RFID Attendance System

Pasquale Cardillo
Computer Science Department
Colorado State University
Fort Collins
pcard@colostate.edu

Hermela Darebo
Computer Science Department
Colorado State University
Fort Collins
hermelad@colostate.edu

Hinzan Diarrassouba
Computer Science Department
Colorado State University
Fort Collins
hinzan@colostate.edu

***Abstract*— This paper describes an implementation of RFID as a tool for keeping track of attendance. RFID is a radio-frequency identification system. It usually comes in the form of a device used to detect physical tags with information on them. Once detected, information can be extracted for whatever purpose is intended. The tag can come in the form of a card that can be scanned by the RFID device. This can and has been used to keep track of attendance/inventory in different institutions, especially the school system. With this implementation, teachers can take attendance of students much more quickly than before. It is an advantage over barcodes or manually inputting information as the tags can be read instantaneously and in groups as opposed to one by one. This paper also outlines out own implementation of this system. We were able to have tags be scanned by a RFID reader and inserted into a database that kept track of information such as the unique ID that comes with each tag and the time that it was scanned.**

I. Introduction

Education is an important part of modern society, and it has seen many transformations over the years as the world evolves and technology changes. As a result, many new approaches to organizing every day functions have been produced to simply the schooling process. EdTech, education technology, has led classrooms to become advanced technological spaces with an abundance of learning tools in place of the traditional way of having to rely on computer labs.

One of the great improvements seen in education in recent years has been the upcoming of the radio-frequency identification system (RFID). RFID itself has been an established system for years. It is utilized in multiple settings such as hospitals, libraries, airports are any other secure environment.

II. Background

RFID uses electromagnetic fields to find and keep track of identifiers that are assigned to objects [5]. The 3 main components are a radio transponder, radio receiver and transmitter. When activated, the identifier/tag of the object sends digital data to the reader. This is what is used to keep track of information. It can be used to keep track of people or inventory of goods or even progress in an assembly line.

The first instance of RFID was Mario Cardullo's device. It came out to simplify transportation, banking (credit cards), security (identification and doorways) and medicine (patient histories) to identify, automate and survey for consumers.

RFIDs can be broken down into 3 types depending on the reader.

1. PRAT: Consists of a passive reader and an active tag. The reader receives signals from battery powered tags.
2. ARPT: Consists of active reader and passive tag. The reader sends and receives signals from tag.
3. ARAT: Consists of an active reader and an active tag. The tag is initiated by a signal from the reader.

Communication between the tag and reader is done in multiple ways. It all depends on the radio frequency that the tag uses. The reader can identify when the tag is attempting to communicate when the tag switches between high and low frequencies.

An electronic product code is usually stored in tags. It is a 96-bit string which contains information from the tag [5]. The first 8 bits are used to identity the protocol. The next 28 are used to identify the source of the data from the tag. The next 24 give an object that identify the product. The final 36 bits are the unique serial number for the tag.

Usually, the reader will initiate an interaction between the two by sending a signal and only particular tags with the correct EPC can communicate back.

The RFID tool can be used to track information, tools, and other assets. It is an advantage over manual systems as the tag with all the information can be read if brought near a reader even if covered by something. This is extremely useful in commerce, transportation, and institutions such as libraries.

In commerce, it can be used to keep track and inventory and even help prevent theft. These are the tags that are placed on items like shirts that cannot be removed unless the item is legitimately purchased.

In transportation, tags can be used to handle bus fares, electric scooter locks, and Zipcars.

Raspberry Pi:
The raspberry pi was one of the main components used in this project. The raspberry pi is a small single-board computer which was first introduced in 2012. It was inspired by the BBC Micro and then later became a very effective way for many different people to discover computers and explore their interests [6]. The raspberry pi is cost effective and because of this it was used in the promotion of teaching the basis of computer science in schools.
Libraries use RFID to libraries to check out books. Multiple books can be read at the same time as the reader only needs to be close to the tags. This overcomes the slow process of scanning each barcode one at a time. Inventory can be managed in seconds with this system.

III. Problem Characterization and Solution

In many schools, the first task is to take attendance, which records crucial information on the number of students present in class as well as how frequently each kid attends each class. In this project we will be working on a way to improve this system.

When taking attendance, the traditional way, teachers may often struggle doing it manually as the process is not instant and each student must be recorded one by one. Even when using regular IDs with a barcode, each ID would need to be scanned one by one which may take a large amount of time depending on the size of the classroom. Also, the data that can be stored on a barcode is very limited since the lines are finite. Barcodes with actual texts are also subject to human error, so information placed into the system can be wrong.

The process of manually recording attendance in each classroom can take a significant amount of time. We will be using an RFID attendance keeper to make this process more efficient. Additionally, it will reduce all errors in the process of keeping track of attendance.

Using an RFID attendance keeper to make this procedure more streamlines will lead to an increase in the quality of learning and make better use of time in the classroom.

A basic attendance system that would record the attendance of around 25 people, would generally cost $500 to $750. More complex software and equipment with features like employee scheduling and payroll integration run anywhere from $2,000 to $4,000 [3].

An attendance monitor can be highly helpful in a variety of settings, including workplaces, in addition to schools. It is incredibly adaptable and can be used for many different applications because it stores very important data like the specific id number and time.

There are many more issues that RFID can help fight against in the school attendance system.

Since data is encrypted and locked, it provides an additional layer of security to the day-to-day operations in a school for both the staff and students. Also, attendance can be examined very closely and instantaneously due to the nature of RFID so no student or staff can enter or leave a school without the system taking notice. This decreases a lot of risk with student safety [4].

Since readers can read many tags at once very quickly, student information can be updated and delivered to parents or any other party more quickly than if the information was manually entered or via barcode.

It is proven that keeping track of attendance within schools can greatly increase academic performance. This has to do with the idea that students would engage less in disciplinary issues knowing that their attendance and information can be tracked live and sent to their guardians [4].

IV. Implementation Strategy

Due to how common our problem is there have been many, many proposed solutions. Ours needed to be different, to stand apart from the others. We achieved this in multiple ways, but most importantly is how lightweight our device is.

The majority of the work is done by a single, incredibly fast, python script:

```python
import mysql.connector as mysql
import time
from mfrc522 import SimpleMFRC522

HOST = "69.164.196.107"

DATABASE = "attendance"

USER = "python"

PASSWORD = "python"

db_connection = mysql.connect(host=HOST, database=DATABASE, user=USER, password=PASSWORD)

print("Connected to :", db_connection.get_server_info())

cursor = db_connection.cursor()

reader = SimpleMFRC522()

while True:
    id, text = reader.read()

    cursor.execute("SELECT id, name FROM users WHERE rfid_uid=" + str(id))
    result = cursor.fetchone()

    if cursor.rowcount >=1:
        cursor.execute("INSERT INTO attendance (user_id) VALUES (%s)", (result[0],))
        db_connection.commit()
    else:
        print("User does not exist")
```

All the python script does is connect to a remote MYSQL database hosted on the cloud, check the rfid chip of the card scanned, compare it to a separate table in the same database (which is configured by an admin using another python script), and if the user is in that table, log the time they clocked in into a different table in the same database.

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print("Connected to :", db_connection.get_server_info())

cursor = db_connection.cursor()

reader = SimpleMFRC522()


id, text = reader.read()

cursor.execute("SELECT id FROM users WHERE rfid_uid="+str(id))
cursor.fetchone()

if cursor.rowcount >= 1:
    sql_insert = "UPDATE users SET name = %s WHERE rfid_uid=%s"
else:
    sql_insert = "INSERT INTO users (name, rfid_uid) VALUES (%s, %s)"

name = input("Name:" )
cursor.execute(sql_insert,(name, id))

db_connection.commit()
```

The second python script is slightly more complicated but is still simple. It starts by doing the same thing as the first script and connects to the remote MySQL database, but this time it's saving users into the "users" table. Then it reads the RFID chip in the card scanned, checks the table to see if the user already exists, if the user already exists it updates that user with a new name. Otherwise, it saves a new user to the table that can be fetched by the second script.

The python on this project was much easier than we originally anticipated so we instead focused our energy on learning SQL so we could configure a remote server by ourselves.

```
+----------+--------------+------+-----+-------------------+-----------------+
| Field    | Type         | Null | Key | Default           | Extra           |
+----------+--------------+------+-----+-------------------+-----------------+
| id       | int unsigned | NO   | PRI | NULL              | auto_increment  |
| rfid_uid | varchar(255) | NO   |     | NULL              |                 |
| name     | varchar(255) | NO   |     | NULL              |                 |
| created  | timestamp    | NO   |     | CURRENT_TIMESTAMP | DEFAULT_GENERATED |
+----------+--------------+------+-----+-------------------+-----------------+
4 rows in set (0.01 sec)

mysql> DESC attendance
    -> ;
+----------+--------------+------+-----+-------------------+-----------------+
| Field    | Type         | Null | Key | Default           | Extra           |
+----------+--------------+------+-----+-------------------+-----------------+
| id       | int unsigned | NO   | PRI | NULL              | auto_increment  |
| user_id  | int unsigned | NO   |     | NULL              |                 |
| clock_in | timestamp    | NO   |     | CURRENT_TIMESTAMP | DEFAULT_GENERATED |
+----------+--------------+------+-----+-------------------+-----------------+
3 rows in set (0.00 sec)
```

The first table is the “users” table and has four fields: the id of the entry in the table (essentially the index of the entries if this was a list). The RFID unique identifier which is a unique 8-byte number for each RFID card and is how the python scripts can differentiate the cards. A name field which is set by the user to keep track more easily of who’s in the database since names are easier for humans than an 8-byte int. Finally, a timestamp which is automatically fetched when the card is read and inserted into the table.

The second table is the “attendance” table and keeps track of the times that people clocked into the attendance system with their RFID cards. The four three fields are: an id or index for each entry into the table, a user id which matches the index of the user in the “users” table, and the time they clocked in, which is an automatically inserted timestamp upon clocking in.

That’s it for the software implementation, now onto the hardware implementation. This device uses a raspberry pi 4, a breadboard and breadboard wires, and an MFRC522 RFID reader/writer. Looking at the datasheet for the device told us which pins on the pi connected to the header pins on the MFRC522.

Pin	Symbol	Type[1]	Description
16	VMID	P	internal reference voltage
17	RX	I	RF signal input
18	AVSS	G	analog ground
19	AUX1	O	auxiliary outputs for test purposes
20	AUX2	O	auxiliary outputs for test purposes
21	OSCIN	I	crystal oscillator inverting amplifier input; also the input for an externally generated (f_{ck} = 27.12 MHz)
22	OSCOUT	O	crystal oscillator inverting amplifier output
23	IRQ	O	interrupt request output: indicates an interrupt event
24	SDA	I/O	I²C-bus serial data line input/output[2]
	NSS	I	SPI signal input[2]
	RX	I	UART address input[2]
25	D1	I/O	test port[2]
	ADR_5	I/O	I²C-bus address 5 input[2]
26	D2	I/O	test port
	ADR_4	I	I²C-bus address 4 input[2]
27	D3	I/O	test port
	ADR_3	I	I²C-bus address 3 input[2]
28	D4	I/O	test port
	ADR_2	I	I²C-bus address 2 input[2]
29	D5	I/O	test port
	ADR_1	I	I²C-bus address 1 input[2]
	SCK	I	SPI serial clock input[2]
	DTRQ	O	UART request to send output to microcontroller[2]
30	D6	I/O	test port
	ADR_0	I	I²C-bus address 0 input[2]
	MOSI	I/O	SPI master out, slave in[2]
	MX	O	UART output to microcontroller[2]
31	D7	I/O	test port
	SCL	I/O	I²C-bus clock input/output[2]
	MISO	I/O	SPI master in, slave out[2]
	TX	O	UART data output to microcontroller[2]
32	EA	I	external address input for coding I²C-bus address[2]

The pins we care about are the serial data line input/output connected to pin 24 which is the CE0 pin for SPI. The serial clock connects to pin 23 which is the CLK pin for SPI. The master out/slave in and master in/slave out connect to 19 and 21 respectively which are the MOSI and MISO on the raspberry pi. The ground pin connects to pin 6 or the ground pin on the raspberry pi. The reset pin connects to pin 22 which is standard IO pin that the MFRC522 python library sets as the reset signal. Finally, the 3.3v power pin is connected to the 3.3v power supply pin on the raspberry pi. We could have interfaced directly with the MFRC522 instead of using a breadboard, but we decided to use a breadboard in case we wanted to expand the circuit further.

V. Conclusions

This project's primary goal is to enhance the system for documenting attendance and inventory. Manual attendance recording is an essential and time-consuming process. This process will be streamlined by using an RFID attendance keeper, which will also prevent any errors from occurring when registering attendance or inventory. To identify and distinguish between many unique RFID identifiers, we combined a Raspberry Pi 4 with an RC522. The RFID would scan each tag individually. Since several objects can be swiftly scanned using RFID, this method of item tracking is very effective.

Acknowledgment *(Heading 5)*

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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