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Tap and Pay Transaction System

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Abstract—*It is the era of technology in which the world is developing. Therefore people are highly dependent on technology for performing their day activities. The days of carrying huge amounts of cash with you every time you go out on shopping have long gone. Nowadays technology has made it possible to make payments in a much easier and a faster way in the form of Credit Cards, Debit Cards, Google Wallet etc. The cards used today are of the Swipe and Pay type where one has to swipe his/her credit or debit card on the reader to make payments. Such cards use Magnetic tapes to store data. Such cards suffer from several limitations such as more processing time, problems during the reading process that is seen when consumers have to swipe their cards two to three times in order to make payments. Such cards also require contact with the reader and the frequent swiping tends to reduce the life of the card. We have attempted to make a payment system-Tap and Pay Transaction system which is a contactless payment system. This system uses RFID technology for establishing communication between the reader and the card. In our system, the user is required to tap his card on the reader. The user is required to enter the unique PIN corresponding to the card through a keypad. After successful authentication the user is asked for the amount which he needs to debit from his account. Since such cards require no contact between the reader and the card, the life of such cards is much more than that of swipe and pay cards. Moreover such cards can also withstand much tougher conditions such as dirt. The transaction time for this system is also lesser than the Swipe and Pay systems.*

1. INTRODUCTION

The mass market introduction of contactless technology is an important event for the payments industry. Consumers and retailers have already benefited from contactless payments, in terms of convenience and higher levels of control for consumers and higher throughput for retailers. And these benefits are just the tip of the iceberg.

Contactless payment technology relies on a secure microcontroller or equivalent intelligence, internal memory, and a small antenna that is embedded in a device that communicates with a reader using a contactless RF interface. This technology is employed in a wide range of applications. From delivering quick and secure transactions as in transit fare payment cards to safeguarding personal information in government and corporate identification cards, electronic visas and passports, contactless payment technology is being leveraged to enhance convenience, speed and security.

Just what are the advantages of contactless payments over other methods of payment–cash and magnetic stripe cards? Why are merchants moving to establish this new form of payment? Why are consumers disposed to change the way they pay? The answer is convenience and speed, as has been validated in the early implementations and in recent market research. Consumers no longer have to fumble with cash and change or bother about having adequate cash for a purchase–they can place their contactless payment card or device in close proximity to a reader and they are good to go. In most of the cases, they do not even have to sign a receipt or enter a personal identification number (PIN).

2. RFID TECHNOLOGY

2.1 Description

Radio-frequency identification (RFID) is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically recognizing and tracking tags embedded in or attached to objects. The tags carry electronically stored data. Some tags are powered by electromagnetic induction from the interrogating radio waves originating from a reader, and act as a passive transponder. Other tags act as an active transponder having a local power source such as a battery and may operate at hundreds of meters from the reader. Unlike a barcode, it is not compulsory for a tag to be within line of sight of the reader and may be embedded in the object to be tracked.

RFID systems comprise an antenna and a transceiver, which read the radio frequency and transfer the information to a processing device, and a transponder or tag, which is an integrated circuit consisting of the RF circuitry and information to be transferred.

This system can be employed just about anywhere, from clothing tags to missiles to animal tags to food -- anywhere that a unique identification system is required. The tag can contain information as simple as a pet owner’s name and address or the cleaning instruction on a sweater to as complex as directions to assemble a car. Some auto manufacturers use this technology to move cars through an assembly line. At each successive stage of manufacture, the RFID tag notify the computers what the next action of automated assembly is.

RFID technology has the ability to both significantly enhance and secure the lives of consumers, and also revolutionize the way companies and firms do business.

2.2 Elements of an RFID System

In a basic RFID system, four fundamental components are required for data to be transferred:

i. **A transponder** (more commonly known as a *tag*) that is embedded with information that uniquely identifies itself, thus the notion of "automatic identification".

ii. **A transceiver** (more commonly known as a *reader*) to handle radio communication using the antennas and transfer tag information to the external world.

iii. **An antenna** connected to the reader to communicate with transponders or tags.

A reader interface layer, or middleware, which compresses thousands of tag signals into one identification and also functions as a channel between the RFID hardware parts to the client's application software systems, such as accounts receivable, inventory, logistics, shipping, and so on.

2.3 Working

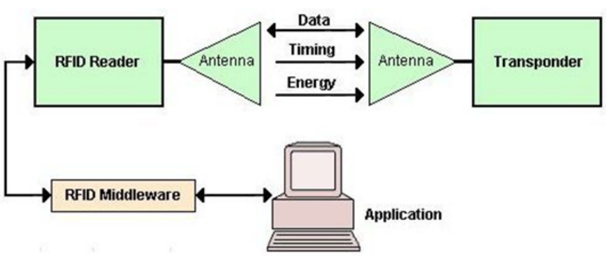

Fig. 1: RFID System

The RFID tag is situated on the objects to be identified and the RFID reader identifies tags and reads from and writes to the tags. The reader can then notify another system about the presence of the tagged objects. The system with which the reader communication takes place usually runs software that stands between applications and readers. This software is known as RFID middleware. Each and every tag has a fixed amount of memory to store information related to the object, such as its unique tag serial number, or in some cases, more details, e.g. production date, expiry date etc.

When these tags come in contact or pass through an electromagnetic field generated by the reader, they transfer this information back to the reader, thereby enabling object identification.

3. TAP AND PAY TRANSACTION SYSTEM

Tap and Pay Transaction Systems also known as Contactless Payment systems, are debit cards and credit cards, smart cards, key fobs or other devices, including smartphones and other NFC enabled mobile devices, that employs radio frequency identification or near field communication to make fast and secure payments. The antenna and embedded chip enable the consumers to wave their personal card, fob, or NFC enabled handheld device near a reader at the point of sale terminal in order to make payments.

3.1 Circuit Description

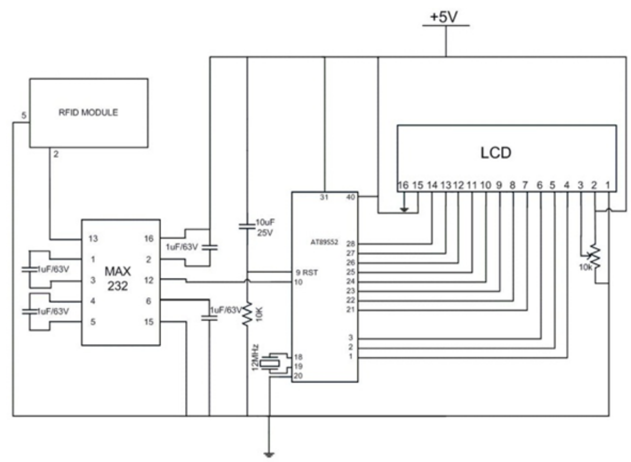

Fig. 2: RFID interfacing with AT89S52

The circuit diagram comprises of following components:

- RFID module consists of EM-18 reader and MAX232 IC. EM-18 reader is used to read the 12 byte unique code from the tag wirelessly through the phenomenon of electromagnetic induction. This is then passed to the MAX 232 IC for conversion to RS-232 protocol. This protocol is best suited for serial communication. The data is then passed using pins 2 and 5 of the EM-18 reader.
- MAX232 is also available on the microcontroller kit. It is used to convert the data in RS-232 protocol back to TTL logic that is required by the microcontroller. The pin 13 is used to receive the data in RS-232 protocol and pin 12 used to send data in TTL format to the microcontroller.
- AT89S52 microcontroller is the processing device in the system that receives the unique ID using pin 10, i.e. RXD pin of the microcontroller. It then takes action according to the algorithm that is fed into it. It is a 40 pin IC. A 12 MHz crystal oscillator is used to provide clock to the microcontroller. PORT 2 is used to send data in parallel to the LCD i.e. pins 21 to 28.Pins 1, 2 and 3 are used as control bus for the LCD. The microcontroller needs +5V supply for its functioning

- The 16x2 LCD is used to interact with the user. It is used in the 8 bit mode with Port P2 of the microcontroller connected to its data bus and pins 1, 2, 3 of Port P3 of the microcontroller connected to pins 4, 5 and 6 of the LCD symbolising RS (Register Select), RW (Read Write logic) and E (Enable) pin of the LCD.
- The potentiometer is used to adjust the contrast of the display of the LCD. By just adjusting the screw over the potentiometer, the display can be adjusted.

3.2 Main Components Used:

- AT89S52 Microcontroller
- RFID System
- MAX232 IC
- 16x2 LCD

4. COMPONENTS DESCRIPTION

4.1 AT89S52 Microcontroller

AT89S52 is an 8-bit microcontroller that belongs to Atmel's 8052 family. ATMEL 89S52 has 8KB of flash programmable and erasable read only memory (PEROM) and 256 bytes of RAM. It can be erased and programmed to a maximum of approximately 10,000 times.

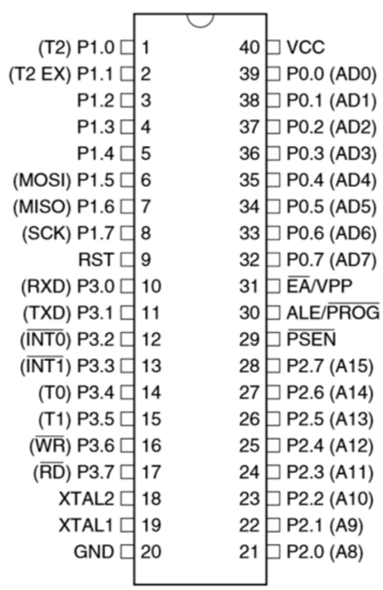

Fig. 3: AT89S52 Microcontroller Pin diagram

In the 40 pin AT89S52, there are four 8-bit ports designated as P0, P1, P2 and P3. These ports are called bi-directional ports because they can be used as both input and output ports. Except P0 which needs external pull-ups, rest of the ports have internal pull-ups. When logic high signals are given to these port pins, they are pulled high by the internal pull-ups and can be used as inputs. Their bits can be accessed individually because these ports are bit addressable.

Port P0 and Port P2 are also used to provide low byte and high byte addresses, respectively, when connected to an external memory. Port P3 pins are multiplexed for special functions like serial communication, hardware interrupts, timer inputs and read/write operation from external memory. This microcontroller has an inbuilt UART (Universal Asynchronous Receiver/Transmitter) for serial communication. It can be programmed to operate at different baud rates. When compared to 8051, it has a third 16-bit timer, capable of a number of new operation modes and 16-bit reloads.

4.2 MAX232 IC

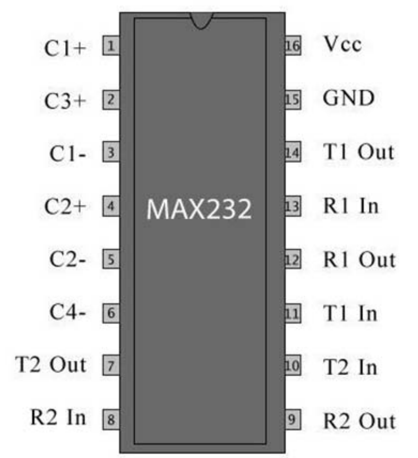

Fig. 4: MAX232 Pin diagram

The MAX232 is an integrated circuit first manufactured in 1987 by Maxim Integrated Products that converts signals from a RS-232 (Recommend Standard 232) serial port to signals suitable for use in TTL (Transistor-Transistor Logic) compatible digital logic circuits. The MAX232 is a dual driver/receiver and usually converts the RX, TX, CTS and RTS signals.

Table 1: Voltage Levels

RS-232 line type and logic level	RS-232 voltage	TTL voltage to/from MAX232
Data transmission (Rx/Tx) logic 0	+3 V to +15 V	0 V
Data transmission	-3 V to -15 V	5 V

(Rx/Tx) logic 1		
Control signals (RTS/CTS/DTR/DSR) logic 0	-3 V to -15 V	5 V
Control signals (RTS/CTS/DTR/DSR) logic 1	+3 V to +15 V	0 V

When a MAX232 IC receives a TTL level to convert, it changes a TTL logic 0 to between +3 and +15 V, and changes TTL logic 1 to between -3 to -15 V, and vice versa for converting from RS-232 to TTL. This can be confusing when realized that the RS-232 data transmission voltages at a certain logic state are opposite from the RS-232 control line voltages at the same logic state. This is clarified in the above table.

The MAX232 has two receivers that convert from RS-232 to TTL voltage levels, and two drivers that convert from TTL logic to RS-232 voltage levels. As a result, only two out of all RS-232 signals can be converted in each direction. Typically, the first driver/receiver pair of the MAX232 is used for TX and RX signals, and the second one for CTS and RTS signals.

4.3 16x2 LCD

LCD (Liquid Crystal Display) screen is an electronic display module and finds use in a wide range of applications. A 16x2 LCD display is very simple and basic module, and is usually employed in many different devices and circuits. These modules, in many cases, are preferred over seven segment displays and other multi segment LEDs because LCDs are easily programmable; economical; have the advantage of displaying even custom and special characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per row and there are 2 such rows. In this LCD 5x7 pixel matrix is used to display each character. This LCD contains two registers, namely, Command and Data.

The command instructions given to the LCD are stored in the command register. A command is an instruction given to LCD to do a predefined task like initializing it, setting the cursor position, clearing its screen, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. The LCD can be used in 8 bit and 4 bit modes, however in this project it is used in the 8 bit mode.

5. WORKING

The working of the project is explained in the following steps:

1. The program starts by initialising Port as input/output. Port P2 is made output for sending data to the LCD for displaying text. The pins 1, 2, 3 of Port P1 are used as control pins for the LCD. Pin 10 i.e. the RXD pin of the MCU (microcontroller) is used to receive data serially from the RFID module.
2. The 12 byte unique code corresponding to the card is read by the reader when the user taps his card onto the reader. The reader then passes the code serially to the microcontroller.
3. The MCU compares the code with the database stored in it in order to identify the user. If the code is found in the database the MCU proceeds by asking for the PIN corresponding to the user.
4. The User enters the 4-digit PIN using a 4x3 keypad. If the PIN matches to the one stored in the database, the MCU proceeds by asking for the amount to be deducted. If however, the PIN does not match, the MCU asks for the PIN again. Upon three successive unsuccessful authentication attempts, the MCU blocks the card.
5. The user after PIN authentication enters the amount by the 4x3 keypad on the kit. The MCU checks the balance in the user's account and if the balance is adequate, it deducts the amount from the balance and new balance is displayed. If however, the user does not have adequate balance in his account, the message 'INSUFFICIENT BALANCE' is displayed on the LCD and amount is asked again.

The microcontroller then tells the user that the transaction has been successfully completed and then becomes ready to accept another card's code.

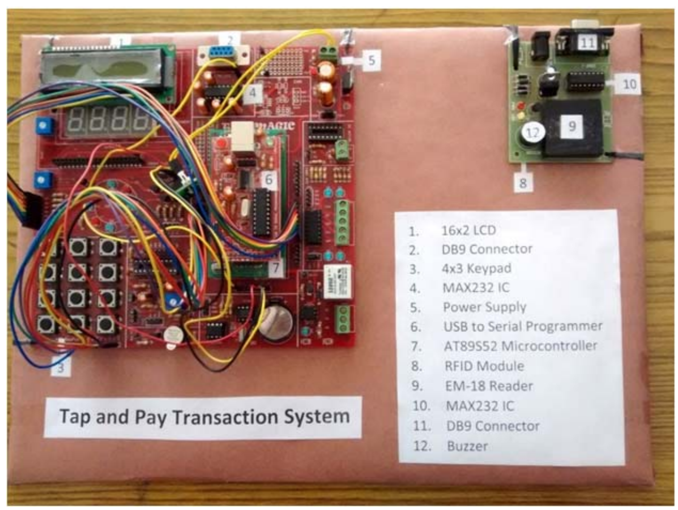

Fig. 5: Working Model of Tap and Pay Transaction System

6. CONCLUSION

This paper has presented an architecture and prototype application for enabling the user to make contactless payments using passive RFID technology. The system presented was based on RFID technology, and was able to accurately make transaction. Generally, contactless payment systems are devoid of PIN authentication, but in order to make this system more secure, there is a provision for PIN authentication as well. The most noteworthy advantage of this system is that there is no contact between the tag and the reader, and the system requires no line of sight. The tags can be read through a variety of substances and surfaces. They can also be read at extremely high speeds. Robustness, reliability, and zero power consumption of the passive tags is the key strength of this system. The reduction of price in RFID tags and readers could lead to extensive development of accurate systems and encourage businesses to use it more and more. The problem with RFID systems is that a tag might not be read, in spite of being in the reader's range, due to collisions, this problems need to be resolved to provide efficient solution for tag identification.

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