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Mechatronics (ME3254)

Course Project

**Security System using RFID & Temperature Sensing with Sanitizer
Dispenser**

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SR.NO	CONTENT	PAGE.NO.
1.	ACKNOWLEDGEMENT	3
2.	ABSTRACT	4
3.	INTRODUCTION	4
4.	LITERATURE REVIEW	5
5.	SENSORS & ACTUATORS	5
6.	METHODOLOGY	8
7.	RESULTS & DISCUSSION	9
8.	COMPARISON & COSTING	11
9.	CONCLUSION	13
10.	REFERENCES	13

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Group Members

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Abstract

The design and development of an economic, contactless sanitization and employee identification security system is presented in this paper. Personnel authorization is done using Radio Frequency Identification (RFID) with its data stored using the Internet of Things (IoT) over Wi-Fi using ESP8266 NodeMCU and sanitizer is dispensed when hands are detected by the Infrared sensor. This economic system will help to reduce human interaction while temperature scanning and employee authorization such as in educational & financial institutes, residential buildings, and industries.

Keywords: RFID, ESP8266 NodeMCU, Infrared sensor, IoT, contactless, sanitization, security.

I. Introduction

Internet of Things (IoT) is the networking of physical devices that contain electronics embedded within their system to communicate and sense interactions amongst each other or with respect to the external environment. In recent years, the IoT has gained a significant importance in the field of academic and industrial disciplines, and majorly in the healthcare sector. Before the Internet of Things, patients' interactions with doctors were limited to visits and text communications. IoT enabled devices to have made remote monitoring in the healthcare sector possible and cost effective also. During the COVID-19 pandemic in the whole world, contactless and less human interaction as far as possible has been an important precautionary measure to consider for many organizations such as industries and institutes.

Many technologies have prevailed for employee identification over the past few years like radio frequency identification, biometric scanner, retinal scanner out of which the biometric is being most widely used. During this COVID-19 pandemic, use of biometric is very dangerous and leads to spread of the coronavirus. On the other hand, retinal scan, being contactless, is a highly dependable technology because it is highly accurate and difficult to hack, in terms of identification. The application of the retinal scanner is very limited due to its cost. They are mainly used for physical access applications and are usually used in environments requiring exceptionally high degrees of security and accountability such as high-level government, military, and classified research centers. Recently, the most common, and less expensive contactless solution for identification is the RFID system. A typical RFID system consists of tags and readers. A RFID tag consists of a microchip that stores a unique sequence identifier that is useful in identifying objects individually, an antenna for receiving and transmitting the signal and a substrate. RFID reader uses radio waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data.

Thermal imaging systems and non-contact infrared thermometers, which are non-contact temperature assessment devices, may be used to measure a person's temperature. A corona infected person may have an elevated temperature and human contact or interaction with that person should be avoided. So non-contact temperature assessment devices such as infrared thermometers which commonly use a temperature sensor (Mlx90614) for scanning temperature.

In this paper we will see the detailed design and development of economic, contactless sanitization and employee identification security systems targeted for educational & financial institutes, residential buildings, and industries

II. Literature review

[1] “Non-contact temperature reader with sanitizer dispenser” presents the design and development of a non-contact temperature reader with a sanitizer dispenser. The system is intended to help control the spread of SARS-CoV-2 infection and maintain the community's health and reduce the negative impact of the coronavirus. The project is divided into two subsystems: The temperature reader (TR) and the Sanitizer dispenser (SD) controlled by a common microcontroller. The temperature reader is designed and developed to perform comparably with the existing thermometers or temperature measuring devices. It provides visual and aural alerts when the temperature exceeds the critical body temperature. The Sanitizer dispenser is designed and developed to dispense appropriate amounts of sanitizer when activated.

[2] “Design and Implementation of a smart hand sanitizer dispenser with door controller using ATMEGA328P” aims to design and implement a low-cost smart hand sanitizer dispenser with door controller based on ATMEGA328P microcontroller, electromagnetic lock and ultrasonic sensor that can help solve the challenges faced by security guards at different stations such as bank doors, school gates, hospital gates etc. in enforcing this hand sanitizing action.

[3]” Design of Automatic hand sanitizer with temperature sensing” aims at designing and developing an automatic hand sanitizer with contacted temperature sensing. The design has been done for easy installation of the hardware across the globe. The design encompasses a few parameters such as installation of temperature sensor, LCD, ultrasonic and PIR sensors, spray pumps and submersible pumps. The ultrasonic and PIR sensors detect the human hand /object; when the sensors are activated the sanitizer is dispensed. The temperature sensor senses the body temperature as soon as it is touched, and the temperature is displayed. If the temperature sensed is above the normal body temperature, an alert is given by the system.

III. Sensors and Actuators

Employee Identification

Employee identification process is carried out using RC522 RFID reader and RFID tags. The module operates 13.56MHz which is an industrial (ISM) band. The reader can read data only from passive tags that operate on 13.56MHz with maximum data rate of 10Mbps and has range of up to 50mm.

Radio-Frequency Identification (RFID)

Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number can be used to track inventory goods.

There are two types of RFID tags:

Passive tags are powered by energy from the RFID reader's interrogating radio waves.

Active tags are powered by a battery and thus can be read at a greater range from the RFID reader, up to hundreds of meters.

RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line, RFID-tagged pharmaceuticals can be tracked through warehouses, and implanting RFID microchips in livestock and pets enables positive identification of animals. Tags can also be used in shops to expedite checkout, and to prevent theft by customers and employees.

Since RFID tags can be attached to physical money, clothing, and possessions, or implanted in animals and people, the possibility of reading personally-linked information without consent has raised serious privacy concerns. These concerns resulted in standard specifications development addressing privacy and security issues. ISO/IEC 18000 and ISO/IEC 29167 use on-chip cryptography methods for untrace ability, tag and reader authentication, and over-the-air privacy. ISO/IEC 20248 specifies a digital signature data structure for RFID and barcodes providing data, source and read method authenticity. This work is done within ISO/IEC JTC 1/SC 31 Automatic identification and data capture techniques.

Temperature sensor:

Infrared temperature sensors sense electromagnetic waves in the 700 nm to 14,000 nm range. While the infrared spectrum extends up to 1,000,000 nm, IR temperature sensors do not measure above 14,000 nm. These sensors work by focusing the infrared energy emitted by an object onto one or more photodetectors.

These photodetectors convert that energy into an electrical signal, which is proportional to the infrared energy emitted by the object. Because the emitted infrared energy of any object is proportional to its temperature, the electrical signal provides an accurate reading of the temperature of the object that it is pointed at. The infrared signals are passed into the sensor through a window made out of specialty plastic. While plastic normally does not allow infrared frequencies to pass through it, the sensors use a form that is transparent to particular frequencies. This plastic filter out unwanted frequencies and protects the electronics inside the sensor from dust, dirt, and other foreign objects.

Advantages of IR Temperature Sensors

IR sensors read moving objects. Contact-based temperature sensors do not work well on moving objects. Infrared temperature sensors are ideally suited for measuring the temperatures of tires, brakes, and similar devices.

IR sensors don't wear. No contact means no friction. Infrared sensors experience no wear and tear and consequently have longer operating lives.

IR sensors can provide more detail. An IR sensor can provide greater detail during a measurement than contact devices, simply by pointing it at different spots on the object being read.

IR sensors can be used to detect motion by measuring fluctuations in temperature in the field of view.

For high precision non-contact temperature measurement, MLX90614 Non-Contact IR temperature sensor is used which is calibrated in wide temperature range that is -40 to 125 °C for sensor temperature and -70 to 380 °C for object temperature having accuracy of ± 0.5 °C.

NodeMCU ESP8266

NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit).[8] The term "NodeMCU" strictly speaking refers to the firmware rather than the associated development kits.[citation needed]

Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua cJSON[9] and SPIFFS.[10] Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications.

Specifications

Microcontroller: ESP8266 Tensilica 32-bit RISC CPU Xtensa LX106

Operating Voltage: 3.3V

Input Voltage: 7-12V

Digital I/O Pins (DIO): 16

Analog Input Pins (ADC): 1

Flash Memory: 4 MB

SRAM: 64 KB/128 KB

Clock Speed: 80 MHz

USB-TTL based on CP2102 is included onboard, Enabling Plug n Play

PCB Antenna

Hand Detection & Sanitization

Hand is to be detected to dispense sanitizer. Hand detection is done with the help of Infrared Proximity Sensor which has a proximity range of up to 200mm and set here of about 120mm to avoid interference. For sanitization, a 0.36W horizontal motor pump is used having a flow rate of 100 L/hr. When Infrared Proximity Sensor detects the hand the motor pump is actuated for 't' secs and sanitizer is pumped and dispensed through the nozzle.

Calculation for 't':

Maximum flow rate of pump = 100 L/hr. = 27.8 ml/sec.

Ideal amount of sanitizer required for disinfection = 2.5 – 3 ml

So, the pump is actuated for approximately = 0.11 sec = 110 milliseconds

IV. Methodology

Algorithm:

- A. When power is supplied to the system and if no RFID card is detected, the LCD displays a message to scan the card.
- B. The RFID card is to be placed on the RFID card reader and at the same time the temperature sensor scans the body temperature.
- C. If authorized personnel scan their card the LCD displays that the employee is authorized and displays the body temperature of that person. If the body temperature is within the limits (according to the WHO guidelines) the LCD displays temperature is 'OK'.
- D. If the card is of unauthorized personnel, then the LCD displays 'Unauthorized' also if the temperature is not within the limits the LCD displays 'Alert'.
- E. The LCD then displays to 'Sanitize your hands'. The respective personnel should place their hand below the sanitizer dispenser where the infrared sensor will detect the hand through which the pump is operated, and sanitizer is dispensed.
- F. Only when the body temperature of authorized personnel is within the limits and has used the sanitizer then the system opens the door, and the person is allowed to enter. G. This above data (Name, date, time, body temperature, within the limits or not, have used sanitizer or not, is stored and sent to the main server through Wi-Fi and stored in a google sheet.

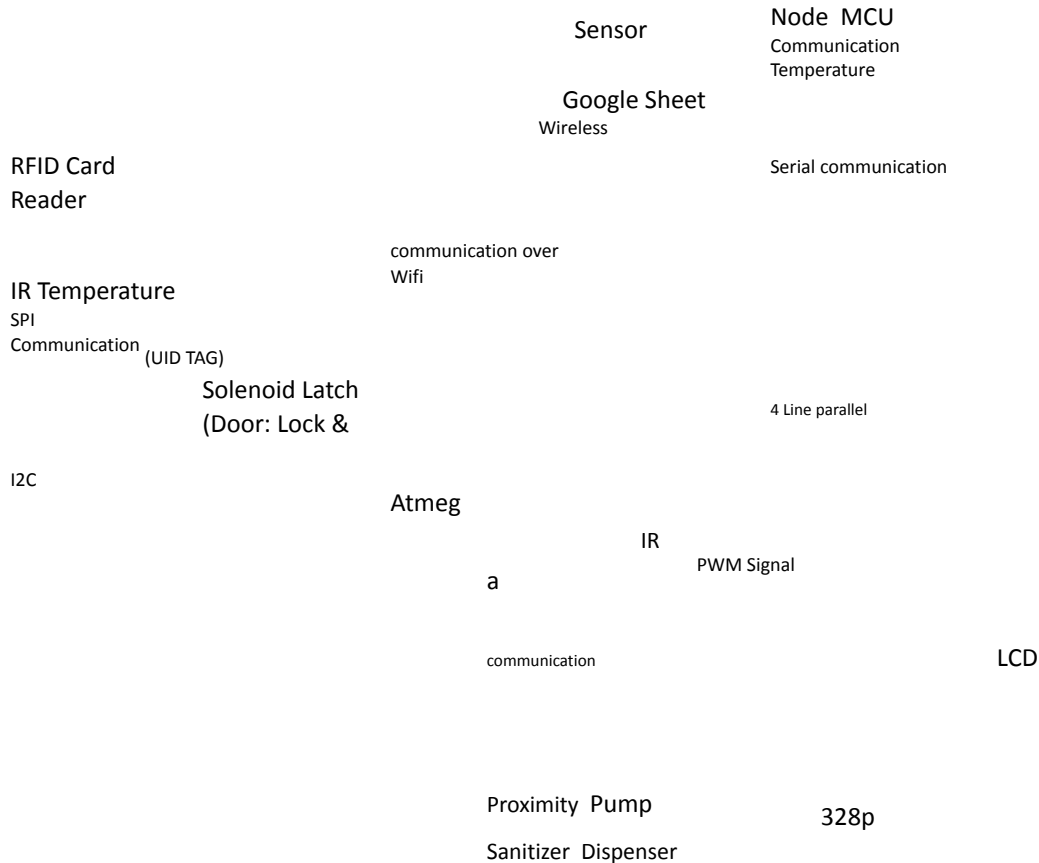


Fig 1: Block diagram of circuit.

VI. Comparison & Costing

Comparing the RFID module with the other systems like Biometric and Retina scanner which are recently used technologies. But due to the pandemic Biometric system is dangerous, it can be the cause of the spread of coronavirus and also comparing on the basis of cost RFID is pretty cheap, RC522 (RFID Module) costs ₹100 while, Optical sensor (Fingerprint) in Biometrics costs ₹3000 and ISD1820 (Microphone) module cost is ₹140. And for Retina scanners the price is ₹20,000 very expensive and these are mostly used in high security places.

PARAMETERS	RFID	Biometrics and Retinal
Contactless	yes	No - fingerprint. Yes- retinal
Size	Less and compact.	Large
Data Storage	less	More data is required
Response time	Less	More
Price	Less	More

These systems are found in various applications according to the requirements. The application of the retinal scanner is very limited due to its cost. They are mainly used for physical access applications and are usually used in environments requiring exceptionally high degrees of security and accountability such as high-level government, military, and classified research centers. One of the more common uses of RFID technology is through the microchipping of pets or pet chips. These microchips are implanted by veterinarians and contain information pertaining to the pet including their name, medical records, and contact information for their owners. If a pet goes missing and is turned into a rescue or shelter, the shelter worker scans the animal for a microchip. If the pet has a microchip, the shelter worker will only be a quick phone call or internet search away from being able to contact the pet's owners. Pet chips are thought to be more reliable than collars, which can fall off or be removed.

RFID	Biometric	Retina scanner
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Companies	Companies	Government Agencies
Label tagging	Vehicle access authentication	Military
Hotel Lodgings	Mobile phone access	Classified research centers
Schools/Institutes	Schools/Institutes	
Banks		

Component	Specification	Quantity	Total Price
RFID Module	RC522	1	₹100
RFID Card	ISO/IEC 14443	1	₹15
Arduino	Atmega328p	1	₹450
IR Temperature Sensor	Mlx90614	1	₹750
LCD	LM016L (16x2)	1	₹165
NodeMCU	ESP8266	1	₹230

Motor Pump	Power rating: 0.36W Max Flow rate: 100L/hr.	1	₹120
Total (approx.)			₹1830

VII. Conclusion

With the help of the economic security system proposed in this paper, it is possible to avoid great risks of viral transmission and obtain an efficient solution for automatic sanitizer dispensing and non - contact temperature measurement systems. The use of IoT will help the owner or manager to access the data from anywhere in the world and to keep and maintain a record.

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