Queue Management System using RFID and Raspberry Pi

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*Abstract* - Recent technological advancements in Internet of Things (IoT), enable the use and integration of existing technology to optimize the business operation. It also allows developing innovative new ideas to increase customer satisfaction. In this report we have briefly described the use of a Raspberry Pi as Central Processing Unit and RFID Tag, Receiver to create a low-cost Queue Management System to reduce long queues at highly sorted after places like amusement parks and/or restaurants. This approach can be modified as required and can be implemented at different locations and different business sectors as well.

*Keywords* - Internet of Things, Radio Frequency Identification, Queue management system.

1. Introduction

RFID Technology has been in use for a long time. Recently, developing nations like India have implemented Automatic Toll collection systems nationwide to reduce the operation time as well as to optimize the whole process by reducing the number of humans involved in it by using RFID Tag and Receiver. The main advantage of RFID Tags is that they are anti-collision which means the receiver can scan or process multiple tags at the same time. Another advantage is that the tags are re-writable which enables small business owners who want to allot a tag to customer and then re-write as per the needs. This feature has played a crucial role in increasing the use of RFID.

The restaurant industry may face issues in managing huge customer demands now and then. Different technological advancements have been implemented to overcome this issue and simplify the process of managing the huge number of queues at different locations. Hospitals, and restaurants have suffered a lot due to this. Since customer satisfaction or disappointment settles the tone as word-of-mouth advertisement plays an important role in this. Retail industry has come up with different solutions which includes increasing the number of employees to overcome the crowd which has worked in their favor significantly. This has not been the case for the previously mentioned industry.

1. Problem statement
2. Background

Radio Frequency Identification consists of 2 components: a Tag and a Receiver. Tags communicate to the Receiver via Radio Frequency, which in returns reads the Tag ID and Tag Description (Tag Data) and interprets and analyze as per the functionality [[3](https://www.fda.gov/radiation-emitting-products/electromagnetic-compatibility-emc/radio-frequency-identification-rfid#:~:text=Radio%20Frequency%20Identification%20(RFID)%20refers,back%20from%20the%20RFID%20tag.)]. The main advantage of RFID tag is that it is rewritable. This can be utilized to write down information from a single number indicating the employee number, large integer like cell phone number or information up to number of pages. This can be a game changer from a perspective in which storing information in a simpler way is crucial.

B B. Approach

The increasing demand from the restaurant industry and increasing population, standing in long queues has been an important issue to mention and which needs to be addressed. Traditionally people used to either stand in line or change their plans or had to plan the trip or dinner long before the weeks. The appointment system is working fine but can be an obstruction in sudden plan. To avoid this people have come up with a solution of QR code to scan and reserve the spot in line.

To automate the process with QR Code is not easy as it involves several libraries to automate and integrate with any controller. Moreover, another big disadvantage of QR Code or Barcode Queue Management System is that once the QR Code or Barcode is written, it cannot be changed. This can be a one-time solution if implemented.

Using RFID as primary sensor and actuator is far easier as Raspberry Pi has already installed libraries in it which makes integration management easier. On the other hand, when compared to QR Code, RFID Tags can be written multiple times. This makes the solution more realistic.

1. Market Analysis

The market cap of existing Queue Management System is around 0.54 billion USD with expected CAGR of 4.1% during the forecast period [[1](https://www.polarismarketresearch.com/industry-analysis/queue-management-system-market)]. And the north American Queue Management System (QMS) is projected to grow by 5.7% annually and reach 351.7 million USD by 2023 [[2](https://www.bonafideresearch.com/product/92001557/north-america-queue-management-system-market)].

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Figure 1: Market Report of QMS by year and by continent

1. Components

There are several types of RFID devices available in the market which can be used for several different purposes [[4](https://www.techtarget.com/iotagenda/definition/RFID-radio-frequency-identification)].

The Raspberry Pi 3 Model B is known to be the third generation Pi, which is a credit-card sized electronic board. Now-a-days, Wi-Fi is the one of the most paramount protocols for wireless connection and accessing the internet. This model delivers wireless LAN and Bluetooth connectivity making it exemplary for powerful designs. The Pi is powered by a Quad Core Broadcom BCM2837 64-bit ARM processor clocked at 1.2 GHz and has a RAM of 1 GB. Raspberry Pi is not only pertinent for prototyping and commercial product design, but also for designing an original PCB layout. As already mentioned in the problem statement, we will be incorporating the RFID system over barcodes [[5](https://tinyurl.com/mrbj6huz)].

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| --- | --- | --- |
| RFID Systems Type | Frequency Range | Sensing Range |
| Low frequency | 30 KHz to 500 KHz | Few inches to < 6ft. |
| High frequency | 3 MHz to 30 MHz | Few inches to Several ft. |
| UHF | 300 MHz to 960 MHz | > 25 ft. |
| Microwave | 2.45 GHz | >30 ft. |

Table 1: Type of RFID Systems

Figure 2: Proposed Block Diagram

## Advantage of RFID

Traditionally barcode was set to replace everything to automate things. Barcode and QR Code works fine until it starts to fadeaway. As discussed earlier, QR Code and Barcode can be written only once and cannot be erased. Moreover, when integrating it with controllers like Raspberry Pi and external device Camera like Pi Camera to be able to detect and scan. Moreover, QR Code needs to be near to be able to scan via camera.

Another technology that had the capability to replace QR Code was Near Field Communication (NFC). Although there are certain areas where NFC outweighs QR Code and RFID Technology both, like Bidirectional flow of information, and less than 15 milliamperes of current requirement but the biggest disadvantage of NFC is that it can only work in distance of less than 0.2 meters while as discussed earlier RFID tags can work in much longer distances.

## Disadvantages of RFID

There are several challenges while using RFID Tag and Receiver like RFID Receiver Collision which can be prevented by using Anti Collision Protocol while programming RFID Tags. Another one is that there might be an issue of RFID Tag Collision.

Data Privacy and Data Security can be a critical issue that needs to be addressed when talking about implementation at a much higher level where data security can be critical. RFID tags can be used to track someone’s location and as they are very minute, they can be hard to spot. Moreover, RFID tags can be read without someone’s knowledge if a proper reader is brought in vicinity. Encryption on an RFID Tag is something which cannot be done unlike other technologies as they have very low computing power.

# A picture containing text, diagram, line, plan Description automatically generatedProposed Implementation

A diagram of a customer

Description automatically generated with low confidenceFor our implementation, we have used Raspberry Pi 3 as our main control unit which will make decision as per the programming. RFID Tag and Receiver will act as Sensors which will be able to use the sense the presence of the sensor and to write and store the information.

Figure 3: Proposed Flow of Information

The customer will be asked to take a tag from a bunch and will be asked to enter his/her cell phone number on which his/her WhatsApp is registered. The customer must scan the tag on to the receiver to write the cell phone number on the tag. After that, the customer must tap another tag again to register himself or herself into the queue. Once customers’ phone number, name and queue number are registered. Post “queuing” the customer is free to roam about as they will receive an alert message minutes before their turn in queue.

The restaurant owners can insert a time delay after which a message will be sent from WhatsApp web application to store mobile number on the tag reminding the customer to return to the spot and wait for their turn.

The WhatsApp message can be changed to simple text message, or an email message. A push notification can be integrated by including several libraries. For simplicity of the project, WhatsApp was used as it had already well detailed library available.

# Future scope and modifications

# In future advancement the system can be integrated with SQLite database to maintain a list of customers visiting the restaurant.

1. A display and buzzer can be integrated to display and alert customers when they are next in queue.
2. Live queue updates. Change and transfer spots with willing customers to accommodate another activity into their day before attending the reservation.
3. Push notifications, and or notification via a call or email can be added to increase preferred modes of communication.
4. Add QR code support. Only software-based queueing support if desired by business. Offer queueing as a SaaS product.

# References

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