingsheng Ma et al. [1] have reported an inductor and capacitor based resonant circuit which works on the technology of low temperature co-fired ceramic. This sensor is wireless, passive and works on eddy current principle. The sensor proposed to detect the metal targets has been modeled, designed and has been tested using electromagnetic simulation. Metals such as Cooper and Aluminum have been tested during the measurement phase. However the decrease in sensitivity with decrease in surface area and thickness is an important observation. The sensor modeled showed a sensitivity of 11.2 MHz/mm which is quite high for a proximity distance of 1–3 mm. The sensor developed works well over a detection range of up to 10mm.

Teena Bodhwani et al. [2] introduced detection of metal by proximity sensor using IC TDA0161. This sensor operates similar to IR sensor. The sensor transmits a signal and looks for the reflected signal. A change in the reflected signal is an indicator of change in surroundings. A current of about 1mA is observed in the absence of metal and it is about 10mA if a metal coil is in the proximity of the sensor. The information captured is processed and the necessary action is taken.

Shashi Shekhar et al. [3] presented a Cloud based metal detector and the method in which potential carriers of weapons and other metal objects passing through a close watch area in which the earth's magnetic field is monitored, and turmoil in the field due to movement of any metal objects are detected and an alert message is sent through email and text message. The consideration of the decisive requirements in relation to foreign body hindrance and detection, for detecting the hidden metal within objects, or else buried metal objects in underground are detected easily and sent to the database of the cloud. A cloud database ordinarily fills in as a standard database arrangement that is largely executed through the system of database programming over a register/foundation cloud. Internet browser or a merchant gave application programming interface (API) for application and administration absorption. The main advantage of a cloud database over an ordinary database is that the former is scaled during the run time. This feature helps in managing extra examples and assets.

Rani, S et al [4] have reported detection of an unauthorized person or intrusion by an unwanted personnel. This system uses various software and hardware tools and also have demonstrated the data transfer to the cloud. This research work has used Raspberry Pi 3 board for data processing. Here, the passive infrared sensor detects entry of an unauthorized person observes the person's activity and captures the images of the person and sends the SMS to the security system and also an alarm is raised [5]. The Pi camera attached to the Raspberry Pi system captures the image and sends it the authorized person through mail system. A built in Wi- Fi module is used for the mailing system [6].

III. PROPOSED SCHEME

In the proposed scheme, metal detection is done using pulse induction method. Here, the sensor is placed inside the screening cubical.

A. System Setup

A cube or a small room is installed with the sensors on the walls and on the floor. A minimum of 4 sensors are employed on each wall. As the person enters the room, these sensors detect the presence of the metal based on the region they are located, then gives audio and LED indications. Presence of metals is detected using the pulse induction metal detector and the on board Pi camera captures the images upon detection of metals. Figure 1 shows the system setup.

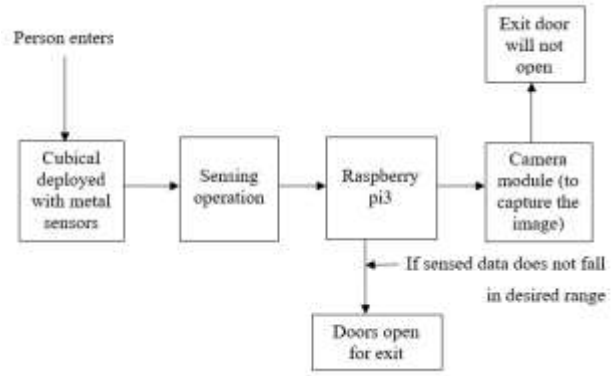

Fig 1. System Setup

B. Sensor Operation

The necessary hardware utilized are Raspberry Pi 3, 8GB SD Card, Ethernet or Wi-Fi, Pi Camera (v3 model), LED Array, Pulse Induction metal detectors, IR Communication using Arduino UNO. Figure 2 shows the Raspberry Pi 3 Model B board.

Fig 2. Raspberry Pi 3 Model B

Details of Raspberry pi 3: It consists of a series of small single-board computers. The B Model uses Broadcom BCM2387 SoC. It operates with a clock of 1.2 GHz and has a 64-bit Quad-core ARM Cortex-A53 processor, with a 512 KB shared L2 cache. The Raspberry pi 3 Model B board supports 802.11 b/g/n Wireless LAN and Bluetooth 4.1 (Bluetooth Classic and LE). The board has dual Core Video Core IV Multimedia Co-Processor. It provides Open GL ES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high-profile decode. It has 1GB LPDDR2 memory. It boots from Micro SD card, running a version of the Linux operating system or Windows 10 IoT. The board has four built-in USB ports. It has Memory Card slot for push/pull Micro SDIO. The board dimension is around 85 x 56 x 17mm. The Raspberry Pi 3 Model B board contains 40-pin 2.54 mm expansion header, providing 27 GPIO pins along with supply and GND lines [7].

Pi camera v3 model: MP, 1080P camera to capture images from the cubical once metal detected. The v3 Camera Module has a Sony IMX219 5- Megapixel Sensor. The Raspberry pi 3 v3 camera module delivers outstanding photographs. The v3 camera module attaches to Raspberry pi through dedicated CSI (Camera Serial Interface) interface. The CSI bus is capable of carrying the pixel data to the processor [8]. Figure 3 shows the Pi camera model.

Fig 3. Pi camera v3 model

IR Communication sensors: Operates for entry and exit Helps in power saving. The data from transmitter side is modulated at 38 kHz before transmission. The TSOP1738 is an IR Receiver with the capability to demodulate signals that have been modulated at a frequency of 38 kHz. Any other TSOP17xx receiver like the TSOP1730 can also be used instead of TSOP1738. The only difference is the carrier frequency that it can demodulate. For example, TSOP1730 can demodulate signals that have carrier frequency 30 kHz. Corresponding changes in the modulation scheme need to be made at the transmitter side if TSOP1730 or some other receiver is used. Figure 4 shows the IR transmitter and Receiver configuration.

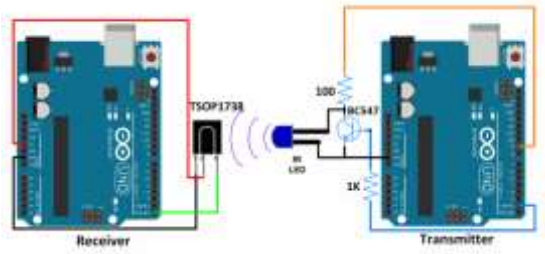

Fig 4. IR transmitter and Receiver

Pulse induction-based metal detector sensor: Embedded sensor for detection of metal article. The pulse induction metal detectors can detect metal targets approaching the sensor, without physical contact with the target. These detectors make use of electromagnetic field that penetrates through the target. The detector consists of an oscillator that generates a high frequency electromagnetic field. This field is radiating from the sensing face of the system. When this field contacts a conducting metal target, a small current is induced within the metal target. These currents will generate their own electromagnetic field that interferes with the field originating from the system. This causes a change in the amplitude of the oscillations of the signals from the system [10]. Figure 5 shows the pulse induction based metal detection circuit.

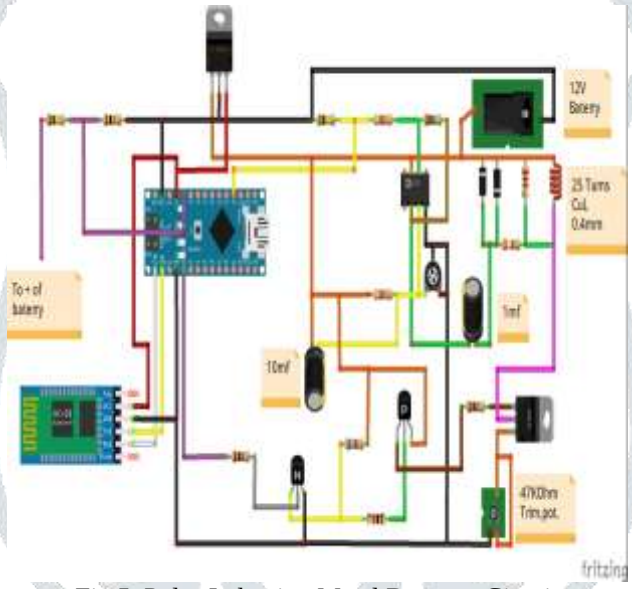

Fig 5. Pulse Induction Metal Detector Circuit

Block diagram of the implementation is shown in Figure 6. The LED array: Helps in locating the pin-point location of the metal article, 8 GB SD card Works as on chip database, for demo purpose and Wi-Fi or Ethernet helps raspberry pi 3 to connect with remotely located database.

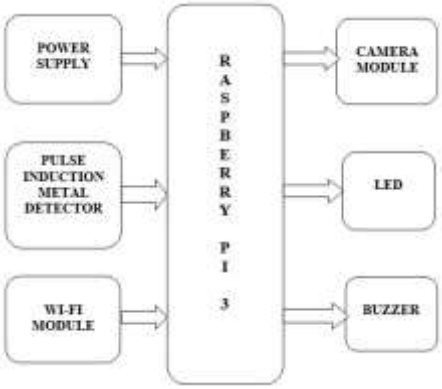

Fig 6. Block Diagram

Operational procedure: The moment when a person will proceed for scanning operation, pair of IR sensors kept at a distance of utmost 1 meter will activate the sensing circuit, once the line of sight communication breaks between IR transmitter & receiver. This is adopted to save the power used to run the circuit. Once the connection breaks the circuit will be activated and sensors are energized. They perform scanning and if any illegit metal article is found, the sensor will send the corresponding information to the raspberry pi 3. Raspberry Pi 3 Model B can handle Python IDE 3.0. So the Raspberry Pi is programmed in such a way that the "detect Metal" function reads the digital value from the input pin and then prints the value out. The state variable will have 2 values which

is 1 or true. So if it is true, Buzzer is made ON, LED is ON and Pi camera captures the image of metal detected person and stores it in SD card (temporary database). In addition to this, the doors will be locked when metal borne person is found. For prototype, the solenoid locks were used to lock the door [8]. RPI.GPIO library is imported to get the input value. Pi-camera library is imported to capture the photo of an intruder. On the other hand, if person is found clean the door will open and another pair of the IR sensors operating at a distance of 0.2 meters will de-energize the circuit, once the person breaks the line of sight communication between the IR sensors. Figure 7 shows the flow chart for capturing the image.

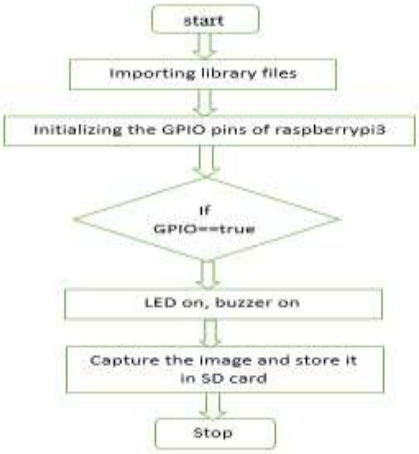

Fig 7. Flow chart for image capturing

IV. FORMAL VERIFICATION

For better implementation, formal verification is required to prove or disprove the correctness of a proposed scheme. Therefore, formal verification is done on two cases.

Case 1: By scanning a person with a metal object such as knife in his shoes. Once this person crossed the IR LOS communication the circuit is energized and upon entering the cubical the circuit sensed the metal at the ankles which resulted in alarming the raspberry pi to lock the door and turned the LED and buzzers on and also captured the picture of the person inside the cubical.

Case 2: By scanning a person carrying no metal objects. Once the person entered the cubical, he is scanned and upon finding no metal raspberry pi opens the door for him no alarming or capturing of picture is noticed

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V. CONCLUSION

The primary objective of this proposal is to implement the efficient way of scanning large number of people in very less amount of time and also to have the scanning operation done without the human intervention. As the existing metal detectors can detect up to millimeter range whereas, this scheme is aimed at scanning range up to greater margins of 1 meter to 5 meters. Therefore, this prototype will be efficient, less time consuming and will have a greater application if it is employed for explosives and landmine detections as future scope.

ACKNOWLEDGMENTS

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