DECLARATION

We, **……**, Hereby declare that this Dissertation Submitted for Advanced Diploma of A1 Level in Electronics and Telecommunication, at Rwanda Polytechnic Kicukiro Campus (IPRC Kigali), is our own original work and has not previously been submitted to any other institution of higher education. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references.

NAMES:

……..…… ……

Date: …… /…… / 2022

Signature: ……

APPROVAL

Name of institution: RP – IPRC KIGALI

Department: Electrical and Electronics Engineering

This is to certify that this report was done under supervision of supervisor:

…….

Signature…….....

Date: ……. / ……./ 2022

Head of Department:

…….

Signature…….....

Date: ……. / ……./ 2022

DEDICATION

It is with genuine gratitude and warm regard that we dedicate this project to our classmate, lecturers, and our parents for their greatest and undoubtful daily inspiration and support as follows:

1. Our almighty God who is always there for us.
2. Our lecturer who has helped us to develop our research.
3. Our beloved families who never fail to support us.
4. Our brothers and sisters
5. Our beloved friends mostly classmates

You have been honest and kind to us, your support and advices really encouraged us to achieve the big thing in our life as of today we came up with this great project.

ACKNOWLEDGEMENT

We are genuinely honored to take this opportunity expressing our gratitude towards our lecturers who supported us throughout our technical and theoretical coursework as it enlightened and shaped our understanding regarding the whole procedures and principles as of discussed in this report. Your truthful advices and perspective on this report was of great important, we gladly appreciate.

We are highly indebted to our fellow trainees as well as IPRC-RP Kigali institute for both their innovative support and advice, we truly honor them for their kind reviews and comments.

ABSTRACT

In short, this project designing “TAP AND PAY SYSTEM”, which is one of interesting topic in my practical course in secondary studies in department of computer and electronics. My project is about the payment system using card, this will facilitate in payment system here in our country by reducing the time consumption and help the seller that uses it to keep record of transactions made.

My project has three main parts which are: RFID system, Arduino microcontroller and computer part which is composed by program and database.

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ABBREVIATIONS

RX:	Receiver
TX:	Transmitter
PWM:	Pulse Width Modulator
RFID:	Radio Frequency Identifier
USB:	Universal Serial Bus
AC:	Alternating Current
DC:	Direct Current
GND:	Ground
VIN:	Voltage Input
ROM:	Read Only Memory
EEPROM:	Electrical Erasable Programmable ROM
LED:	Light Emitting Diode
IDE:	Integrated Drive Environment

CHAPTER 1. GENERAL INTRODUCTION

1.1. BACKGROUND STUDY

In amidst of this COVID-19 Pandemic Era, it asserts the importance of avoiding human to human contact as much as possible to break the chain of this contagious spread. So, the problem that we choose to solve is the fare collection. Perhaps it comes down to achieve two aims at once. Meaning that we Rwandan really needs some robust system for collecting fare in the public market sector also during this time of contagious spread, we are in an indispensable need to avoid human to human contact. That's where our system comes into play.

Now a days as the world development is increasing so fast people are busy for searching money. So, every day they try every way that can be used to gain more money. But apart from that there is important issue which is more needed than searching for money, it is the better way to secure them and access them whenever and wherever they are needed. So, I decided to implement this project "TAP AND PAY SYSTEM" to facilitate payment system here in our country.

In the design of this project, I have used RFID Reader to differentiate different cards present and ATMEGA 328P microcontroller that contains the program and sends data to server and computer that will provide an interface for payment.

1.2. PROBLEM STATEMENT

A. The government of Rwanda they are encouraging people to use cashless payment to avoid more human contact.
B. The cashless payment mostly is used in big company like supermarket and others but not in the other small business so our system will help also those small company.
C. The long await line of people pending to pay.
D. Connection issue.

1.3. OBJECTIVE OF THE PROJECT

1.3.1. GENERAL OBJECTIVE

The overall objective of this project is to design and implement a paying System with different settings to internet of things contributions developed in PHP and MySQL with Arduino IDE and some hardware components where citizens will pay their goods everywhere in any shops with this system and it will help them a lot.

1.3.2. SPECIFIC OBJECTIVES

Briefly, this project will be used:

- ❖ To facilitate clients to pay in easy way.
- ❖ To avoid the long line of people pending to pay.
- ❖ Helps to keep data of all transaction because there will be database.
- ❖ To provide more security for payment systems.

1.4. SCOPE OF THE PROJECT

In this project, there is a limitation that the system isn't directly connected to their real bank accounts and it is not hosted so that it can be used online on internet.

1.5. RESEARCH QUESTION

- ➢ What is really the purpose of this project?
- ➢ How will you gain profit in your project?
- ➢ How will people pay exactly?
- ➢ We are willingly in need of helping you with a development of a system to help you in all your work. Is there any suggestion you may give?

1.6. PROJECT HYPOTHESIS

The proposed system would efficiently help citizens around Rwanda to pay their goods in easy ways without taking a long time pending to pay, and also will avoid the human contact due to the era of pandemics where government encourage us to use untouchable money.

Also, we have taken a look at how on public toilets and cars parking all over the country there is no any cashless method implemented there to be used so I decided also to provide a modified hardware that will help them to march through cashless world.

1.7. SIGNIFICANCE OF THE PROJECT

This project it's so significant because it will help many people whole all over the world when paying. And so many other things like avoiding loss of time while pending to pay.

1.8. LAYOUT OF THE STUDY

This work is mainly composed by five chapters where by:

"*Chapter 1*" ~ describes the general introduction and deals with some brief background information, the problem statement and significance of the study, specific objectives and methodology intended to employ to solve the problem as well as the scope of the study or report outline.

"*Chapter 2*" ~ is the literature review which gives the insight on how proceed by reviewing other related works or existing related technologies in our field of study.

"*Chapter 3*" ~ mentioned the research methodology which provides detailed approached used to accomplish this project.

"*Chapter 4*" ~ focus on the complete design of the project and further provides implementation of the final product of our work "Tap and Pay".

"*Chapter 5*" ~ is conclusion and recommendation, it includes remarks and provides some recommendations encountered during the conduction of the project.

1.9. ORGANIZATION OF THE PROJECT

The work is divided and organized into five chapters:

- Chapter 1 - deals with the general introduction of the project.
- Chapter 2 - deals with literature review.
- Chapter 3 - deals with the methodology used.
- Chapter 4 - includes system implementation.
- Chapter 5 - composed conclusion and recommendation.

CHAPTER 2. LITERATURE REVIEW

The literature review is introduced to include what other researchers have done and fundamental definitions used in the current project.

2.1. ELECTRONIC PART

2.1.1. ARDUINO UNO (MICROCONTROLLER)

The Arduino UNO is a microcontroller board based on the AT mega 328 datasheet. It has 14 digital input/output pins (of which 6 can be used as PMW outputs), 6 analog pins, a USB connection, a power jack and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

A. DESCRIPTION

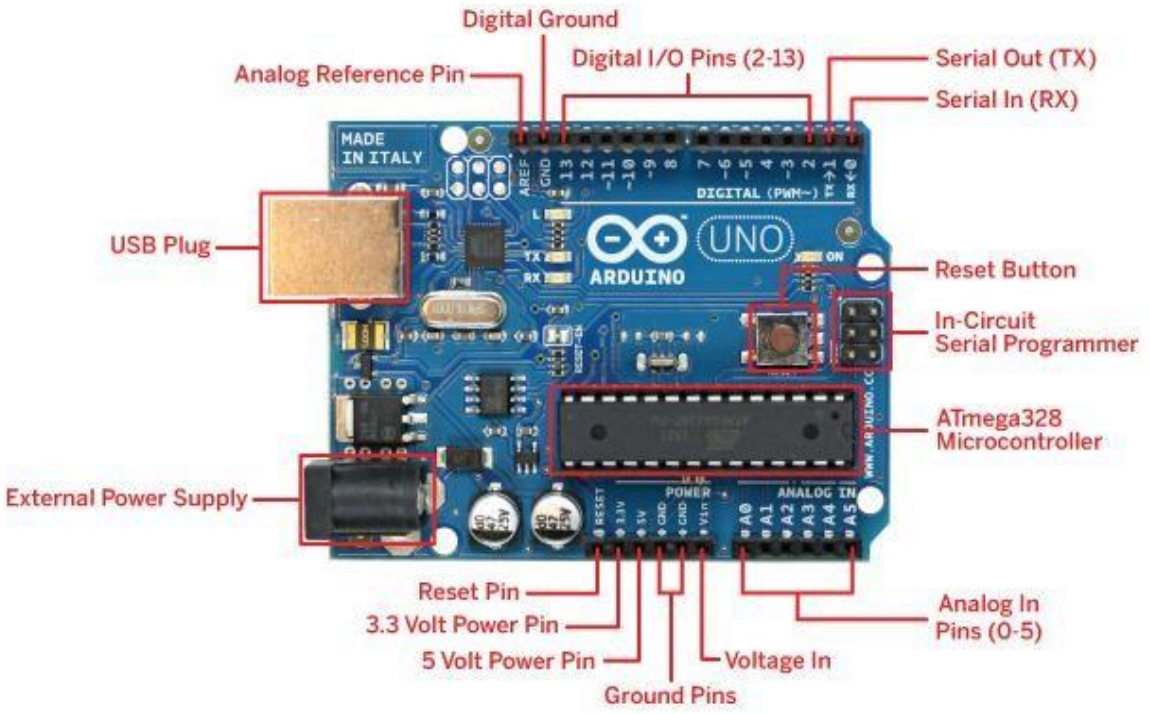

Figure 1: Arduino Uno microcontroller

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 Digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz Ceramic

resonator, a USB connection, a power jack, an ICSP header, and a reset button, analog pins and digital pins in which analog ones support variable values.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

B. POWER

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mmcenter-positive plug into the board's power jack. Leads from a battery can be inserted in the ***Gnd*** and ***VIN*** pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

C. MEMORY

The ATmega328 has 32 KB of memory with 0.5 KB used for the boot loader. It also has 2 KB of SRAM and 1 KB of EEPROM which can be read and written with the EEPROM library.

D. INPUT AND OUTPUT

Each of the 14 digital pins on the Uno can be used as an input or output, using ***pinMode***(), ***digitalWrite*** (), and ***digitalRead*** () functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor disconnected by default of 2050 ohms. In addition, some pins have specialized functions:

Serial: 0 (***RX***) and 1 (***TX***). Used to receive (***RX***) and transmit (***TX***) serial data. These pins are connected to the corresponding pins of the ATmega.PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labelledA0 through A5, each of which provide 10 bits of resolution. By default, they measure from ground to 5 volts.

E. PROGRAMMING - SKETCH

The Arduino Uno can be programmed with the Arduino software called Arduino IDE using c language and the program is uploaded in the board. Arduino program is known as Sketch.

F. ARDUINO IDE

Arduino IDE is a software used to program Arduino boards and it is an interaction between Arduino board and computer. To upload the sketch into the Arduino chip you will need to Select "Arduino Uno from the Tools > Board menu.

After selecting the board, you will select the virtual port by Tools>Port then it helps you with the communication of the Arduino with the computer. After this you start your program normally.

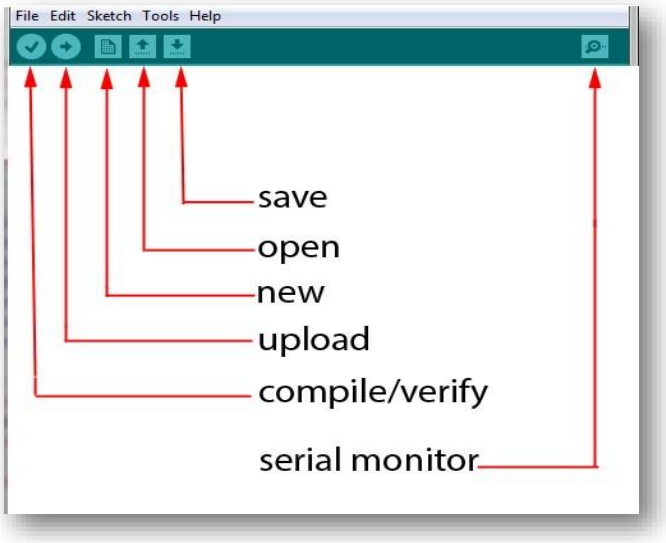

Figure 2: Arduino IDE interface

In addition, here a serial monitor is as interface that is used to test the communication between the Arduino and the computer by using serial communication, this will help to check if our microcontroller is able to receive commands.

The Arduino programming language is basically made of two important parts

Void setup () {

Statement

}

{

Statement

}

The setup function should follow the declaration of any variables at the beginning of the program. It is the first function to run in the program, is run only once, and is used to initialize *pinMode*.

Ex: void setup ()

{

PinMode (pin, OUTPUT); // sets the 'pin' as output**.**

After calling the setup () function does precisely what its name suggests, and loops consecutively, allowing the program to change, respond, and control the Arduino board.

Ex: void loop ()

{

DigitalWrite (pin, HIGH); //turns 'pin' on

Delay (1000); //pauses for one second

DigitalWrite (pin, LOW); //turns 'pin' off

Delay (1000); //pauses for one second in

The Arduino programming we also find other functions:

"*digitalRead(pin)*" - Reads the value from a specified digital pin with the result either HIGH or LOW. The pin can be specified as either a variable or constant *digitalWrite*(pin) outputs either logic level HIGH or LOW at (turns on or off) a specified digital pin. The pin can be specified as either a variable or constant.

***"analogRead(pin)"* -** reads the value from a specified analog pin with a 10-bit resolution. This function only works on the analog in pins(A0-A5).

***"analogWrite()"* -** writes analog value using hardware enabled pulse width modulation to an output pin marked PWM.

2.1.2. RFID

RFID stands for radio frequency identification; RFID is a basic technology that allows the identification of a device (RFID tag) to be read wirelessly by a reader (RFID reader) using radio frequency.

A. RFID TAG

The RFID tag contains a small IC containing the identity information. The IC is attached to the antenna and transmits its identity to a reader. It detects the electromagnetic energy produced by the reader. The identity information is transmitted as radio frequencies. The reader then converts the received radio frequencies into the identity data.

B. RFID READER

RFID reader a device that is used to gather information from a RFID tag. Normally RFID reader is made of scanning antenna, and the scanning antenna puts out radio frequency signals in a relatively short range which provides a means of communicating with the RFID tag. When an RFID tag passes through the field of scanning antenna, it detects the activation signal from the antenna that "wakes up" the RFID chip, and it transmits the information on its microchip to be picked up by the scanning antenna.

In my project I have used MFRC522

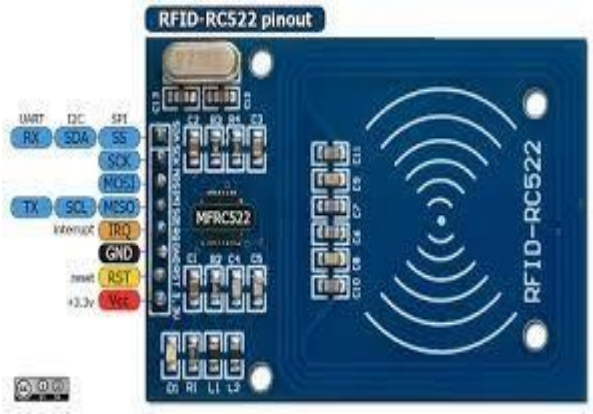

Figure 3. RFID MFRC522 READER

It has 8 pins: 3.3V, RST, GND, RQ, MOSI, MISO, SDA and SCK

2.1.3. RESISTOR

A. FIXED RESISTOR

Resistor is a passive component that is used to control the amount of current in the circuit it will control by using resistance is symbolized by:

Figure 4. symbol of resistor

Resistance is the property of any material that oppose to the flow of current. Means if the flow of current increases the resistance will reduce.

"The ohm's law"

Ohm's law states that the resistance of conductor is directly proportional to the voltage occurs conductors are inversely proportional to the flow of current.

R= V/I

Where, V= voltage (V)

I: current (A) and R= resistance (Ω)

2.2 COMPUTER PART

2.2.2. LANGUAGES USED

- HTML (Hyper Text Markup Language)

- CSS (Cascading Style Sheet)
- PHP (Hypertext Preprocessor)
- Java Script

A. HTML

HTML stands for **H**yper **T**ext **M**arkup **L**anguage, it is not a programming language, it is a markup language**;** A markup language is a set of markup tags. Hyper means active, whenever you are accessing internet through web browser you can browse a web page trough world wide web; in this case both navigators interpret HTML. Mark up comes from fact of marking up where you must type in text and then marking up the next. Language describes that you are using the specified syntaxes.

HTML uses markup tags to describe web pages where the tags are written in any editor and Then can be displayed by any internet browser such as internet explorer, Mozilla fire fox, etc...

As a static website. You can't work with: TML without having any editor and web browser but doesn't need any server because it is not a server-side language

B. HYPER TEXT PREPROCESSOR (PHP)

PHP (recursive acronym for "Hypertext Preprocessor") is a widely-used Open-Source general purpose scripting language that is especially suited for Web development and can be embedded into HTML.

PHP is one of the most popular server-side scripting languages now; because is typically the fastest server-side script language and supports wide range of popular databases.

C. CASCADING STYLE SHEET (CSS)

CSS stands for **C**ascading **S**tyle **S**heets; Styles define how to display HTML elements such as to increase their appearance. Styles can be stored in External Style Sheets in order to save you lot of work where multiple style definitions will cascade into one. Style sheets allow style information to be specified in many ways. Styles can be specified inside a single HTML element, inside the <head> element of an HTML page, or in an external CSS file. Even multiple external style sheets can be referenced inside a single HTML document.

D. JAVASCRIPT

JavaScript is the scripting language of the Web. It is used in millions of Web pages to add functionality, validate forms, detect browsers, And much more.

2.2.3. RELATIONAL DATABASE MANAGEMENT SYSTEM (RDBMS)

An RDBMS is a DBMS designed specifically for relational databases. Therefore, RDBMS are subset of DBMS.

A relational database refers to a database that stores data in a structured format, using rows and columns. This makes it easy to locate and access specific values within the database. It is "relational" because the values within each table are related to each other. Tables may also be related to other tables. The relational structure makes it possible to run queries across multiple tables at once. While a relational database describes the type of database an RDBMS refers to the database program itself. It is the software that executes queries on the data, including adding, updating, and searching for values. An RDBMS may also provide a visual representation of the data.
(gartner.com, 2016).

2.2.4. DATABASE

A database is an organized collection of data, generally stored and accessed electronically from a computer system. Where databases are more complex, they are often developed using formal design and modeling techniques. A database (DB), in the most general sense is an organized collection of data. More specifically, a database is an electronic system that allows data to be easily accessed, manipulated and updated.

In other words, a database is used by an organization as a method of storing, managing and retrieving information. Modern databases are managed using a database management system

(Oracle Cloud Free Tier, 2012).

2.3. SOFTWARES USED

2.3.1. XAMPP

XAMPP is developed by Apache Friends to promote the Apache web server. Apache Friends was founded in the spring of 2002 by Kai 'Oswald' Seidler and Kay Vogelsang. Its Alexa rank is 7,939 as on today. Because, I use any software or website based on its Alexa rank, I am mentioning its

rank here to help my blog readers. XAMPP Acronym is X or extended (Apache, MySQL, PHP, PERL); Apache Friends developed this software to help the people to install and configure Apache web server along with MySQL, PHP and Perl.

So, when I was releasing my project, I used this software in order to be connected together with MySQL database, PHP and Apache as a web server within local host. And also, to be able to access MySQL database through graphical interface of web browser by using one feature of Xampp called PhpMyAdmin.

2.3.2. WEB BROWSER

A web browser (commonly referred to as a browser) is a software application for retrieving, Presenting and traversing information resources on the World. An information resource is Identified by a Uniform Resource Identifier (URI) and may be a web page, image, video or other piece of content. Hyperlinks present in resources enable users easily to navigate their browsers to related resources. Although browsers are primarily intended to use the World

Wide Web, they can also be used to access information provided by web servers in private Networks or files in file systems.
The primary purpose of a web browser is to bring information resources to the user ("retrieval “or "fetching"), allowing them to view the information ("display", "rendering"), and then access other information ("navigation", "following links").

2.3.3. VISUAL STUDIO CODE

Visual Studio Code is a lightweight but powerful source code editor which runs on your desktop and is available for Windows, macOS and Linux. It comes with built-in support for JavaScript, TypeScript and Node.js and has a rich ecosystem of extensions for other languages and runtimes (such as C++, C#, Java, Python, PHP, Go, .NET).

Visual Studio Code includes basic support for most common programming languages. This basic support includes syntax highlighting, bracket matching, code folding, and configurable snippets. Visual Studio Code also ships with IntelliSense for JavaScript, TypeScript, JSON, CSS, and HTML, as well as debugging support for Node.js. Support for additional languages can be provided by freely available extensions on the VS Code Marketplace.

Instead of a project system, it allows users to open one or more directories, which can then be saved in workspaces for future reuse. This allows it to operate as a language-agnostic code editor for any language. It supports many programming languages and a set of features that differs per language. Unwanted files and folders can be excluded from the project tree via the settings. Many Visual Studio Code features are not exposed through menus or the user interface but can be accessed via the command palette.

2.3.4. PROCESSING

Processing is an open-source programming language and environment for people who want to program images, animation, and interactions. It is used by students, artists, designers, researchers, and hobbyists for learning, prototyping, and production. It is created to teach fundamentals of computer programming within a visual context and to serve as a software sketchbook and professional production tool. Processing is developed by artists and designers as an alternative to proprietary software tools in the same domain. And it is mainly used for programming and interaction with Arduino using java language.

Figure 5: Processing application software

2.3 Critical Review

2.3.1 Existing System

2.3.2 Proposed System

2.4 Summary

TAP AND PAY will eventually help citizens of Rwanda to pay their goods in easy ways without taking a long time pending on line also without waiting for hours connection when lost. We decide to develop a system which has a hardware part where every shops will have their own as well as a software system to record those data.