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Smart Toolbox using RFID

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Abstract -As tool misplacing in industry has led to efficiency loss of 20-25% of working hours, tool control is must for the industries not only to prevent misplace of tools in the industry but also to boost the effectiveness of the work. RFID-Enabled Smart toolbox system has the capability of streamlining storage and inventory management services. It records employee time-in and time-out details and proximity to determine a tool's position and its allotted user. This system gives accountability for every tool used by an employee and if the respective tool is found to be misplaced, and the database keeps a record of the tool last being assigned to.

Key Words*:*RFID Tag, Proximity sensor.

1.INTRODUCTION

The RFID Smart Tool Box makes use of RFID technology to keep track of all tools without hindrance to the usage of the tools. It is capable of tracking all kinds of tools, regardless of whether they are metal, non-metal, big or small. The toolbox can be used for the storage and retrieval of equipments that require management of asset 24×7, and with such system, manpower can be significantly reduced and operations can proceed without being delayed.

RFID system mainly consists of three components and they are RF (radio frequency) tags, RF readers, Database server .Tags contain a unique identifier and are embedded in plastic cards or tokens. The RFID reader constantly emits short range radio frequency field through its antenna. When the card comes within range of the reader, an electric current is induced, activating the tag. The tag communicates its UID to the reader, which grants or deny access. The details of the card is stored in the database.

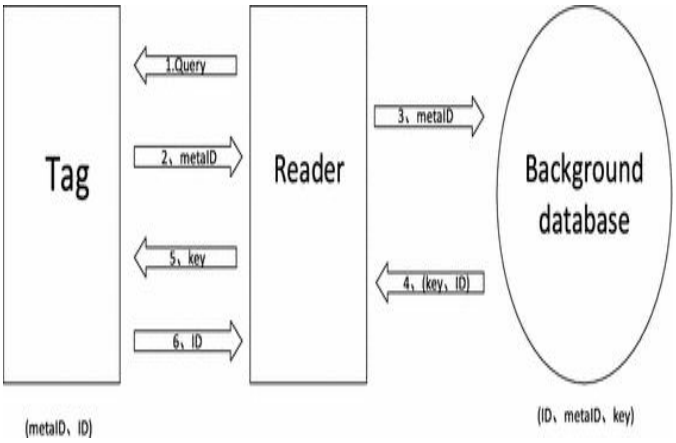

Fig1.1: RFID authentication

Contactless detection of the tools is done by proximity sensors in the tool vicinity. It usually detects the object/tool by making use of electromagnetic waves. Proximity sensors have a high reliability and long functional life. The sensor converts the information if the object/tool is present/absent into electrical signals. IR sensors can be used for proximity and distance approximation by varying light reflected intensities.

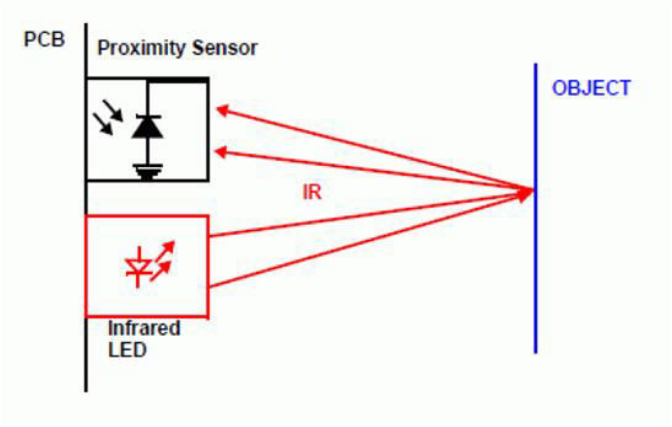

Fig 1.2: Proximity Detection Model

2. LITERATURE REVIEW

An embedded system for practical security using contact less smart cards which uses RFID technology is briefly analysed. A flexible low level reader and ISO 14443 tags have been successfully tested. This tool design is built using electronic hobbyist equipment[1]. The classification of RFID devices into two base categories as active and passive is explained. These categorization is based on power supply infrastructure or integrated battery environment[2]. Advancement in the field of RFID systems that involves anti- tamper technology constructed using capacitor and conductive materials is explained. It explains RFID tags with a new anti-tamper able system which is constructed using capacitors and conductive members[3]. Unclonable environmentally sensitive chip-less RFID tags with a plurality of slot resonator system is studied. It embodies and provides information on using unclonable chip-less RFID which are a more secure way of accessing data or permission granting applications[4]. The lock system consists of a detection unit positioned proximate to a lock system. This system consists of a micro-controller which is used for identifying information gathered and access granting to a specified restricted RFID tag[5]. Inventory control system uses RFID technology for automatic monitoring the taking and returning of items such as tools, weapons, jewelry, surgical instruments, etc., from one or more container and to maintain a status of each item as well as to keep a record of each item[6]. Smart box application principles based on the location of asset is examined thoroughly. It explains the asset box application based on the position of object and used to represent various items or persons related to the box for various applications[7].

3. METHODOLOGY

Smart Toolbox is implemented to signify the idea of automatic and unobtrusive content monitoring with the help of RFID technology. The RFID tags will be attached to all the tools. The box will be furnished with RFID readers and antenna. The identification of the toolbox inas well as the identification of every tool will be written on each RFID tag, which says, the toolbox can genuinely identify all the tools that are in the toolbox at any given moment and automatically execute the routine and base completeness check. The smart toolbox works autonomously and it sends the information about the tool usage and examines wirelessly to the tool management system.

RFID reader is a low frequency reader that is connected to the computer through USB cable. We are using RFID-RC522 reader that uses SPI for communication. This card reader and the tags communicate using a 13.56 MHz electromagnetic field. The RFID tag will be scanned from the reader and the information embedded on the tag will be transferred to the system to allow data handling. SD card module is used to store the data base. Employee information which consists of details like employee name, unique number, tag ID will be stored in the system. RTC (real time clock systems) are used to keep track of the log in and log out details.

Since we require more input and output pins, we are using Arduino mega 2560 with more memory space to interface with RFID-RC522. Wi-Fi module is used to provide connectivity and give access to the microcontroller to the network. External part of the circuit will be door lock with relay. Relay is enabled by the RFID card and it works with delay counts. Voltage regulator is used along with the relay to control and monitor the voltage parameters. Arduino IDE software is used for interfacing where programming can be done in C or C++. Proximity sensor detects the proximity of the tools in the box. Code is written for the door lock in such a way to give access only when the data read by the reader matches with the stored data base. LEDs are used to indicate the missing tools where infrared beam will be used to detect the presence.

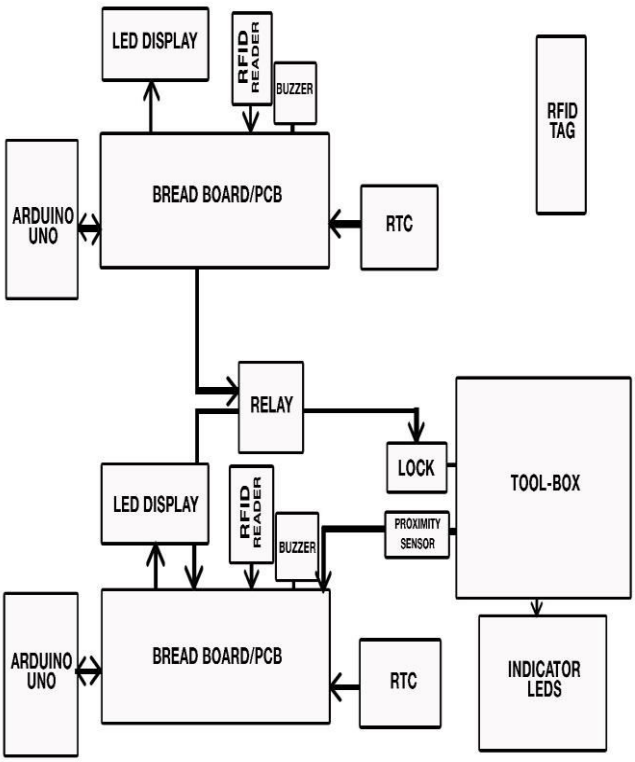

Fig 2.1: Block diagram of smart tool box

4. RESULTS AND DISCUSSION

The process of identification and authentication is based on RFID detection of tags and collecting its stored information into a determined format of database. RFID tags are attached to both the employer tags and tools for identification. The steps involved in successful operation of this system is shown in the following steps below:

A. RFID Detection and Authentication Process

The required information of allowed employees and tools are stored in the database in the form of a google datasheet on real time database system such as Firebase. The successful detection of a tag and improper detection of a tag are demonstrated in the figures.

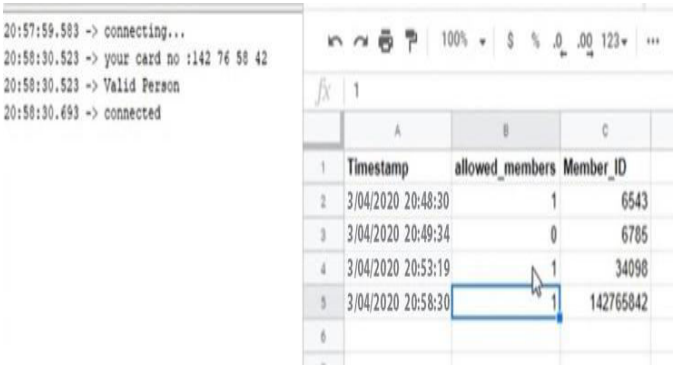

Fig: 3.1.1

The figure 3.1.1 shows the detection and storage of RFID tag information in a google sheet and allowing access to authenticated ID. For a wrong or false detection, the access is not granted but the information is stored in the database as shown in figure 3.1.2.

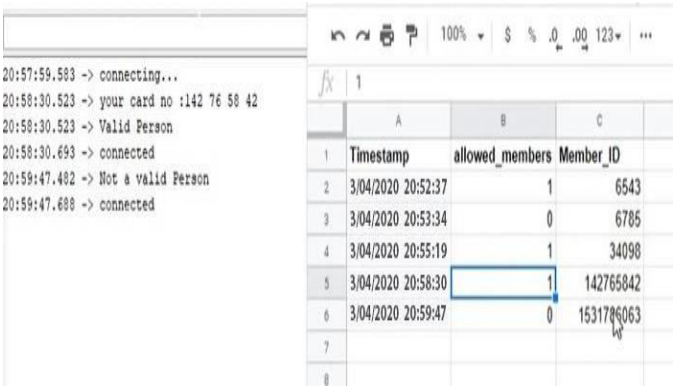

Fig : 3.1.2

B. Tool Detection

A circuit of proximity sensors are used to know the status of each tool present in the toolbox or shelf to give live status of each tool position and status .The presence and absence of a tool is shown to the employees using a set of LED lights which glow to show presence and are off to show absence in the tool box.

The figure 3.2.1 shows the LED status when all the tools are present in the toolbox and they give a visual representation to the user and maximize efficiency.

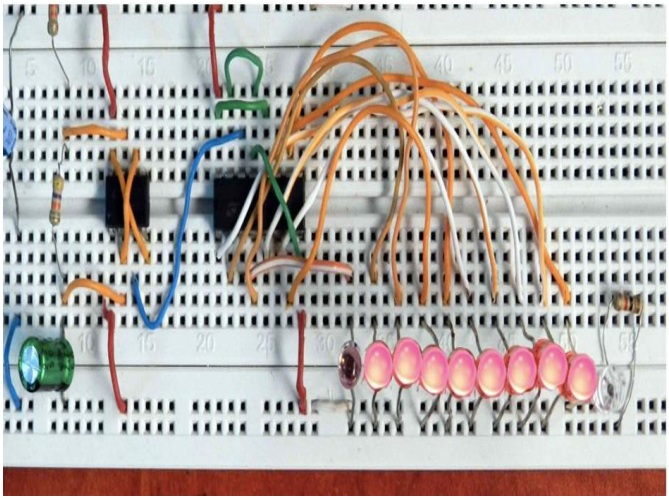

Fig : 3.2.1

Thefigure 3.2.1 shows the user availability of tools in the tool chest at any given moment of time and LED turns off when tools are taken from the toolbox. The figure 3.2.2 shows the status of LED after 2 tools have been taken from the box.

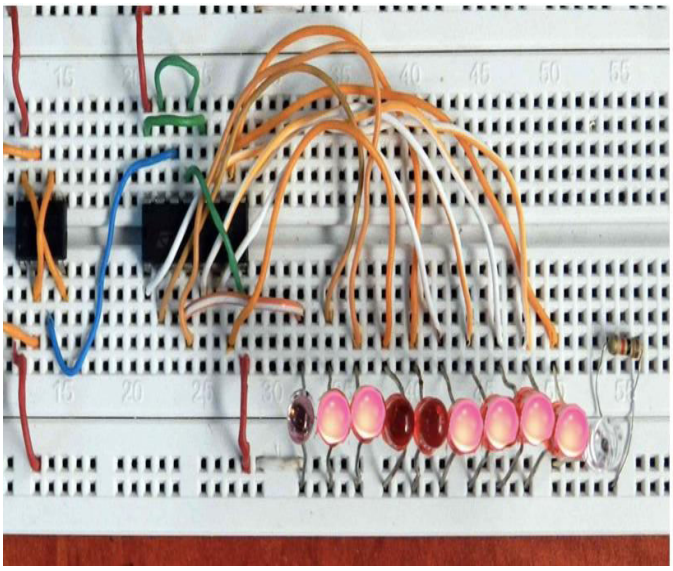

Fig :3.2.2

c. Data Updation on Real Time Database

The status of tools in the box are physically known by observing the LED lights ON/OFF status but to keep a record of the tool movement in a systematic method we use a table format. The table stores the details of type of tool taken, tool position and employee ID who has procured the tool and is using it. The figure 3.3.1 shows the database table when all the tools are inside the toolbox.

Table 1

NAME:	IN/OUT	ID
• (2) 3/8 in. Drive 6 point Spark Plug Sockets: (1) 3/4 in., (1) 13/16 in.	IN	-
• (1) 3/8 in. Drive Universal Joint	IN	-
• (1) 1/4 in. Drive Universal Joint	IN	-
• (1) 3/8 in. Drive 3" Extension	IN	-
• (1) 1/4 in. Drive 3 in. Extension	IN	-
• (1) 3/8 in. to 1/4 in. Drive Adapter	IN	-
• (1) 3/8 in. Drive 6 in. Extension	IN	-

Fig :3.3.1

The above figure shows the table when no employee has accessed the tools hence the ID column is NIL or empty. When the employee accesses the tools the respective ID is stored in the respective columns as shown in figure 3.3.2.

Table 1

NAME:	IN/OUT	ID
• (2) 3/8 in. Drive 6 point Spark Plug Sockets: (1) 3/4 in., (1) 13/16 in.	IN	
• (1) 3/8 in. Drive Universal Joint	IN	-
• (1) 1/4 in. Drive Universal Joint	IN	-
• (1) 3/8 in. Drive 3" Extension	OUT	142765842
• (1) 1/4 in. Drive 3 in. Extension	OUT	1531786063
• (1) 3/8 in. to 1/4 in. Drive Adapter	IN	-
• (1) 3/8 in. Drive 6 in. Extension	IN	-

Fig :3.3.2

Here , we observe the tool which has been taken has ID referenced to it and hence helps Admins and office staff keep a track of daily usage and also gives knowledge of who is using what tool at a given point of time. The above figuresshow theconcept for a small dataset but the same principles can be applied to a larger application in industries.

5. CONCLUSIONS

Several applications of RFID technology and different methods of tracking and monitoring tools in the industry have been studied. Observing the perks and limitations of the technologies used in the smart tool box it is found that thesystem proposed above is more advantageous. It is observed that only 10% of the industries have fully developed tool control which costs 50,000/- INR. The use of proximity sensor and RFID technology has made the system cost effective and has helped in accessing the user and tool information by a contactless method and authenticate data with information backend database. According to the survey done, it is noted that tool quality and control issues costs industry over 4,00,000-5,00,000 INR every year due to lost tools, broken tools, etc. By employing the system proposed above in the industry, the capital spent on the tool control can be reduced. An integrated system like this can reduce toolbox replacement from every 3-4 months to more than once a year. This system can increase the work efficiency by 20-25%. Also it is customizable on the existing tool box according to customer and industrial needs. Therefore, implementation of this system in industry is a viable solution.

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