A Design of an RFID Based Microcontroller Integrating Real Time Media Auto-Stream for Vehicle Packing

Conference Paper · January 2021

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A Design of an RFID Based Microcontroller Integrating Real Time Media Auto-Stream for Vehicle Packing

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Abstract: Microcontrollers control the actions and features of a product. They are embedded controllers inside devices. Microcontroller based devices are dedicated to a single task that run one specific program at a time. It integrates with advanced peripherals like a graphics processing unit (GPU), a Wi-Fi module, or one or more coprocessors. A number of devices currently are taking advantage of minimal requirements for memory and program length, with no operating system, and low software complexity. Typical input and output devices include switches, relays, solenoids, LED's, small or custom liquid-crystal displays, radio frequency devices, and sensors for data such as temperature, humidity and light levels. In our discussion we are coming up with an architectural design of an RFID based microcontroller for car packing. The design is created using a Qemu system running Raspbian on Windows 10.Specifically focusing on how the components that relay data interface with each other. While discussing standard definitions, challenges, and benefits of this microcontroller based technologies, as well as some interesting players in this space.
Keywords: component; formatting; style; styling

1. INTRODUCTION

Automatic identification, or auto ID for short, is the broad term given to a host of technologies that are used to help machines identify objects. Auto identification is often coupled with automatic data capture (koh *et al*, 2003). That is, companies want to identify items, capture information about them and somehow get the data into a computer without having employees type it in. The aim of most auto-ID systems is to increment efficiency, reduce data ingress errors, and free up staff to perform more value-integrated functions. There are a host of technologies that fall under the auto-ID umbrella. These include bar codes, astute cards, voice apperception, some biometric technologies (retinal scans, for instance), optical character apperception, radio frequency identification (RFID) and others.

RFID (Radio Frequency Identification) is a means of identifying an item based on radio frequency transmission (Zumsteg and Qu., 2018). This technology can be utilized to identify, track and detect a wide variety of objects. Communication takes place between a reader and a transponder (derived from Transmitter/responder - Silicon Chip connected to an antenna), customarily called “tag”. Tags come in many forms, such as perspicacious labels that are stuck on boxes, keenly intellective cards and a box that you stick on your windshield to enable you to pay tolls without ceasing.

Tags can either be passive (powered by the reader field), semi-passive or active (powered by battery) (Somervell, *et al.*, 2019). Active RFID tags are powered by an onboard powering source and incline to be more extravagant than passive tags that harvest power from the RF energy of the reader. On board power sanctions the active tags to have more preponderant communication distance and more expeditious replication time. These tags are more multifarious and customarily have more sizably voluminous recollection capacity. Passive RFID tags have no internal power source and use external power to operate. These tags are powered by the electromagnetic signal received from a reader. The received electromagnetic signal charges an internal capacitor on the tags, which in turn, acts as a puissance source and supplies the potency to the chip (Ramos *et al,* 2020)

RFID systems differentiation criteria depend on operating reader frequency, physical coupling method and communication distance (read range) (Mbacke, Mitton and Rivano, 2018). The communication frequency used ranges from 135 KHz long wave to 5.8 GHz in the microwave range and are classified into four basic Ranges: LF (low frequency, 30 - 300 kHz), HF (high frequency, 3 - 30 MHz), UHF (ultra-high frequency, 300 MHz – 2 GHz) and Microwave (> 2 GHz). The physical coupling uses magnetic and electromagnetic fields. The communication distance varies from few millimeters to above 35 meters (close coupling: 0 - 1 cm, remote coupling: 0 - 1 m, long range: > 1 m) (Pichorim, Gomes and Batchelor. 2018).

2. STATEMENT OF THE PROBLEM

Automatic car parking technologies are in different dimensions, nonetheless there are different approaches to design car parking solution. It can be noted that each of the existing solutions have different technological requirements in relation to all the components that are integrated to provision a working car park. Many types of research have influenced the ways in which the existing systems have been designed, measuring their performance and quality from the perspective of the designer, engineer, or developer, and not the stakeholders. The real time media auto stream model interfacing micro-controller and RFID towards coming up with a secure embedded car parking model, seeks to bridge the gap by minimizing challenges with an innovative approach of designing a car parking solution that interfaces all the components required using latest microcontroller and RFID technology.

3. RESEARCH OBJECTIVE

The main objective of the study is to come up with a design of an RFID embedded Micro-controller framework that aids in scheduling cars automatically into car park. The model interfaces all the components required for designing a working microcontroller and RFID while integrating real time media auto-stream.

4. SURVEY OF LITRATURE

The mainstream media in the last few years have increasingly begun to cover radio frequency identification (RFID) technology, it may seem as if this technology was invented recently. This is definitely not the case, on the contrary: one would be surprised to learn that it has been around for more than 60 years.

Even though RFID has been around for a while now, only recently it is getting more and more attention for application in different areas. The reasons for many companies not to implement or consider RFID technology earlier, were "the high costs of RFID hardware, software & services.

Also, the immaturity of technology and the lack of common standards"; as RFID components costs continue to decrease and the technology matures, it is assumed that more companies will become interested. Moreover, the mandates from two major players in the United States: Wal-Mart (the largest retailer in the world (Jones, 2018) and the Department of Defence (DOD) also have contributed to an increased interest in RFID.

It is a technology similar in theory to bar code identification. With RFID, the electromagnetic or electrostatic coupling in the RF portion of the electromagnetic spectrum is used to transmit signals. RFID is a technology belongs to the Automatic Identification (AUTO-ID) technologies which includes (amongst others): Bar Code, Optical Character Recognition and Magnetic Stripe.

The AUTO-ID technologies concept operates on the premise that, it is not necessary for humans to both read data and enter data manually into a computer system, because this all happens automatically and thus data entry is done efficiently and errors are minimized (RFID Journal, 200-). In an RFID system an object or person can be assigned a unique serial number (for instance, the identity) and this number is send out wirelessly by means of radio waves (Kuang and Xu, 2018).

4.1 Components of RFID

An RFID system is comprised of several components, they are: tag, reader, antenna, and middleware and enterprise applications. Imagine that a pallet has a RFID tag (a small plastic device which contains a unique identification) attached to it. This pallet is transported from location A (the pool manager) to B (the retailer). The pool manager can identify this particular pallet as follows: a reader will send out radio frequency signals via its antenna and then wait for a response from the tag. When the tag is in the neighbourhood of this reader it is activated (for example this only applies to passive tags (for example a type of tag)) and then sends back its data (via its own antenna) which is collected by the same antenna/reader that send out those signals. This data is then transported to software called middleware which filters data, and then (usually) sends it to an enterprise application (for example warehouse management system (WMS) or a database. This basically describes how RFID technology works. This process is summarized in figure 1. As shown in below, the RFID system is made up of different components and each serves a specific purpose in the system, hence they are only useful when used collectively

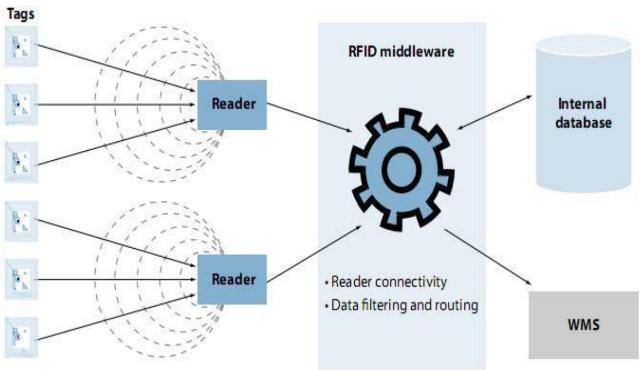

Figure 1.General RFID system overview (Source: Leaver *et al*. 2004)

5. MODEL DESIGN

The Design of an Architectural Model Based On RFID Microcontroller Integrating Real Time Media Auto-Streaming for Vehicle Packing followed the proof of concept research design. This phase involved validation of user needs, technical feasibility, identifying potential stumbling blocks, identifying what the RFID based microcontroller interfaced model for car packing would or would not provide. This helped determine the scope and level of customization necessary so as to complete deployment of the proposed model (makupi D., 2016).

The design was created using a Qemu system running Raspbian on Windows 10. The source code provided for this simulation deviated insignificantly with results even as much as there were various input sources and from real data. The figure below shows design of the carpark structure that was implemented on the Qemu system.

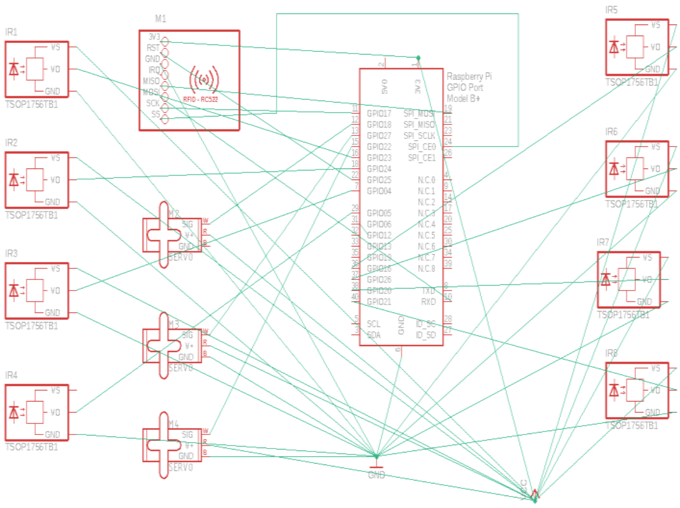

Figure 2: Design of the Car Park system later implemented on Qemu

Figure 2 shows the Qemu simulation for bus interconnection of car park structure and components. It illustrates the general overview on how the different components that make up the model interface with each other. The next section discusses how the simulation parameters were realized on Qemu.

5.1 Design of Simulation Parameters on Qemu

The simulation flow diagram involved a precise description of functionalities and data flow from inception of car entry into the car park area, entry/exit outputs, checking of vacant car spaces, capturing of multimedia into the data repository, RFID tagging and recording, below in figure 3 indicates the circuit components and the simulated circuit of the experiment.

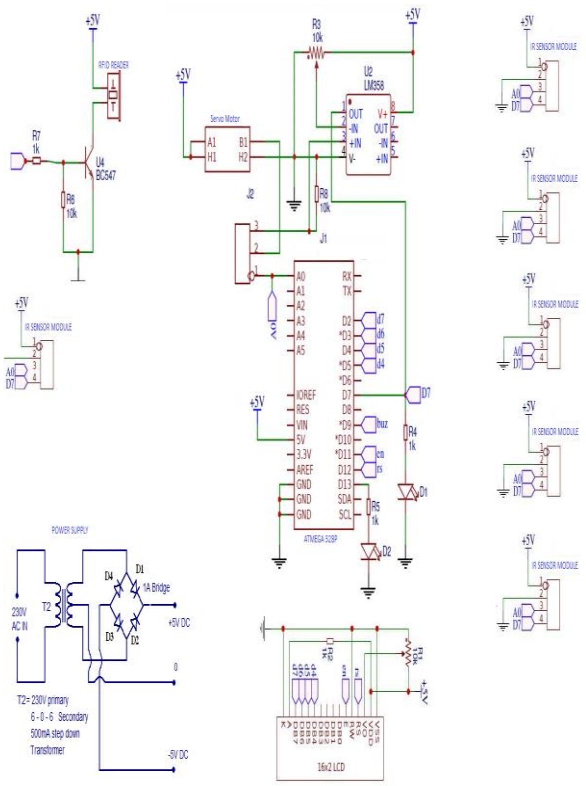

Figure 3: Qemu Circuit Diagram

The figure below shows design of the simulation flow which the experiment followed on the Qemu system.

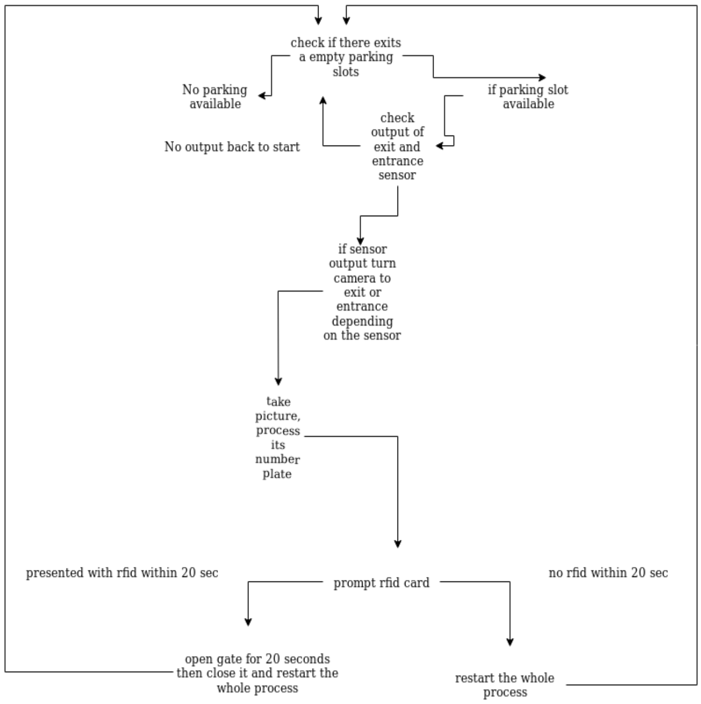

Figure 4: The Simulation Flow diagram

This was followed by selection of the simulation parameters on the Qemu system. Figure 5 below shows the selection process of the parameters for this study.

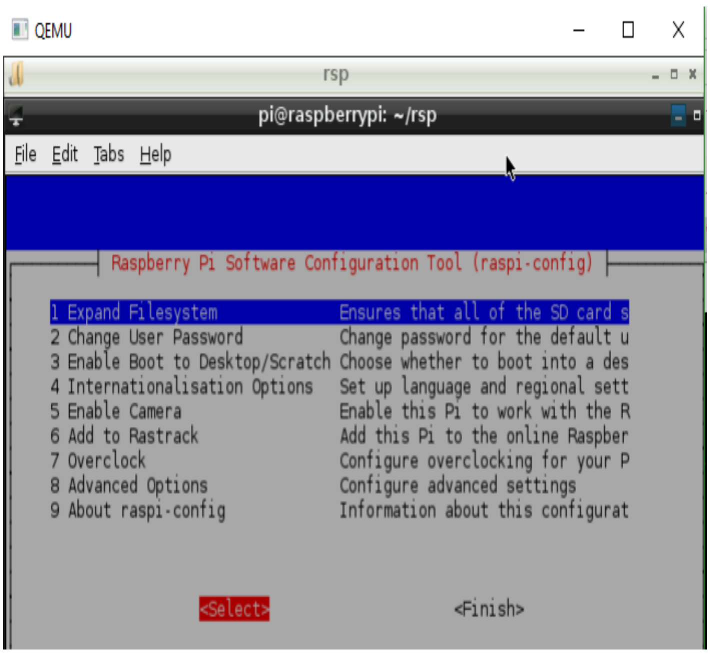

Figure 5: Simulation using Qemu system

Further, to enable negligible results deviation, there was need to align this simulation within real-time events that are experienced in a car-parking lot system. Thus in comparison and to be in tandem to the real raspi-config which could be used to configure the LCD, localization and interfacing options were configured to align the camera and the RFID as to be used in this project. The figure below shows configuration and alignment of various options within the Raspberry Pi.

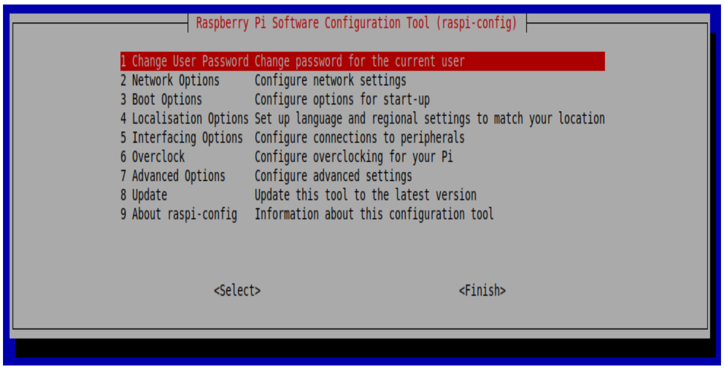

Figure 6: Simulation configuration and alignment on the Qemu system

5.2 The Logical Design of the RFID cameras and Sensors

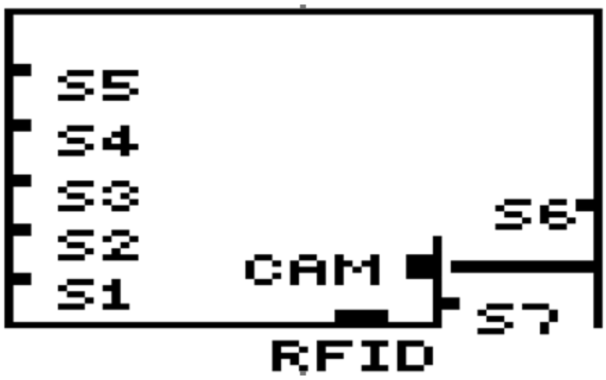

Figure 7: Logical design of the RFID

The above logical design composed of S1 - sensor1, S2 - sensor2, S3 - sensor3, S4 - sensor4, S5 - sensor5. S6 - sensor6, S7 - sensor7, G1 – gate, CAM – Camera & RFID - RFID tag

5.2.1 Operational Design

When a car approaches the gate, it turns sensor 7 on alerting the system on an incoming car. The system then checks if there are available slots by checking through sensor one to sensor five of any available cars. This is done by checking if any of the sensors if high which indicates a car presence or low which indicating the empty parking slots. If any parking slots available, the camera turns towards the incoming car, takes the picture of the incoming vehicle, processes the number plate as well as storing the encrypted car plate numbers. Then the system prompts the user to produce a RFID card for authentication.

i) The RFID Card Tag number is checked and if authenticated the gate opens and upon entrance the car will be guided towards the vacant slot by the system. The LCD will tell which slot is vacant.
ii) If the parking garage is full the systems outputs its parking slots are not available to the LCD and does not allow the vehicle owner to enter the parking garage.
iii) On arrival to its parking location and on sensor activation a time count is done which stops when the sensor turns low indication the car is on its exit way.
iv) On reaching the gate, sensor six is turned on and indicates to the system the car is on exit. This turns the camera to capture the exiting vehicle and stores it encrypted on the SQLite database, prompts the user for his or her RFID card for authentication.
v) If authenticated the gate opens for the outgoing car and a free slot is advertised on the LCD.

6. DESIGN CHALLENGES

Design challenges of realizing the model was on readjustment of parameters on Qemu. The following re-adjustments were done on the simulator since it failed to install RPi.GPIO pins as the module is only for real raspberry pi. It was also unable to connect sensors for example camera, RFID module and ir modules. There was also lack of open source free raspberry simulators. The following were the steps followed;

i) Scripts were modified so as to run on the simulator.
ii) Picamera, RPi.GPIO, MFRC522 modules were re-written to run on our simulated environment
iii) Qemu simulator was used running Raspbian

7. ASSUMPTIONS

According to already existing technological solutions, all of the sophisticated smart parking systems are proposed in academia (Bandyopadhyay, 2021). The solutions agreed mostly depend on the knowledge of real-time parking information, based on which the system makes and apportions allocations for drivers. Current sensing technologies provide several options to monitor parking spots. In general the design from this study provisions a guideline for designing any smart parking system that depends on sensors working either by sensors being deployed in each parking spot or by the construction of a network of wireless sensors with sink, which connects all sensors together and transmits sensing data to the gateway and then to the driver through GUI via the server. Typically, several Mesh networks supports multi-hop routing through which data packets can be relayed from one to another (Rashid & Rehmani, 2016). Thus, in this solution sensors provides a mechanism to relay signal's from a distance.

8. ASSUMPTIONS

Living in a world that is aspiring to reach the epitome of technological advancement in every field, but the question remains: Where to park the car at? As the progression in the vehicle industry is taking place, it is a dire need to find advance means to accommodate these vehicles. Over the years it has become a challenge for both the planners and builders to manage the parking spaces to curtail traffic congestion; it asks for a well-managed parking system that ensures efficiency and smart utilization of available space. This project aims to create a more assertive system for an automated parking lot that is time saving and more effective as compared to the conventional manual system that is inefficient and prone to creating nuisance.

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