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NON-CASH PAYMENT METHOD USING QR CODES IN AN AUTOMATED MICROCONTROLLER-BASED VENDING MACHINE

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BRAC University, Dhaka, Bangladesh

Declaration

We declare that this dissertation is the product of our own research and project work that is mentioned in details in this paper. This thesis project has not been submitted previously for any degree or examination in any other university and that all the sources we have used or quoted have been indicated and acknowledged as complete references.

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Date:

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Abstract

The purpose of this thesis project is to implement a micro-controller-based automated vending machine which uses codes as a method for authorization of payments of online accounts to implement a non cash payment method for a contact less mobile payment system. Once a user places his/her order in the vending machine a QR (quick response) code is generated which holds all of the information of the user's order. An application is used to scan that QR code. The QR code once scanned with that application, populates the information of the order and sends that information to a web server only after the user’s approval for using their online account for payment. This web server takes this input from the user and processes the payment. The transaction is made from the web server with an online payment platform which holds the user's account. After the transaction is made, a second QR code, which stores the user's order information and authorization, is sent to the user's application from the server. User displays the QR code and it is scanned by the vending machine's scanner to release the desired product(s) thus making the process contact less.

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Chapter - 1

Introduction

We all know that science and technology that has made our life easier, given us immense opportunity to access to anyone we desire. Mobile phone is one of the greatest invention among all of the technologies, It's a wonderful invention of modern science, was first introduced in Bangladesh in the middle of 1990s. At that time only the rich people were blessed with that fascinating machine of communication. Now-a-days mobile phone has become a part & parcel of our everyday life and it is quite affordable to the poor people as well. Bangladesh is home to 160 million people with over 70% of the population living in rural areas on $2 per day or less.[12]. The country is the ninth-largest market worldwide in terms of mobile subscribers in Q1 2013 with 70 million 'unique' actively using 112 million mobile connections Technology behind mobile phone has been changed several times and it's an ongoing process. So far mobile phones have experienced 1G, 2G, 2.5, 3G and in some developed countries 4G technology. As 4G is yet to get a vast coverage, 3G is one of the most talked technologies in the present scientific world. Although developed and our neighboring countries have been experiencing 3G for a handsome number of years, Bangladeshi telecom operator Teletalk launched 3G only in 2012, a trend followed by other telecom operators as well till now. Though Mobile phone has traditionally been used for voice communications, today it can serve as the platform for a variety of communication outputs including data , video and contactless payment.

Now a days, Bangladesh has also found significant utility with mobile services. So, suddenly we got an idea that mobile can be used as the latest buzz in retail payment applications in contactless payment—a non-cash payment transaction that doesn't need a physical connection between the consumer payment device and the physical point-of-sale (POS) terminal. Contactless payment devices are available in multiple form factors, ranging from traditional plastic cards to key fobs, watches and mobile phones. Whether it is a new feature on a standard credit card or a dedicated payment account, contactless payment offers an alternative to more traditional payment methods such as magnetic stripe credit cards or cash.

In early 2010, the mobile financial services to take off in Bangladesh. Bangladesh has moved partly down this path.[11] A newly released overview report on Mobile

Financial Services by Bangladesh's Central Bank highlights the progress achieved two years on. 9

Firstly. We know that, Contactless payment is particularly attractive in merchant segments where speed and convenience of payment are essential, including quick-service restaurants, gas stations, convenience stores, parking facilities, transit services, entertainment venues and unsafe vending locations.

Secondly, its offers consumers the speed and convenience of "touch-and-go" or "pay with-a-wave" payment devices. No more fumbling for cash, counting change, or worrying about whether you have enough cash for a purchase. In many cases, consumers also don't need to signal receipt or enter a personal identification number (PIN). Perhaps the biggest benefit however is that it will give consumers a fast alternative to cash payment.

Thirdly, A "Contactless Payments: Delivering Merchant and Consumer Benefits," detailed the many benefits to retailers who accept contactless payment—faster transaction times, increased revenue, improved operational efficiency and lower operating costs. The report includes results from the MasterCard and American Express pilots to illustrate the benefits to merchants and issuers. For example, transaction volume and size increased .Master Card PayPass cardholder transaction volumes increased 12 percent from the prior year at the PayPass trial merchants. American Express Pay pilot results showed that customer average transaction size increased 20 to 30 percent compared to cash spending at participating merchants. The technology allows issuers to penetrate the cash payment market, enjoy increased customer transaction volume and improve customer retention and loyalty.

A consumer presents a contactless MasterCard, Visa or American Express payment card or key chain device to within a couple of inches of the POS terminal. The

terminal automatically reads payment account information stored on the smart chip embedded in the card and securely processes the payment transaction. Inside the card or keychain device a contactless smart chip is wired to an antenna.

Finally, Contactless payment terminals emit high frequency radio waves which are used to both provide power to the contactless payment device and communicate information between the device and the reader.

When the contactless payment device is brought close to the reader (typically less than 4 inches away), the contactless smart chip is powered on. Once the chip is powered on, a wireless communication protocol is established between the contactless device and the reader. The card and the terminal exchange security information, then conduct a secure payment transaction, all in less than one-third of a second.

A. Literature review:

Contactless payment is already being used in Asia, Europe and North America. Trains and subway systems around the world already use contactless smart cards for transit payment, with many major cities in the United States like Washington D.C., Chicago, Boston and San Francisco also implementing or planning to implement contactless smart card-based automatic fare collection (AFC) systems. American Express and MasterCard conducted contactless payment pilots in several cities (Orlando, FL and Dallas, TX for MasterCard PayPass and Phoenix, AX and New York, NY for American Express ExpressPay) before they and Visa USA announced that contactless payments were ready for nationwide launch.

Millions of U.S. consumers are already using contactless payment technologies, with tens of millions more expected this year as the new financial industry-backed contactless payment initiatives are launched nationwide. Chase Bank U.S.A. recently announced a broad roll out of "blink" credit cards with contactless payment technology. American Express, JCB, MasterCard, and Visa have all conducted pilot programs for contactless payment. Transit riders in major cities pass through turnstiles and parking facilities using contactless AFC cards. Consumers purchase gasoline, fast food and groceries using ExxonMobil Speedpass™. Motorists speed through toll lanes on freeways, bridges and tunnels using ultra high frequency contactless payment systems such as E-Z Pass™ and similar toll payment systems.

Both American Express, MasterCard and Visa contactless payment devices and RFID tags use RF technology to communicate information, the contactless payment devices have fundamentally different capabilities than RFID tags. Applications that use RF to communicate are implemented using different frequencies and hardware capabilities, resulting in operational ranges and security features that are based on the needs specific to each market. The contactless smart chips used in payment devices can provide much higher security using techniques like mutual authentication, unique diversified session keys and data encryption. As a general definition, RFID tag technology is used in applications that identify or track objects and contactless smart chip technology is used in applications that

identify people or store financial or personal information. You can think of the RFID tag as an alternative to a bar code.

Contactless smart chip technology is a type of smart card, and you can think of it as a tiny computer in a contactless device that is designed to protect the information inside it and any transactions made with it.

In general the differences between these two technologies, particularly the security and privacy protection advantages of contactless smart chips, are poorly understood due to the complexity of the subject

Different contactless payment schemes use different technology to implement contactless radio frequency communications and consumer account information storage. This is very important to remember since the operational range and security features will not be the same for all contactless payment implementations.

In general, contactless payment devices that use smart chip technology comply with the international standard ISO/IEC 14443. This standard limits the ability to read the contactless device to approximately 4 inches (10 centimeters) and smart chips complying with this standard can support a wide variety of security measures to ensure the integrity, confidentiality and privacy of stored or transmitted information and to counter potential security threats. For example, the American Express, MasterCard and Visa contactless payment initiatives and many new contactless transit fare payment cards implement ISO/IEC 14443 compliant smart chip technology in the contactless payment cards and devices. Longer-range contactless toll payment implementations and ExxonMobil Speedpass do not use smart chip technology.

It is also important to note that there are contactless payment implementations that use proprietary smart chip technology that is not compliant with ISO/IEC 14443, but that may incorporate security features to protect the payment transactions.

B. Motivations:

Bangladesh became the latest nation with at least 100 million active cell phone users so mobile phones are available almost in every hand. Mobile payments by

smartphone hold the future as it is became a part of our day to day life. So, contactless payment through mobile is an easy, safe and fast payment method. Smartphones also offer possibilities for potentially taking over more functions from the wallet. Customers want to be able to pay quickly, easily and safely. Also, Contactless payments is a new payment method that fulfils this need. It makes it possible to make a payment directly from the mobile account by holding a smartphone against the terminal. Payments are made more quickly because customers can pay amounts with in a second by choosing the product and entering a personal identification number and password and it's a complete self-service process. So, people can purchase anything anytime if they have a Smartphone on hand with a purchasable amount of money on his/her account. We thought to make an overall system for non-cash contactless payment and that was our core motivation to do this work.

C. Arrangement:

Since its independence in 1971, Bangladesh has been plagued with many social issues like poverty, illiteracy etc. Hence, science and technology have lagged behind in the priority list of the successive governments. However, that so called old process of transaction are still going on and that's the main reason for stepping back in technology sector with respect to this competitive world. This is why we tried to develop this system to make the things smarter. We arranged all the sensors and integrated them in our system and they worked properly which helped us to fulfill our desire about this project.

Chapter-2

System Overview

Our system is an Arduino based vending machine which uses codes as an encryption method for the proper authorization of the payment. The user subscribes the system by registering an account prior to using the system. The Arduino based circuit then encrypts the given user information and encodes it into a QR code. The QR code is displayed in the Graphical LCD. An android application is used to read that QR code.

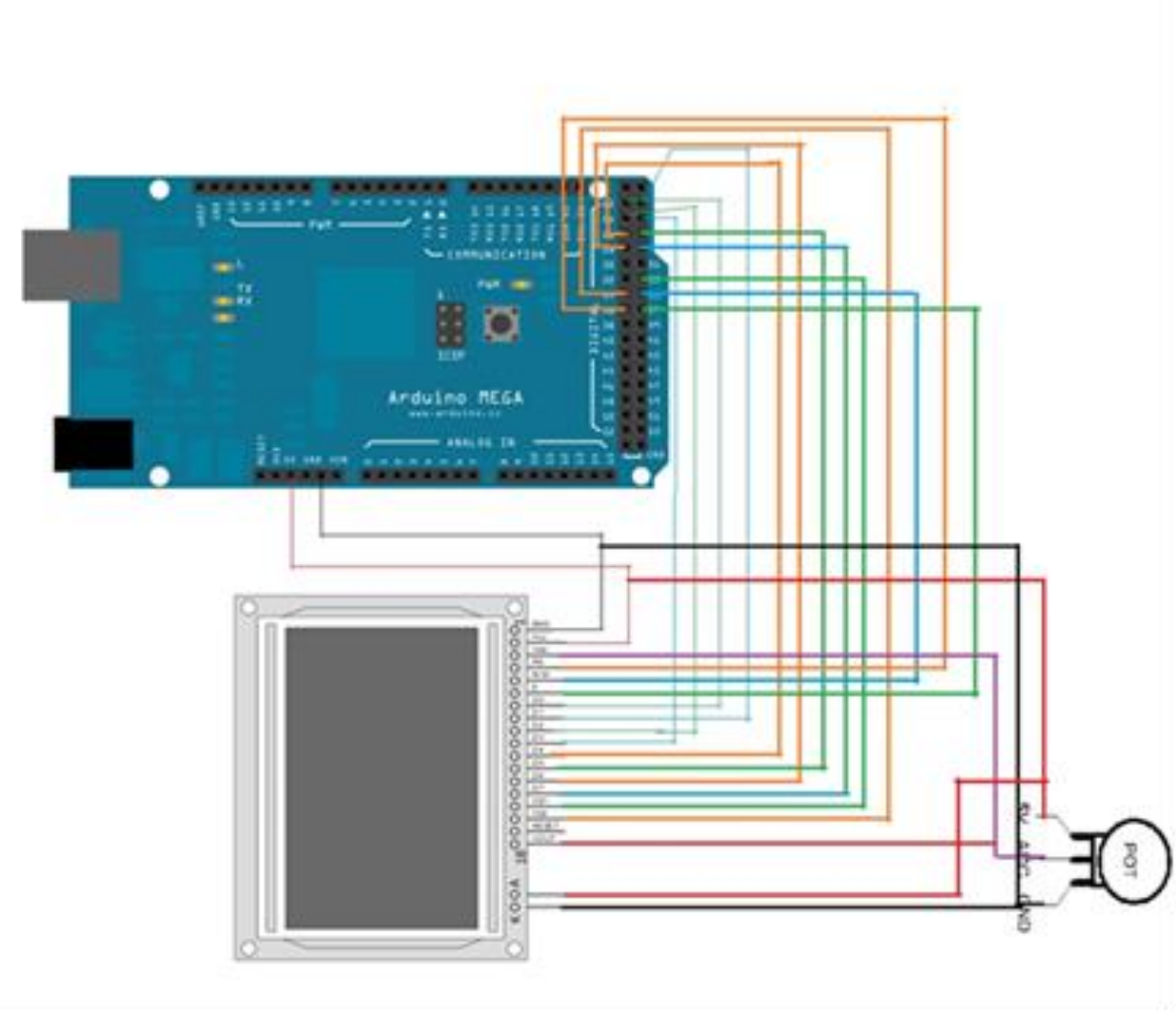
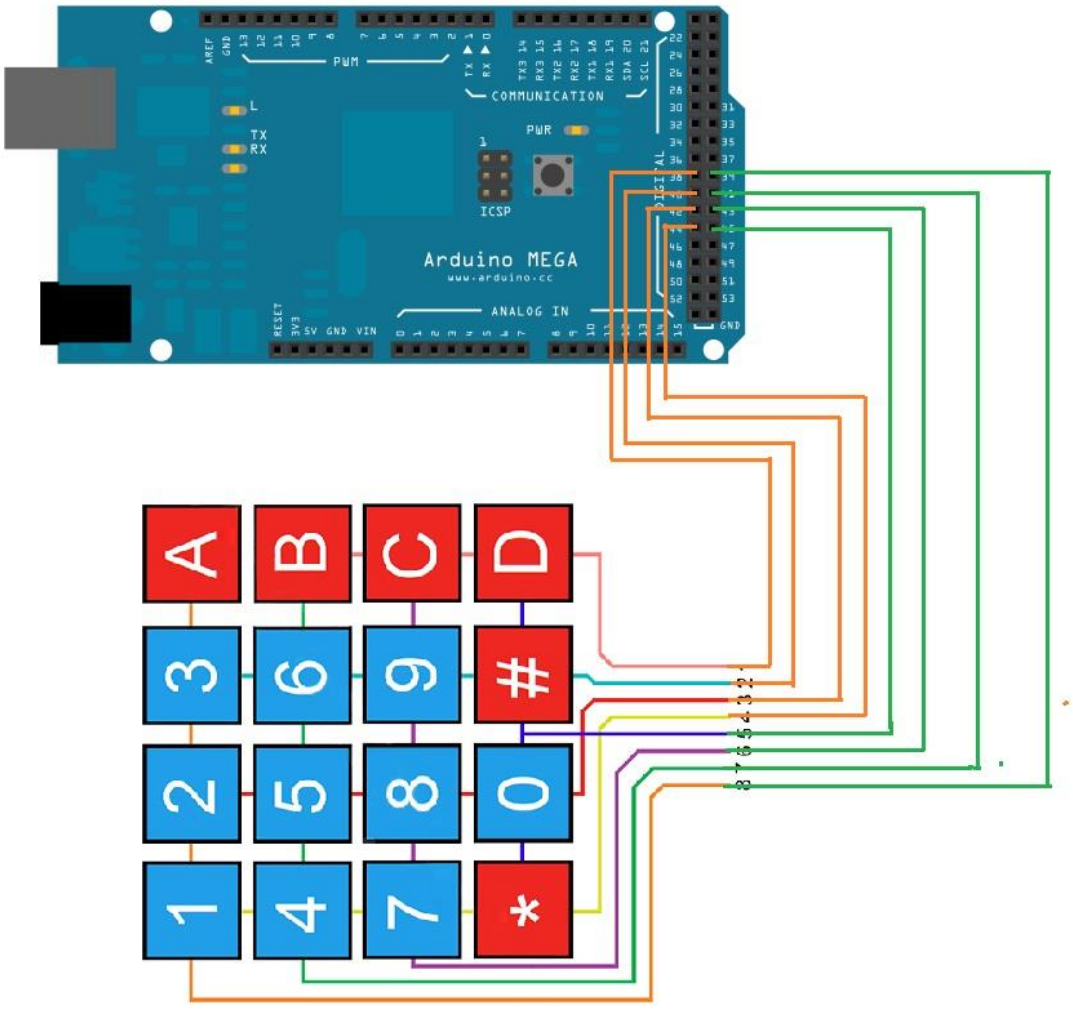


Fig: Interface between Arduino Mega and GLCD

The QR code holds the user information, purchase information and a unique number [14]. Only after scanning the QR code can the unique number be deciphered [15]. Using the keypad connected to the Arduino the pin number is inserted into the machine. The Arduino checks if the pin is correct. If it is correct it waits for the users' confirmation. Once confirmed a signal from Arduino goes into a relay circuit connected to a 12V source and an actuator connected to that 12 V source.

Fig: Interface between Arduino Mega and Keypad Matrix:



The actuator moves forward and pushes a can out of the machine. And immediately retracts into its original position.

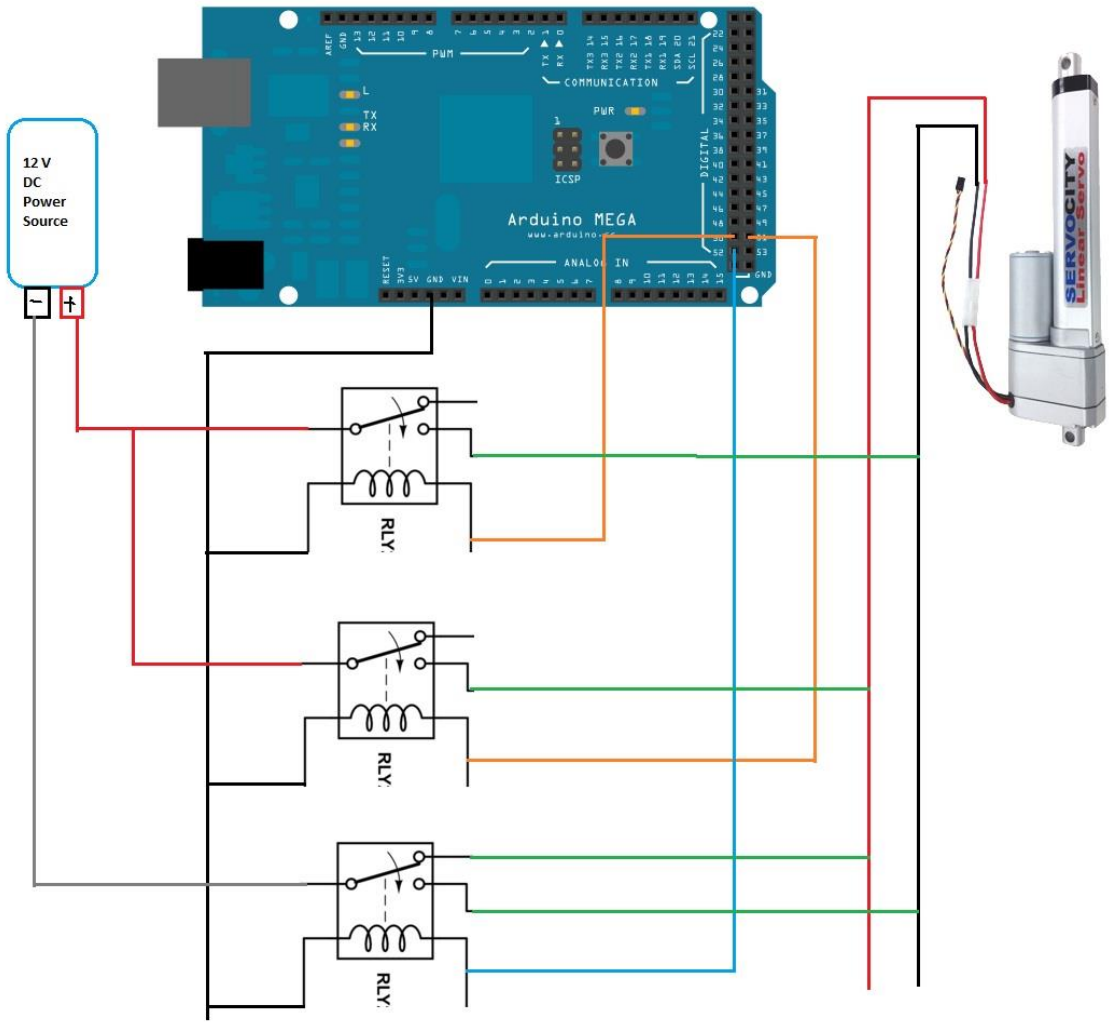


Fig: Interface between Linear Actuator and Relay Circuit:

Furthermore as the vending machine will hold food items, it is imperative to observe the inside temperature and therefore an Arduino Uno is connected separately to a grove temperature and humidity sensor to keep monitoring.

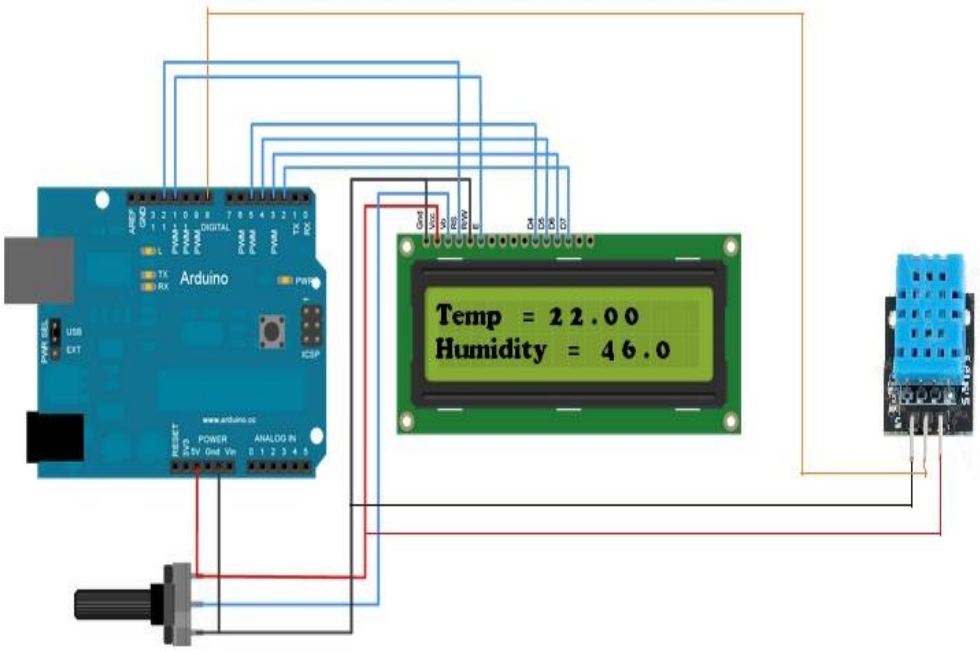


Fig: Interface between Arduino Uno and Temperature and Humidity Sensor:

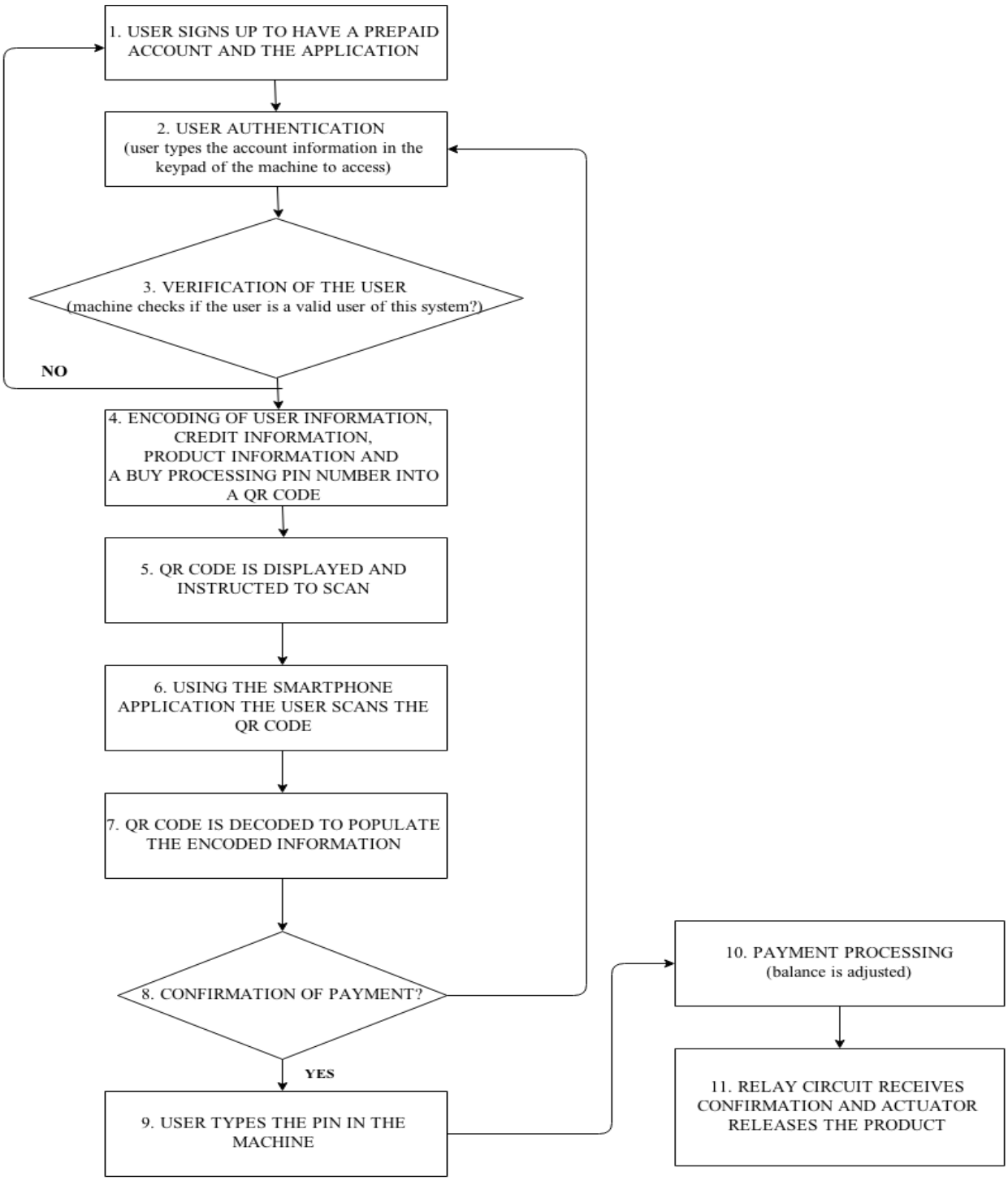


Figure Flowchart of the system

Chapter-3

System Implementation

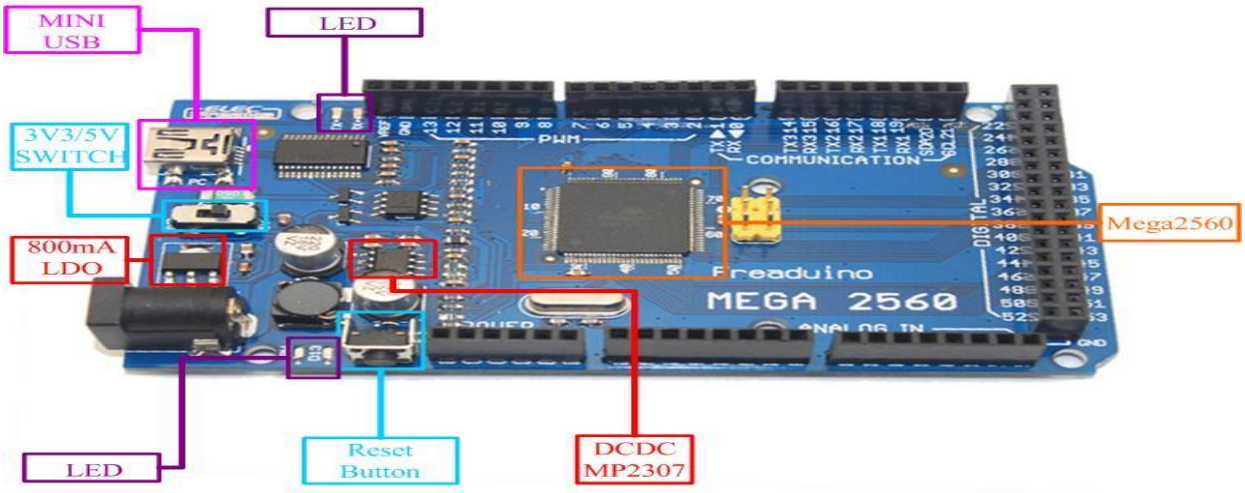
Arduino mega 2560

The Arduino Mega 2560 is a microcontroller board based on he ATmega2560 (datasheet). It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, 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 a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

The Mega 2560 is an update to the Arduino Mega, which it replaces.

The Mega2560 differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the ATmega16U2 (ATmega8U2 in the revision 1 and revision 2 boards) programmed as a USB-to-serial converter.
Revision 2 of the Mega2560 board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.
Revision 3 of the board has the following new features:

1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.



Technical specification:

Summary : [3]

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

Power:

The Arduino Mega 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 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Ground 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.

The power pins are as follows:

- VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.
- IOREF. This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

Memory

The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

Input And Output:

Each of the 54 digital pins on the Mega 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 20-50 kOhms. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega16U2 USB-to-TTL Serial chip.

External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2).These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See theattachInterrupt() function for details.

PWM: 2 to 13 and 44 to 46. Provide 8-bit PWM output with the analogWrite() function.

SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication using the SPI library. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Uno, Duemilanove and Diecimila.

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.

TWI: 20 (SDA) and 21 (SCL). Support TWI communication using the Wire library. Note that these pins are not in the same location as the TWI pins on the Duemilanove or Diecimila.

The Mega2560 has 16 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and analogReference() function.

There are a couple of other pins on the board:

AREF. Reference voltage for the analog inputs. Used with analogReference().

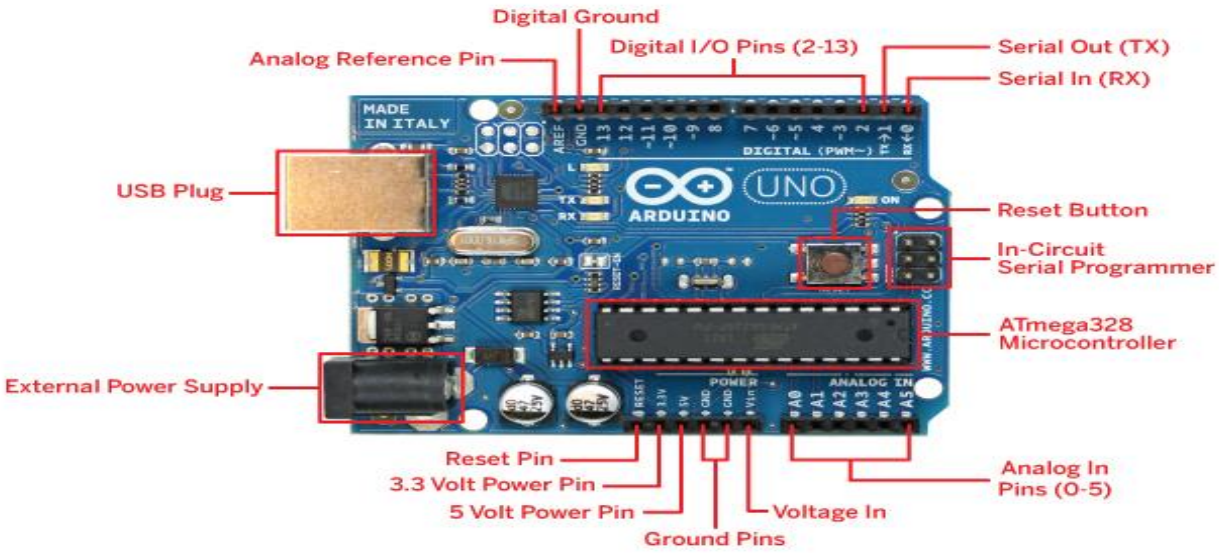
Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Overview of using Arduino

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP). Arduino is a cross-platform program. You'll have to follow different instructions for your personal OS.

Arduino Uno

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 crystal oscillator, a USB connection, a power jack, an ICSP header, 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 a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduno, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduin board.



Technical specifications:

Summary: [4]

Microcontroller	- ATmega328
Operating Voltage	-5V
Input Voltage (recommended)	- 7-12V
Input Voltage (limits)	- 6-20V
Digital I/O Pins	- 14 (of which 6 provide PWM output)
Analog Input Pins	- 6
DC Current per I/O Pin	- 40 mA
DC Current for	-3.3V Pin 50 mA
Flash Memory	- 32 KB of which 0.5 KB used by bootloader
SRAM	- 2 KB
EEPROM	- 1 KB
Clock Speed	- 16 MHz

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 2.1mm center-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.

The power pins are as follows:

• VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

• 5V. The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.

• 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

• GND. Ground p

Memory:

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input 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 20-50 kOhms. In addition, some pins have

specialized functions:

• Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. TThese pins areconnected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip .

• External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

• PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

• SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

• 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, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

• I^2C: 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library.

There are a couple of other pins on the board:

• AREF. Reference voltage for the analog inputs. Used with analogReference().

• Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Overview of using Arduino uno:

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP). Arduino is a cross-platform program. You'll have to follow different instructions for your personal OS.

Actuator

An actuator is something that converts energy into motion. It also can be used to apply a force. An actuator typically is a mechanical device that takes energy — usually energy that is created by air, electricity or liquid — and converts it into some kind of motion. That motion can be in virtually any form, such as blocking, clamping or ejecting. Actuators typically are used in manufacturing or industrial applications and might be used in devices such as motors, pumps, switches and valves. In engineering, actuators are frequently used as mechanisms to introduce motion, or to clamp an object so as to prevent motion. In electronic engineering, actuators are a subdivision of transducers. They are devices which transform an input signal (mainly an electrical signal) into motion. Therefore, Generally An actuator is a type of motor that is responsible for moving or controlling a mechanism or system[7]. It is operated by a source of energy, typically electric current, hydraulic fluid pressure, or pneumatic pressure, and converts that energy into motion. An actuator is the mechanism by which a control system acts upon an environment. The control system can be simple (a fixed mechanical or electronic system), software-based (e.g. a printer driver, robot control system), a human, or any other input.

Keypad

A keypad is a set of buttons or keys bearing digits, symbols and/or alphabetical letters placed in order on a pad, which can be used as an efficient input device. A keypad may be purely numeric, as that found on a calculator or a digital door lock, or alphanumeric as those used on cellular phones. If it mostly contains numbers then it can also be called a numeric keypad. [5]Keypads are found on many alphanumeric keyboards and on other devices such as calculators, push-button telephones, combination locks, and digital door locks, which require mainly numeric input.


1 2 3 A
4 5 6 B
7 8 9 C
* 0 # D

LCD Display

Liquid crystal displays (LCDs) are a passive display technology. This means they do not emit light; instead, they use the ambient light in the environment. By manipulating this light, they display images using very little power. This has made LCDs the preferred technology whenever low power consumption and compact size are critical[8].A liquid crystal display or LCD draws its definition from its name itself. It is combination of two states of matter, the solid and the liquid. LCD uses a liquid crystal to produce a visible image. Liquid crystal displays are super-thin technology display screen that are generally used in laptop computer screen, TVs, cell phones and portable video games. LCD's technologies allow displays to be much thinner when compared to cathode ray tube (CRT) technology.

Liquid crystal display is composed of several layers which include two polarized panel filters and electrodes. LCD technology is used for displaying the image in notebook or some other electronic devices like mini computers. Light is projected from a lens on a layer of liquid crystal. This combination of colored light with the grayscale image of the crystal (formed as electric current flows through the crystal) forms the colored image. This image is then displayed on the screen.

An LCD is either made up of an active matrix display grid or a passive display grid. Most of the Smartphone's with LCD display technology uses active matrix display, but some of the older displays still make use of the passive display grid designs. Most of the electronic devices mainly depend on liquid crystal display technology for their display. The liquid has a unique advantage of having low power consumption than the LED or cathode ray tube.

Liquid crystal display screen works on the principle of blocking light rather than emitting light. LCD's requires backlight as they do not emits light by them. We always use devices which are made up of LCD's displays which are replacing the use of cathode ray tube. Cathode ray tube draws more power compared to LCD's and are also heavier and bigger.

The principle behind the LCD's is that when an electrical current is applied to the liquid crystal molecule, the molecule tends to untwist. This causes the angle of light which is passing through the molecule of the polarized glass and also cause a change in the angle of the top polarizing filter. As a result a little light is allowed to pass the polarized glass through a particular area of the LCD. Thus that particular area will become dark compared to other. The LCD works on the

principle of blocking light. While constructing the LCD's, a reflected mirror is arranged at the back. An electrode plane is made of indium-tin oxide which is kept on top and a polarized glass with a polarizing film is also added on the bottom of the device. The complete region of the LCD has to be enclosed by a common electrode and above it should be the liquid crystal matter.

Next comes to the second piece of glass with an electrode in the form of the rectangle on the bottom and, on top, another polarizing film. It must be considered that both the pieces are kept at right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back. As the electrode is connected to a battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. That particular rectangular area appears blank.

Advantages of an LCD's:

- LCD's consumes less amount of power compared to CRT and LED
- LCD's are consist of some microwatts for display in comparison to some mill watts for LED's
- LCDs are of low cost
- Provides excellent contrast
- LCD's are thinner and lighter when compared to cathode ray tube and LED

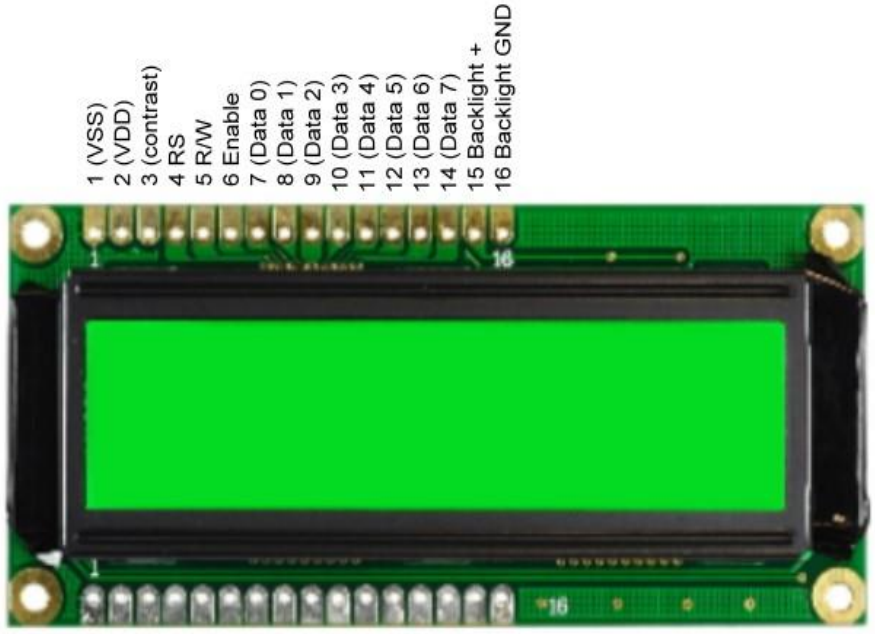
Disadvantages of an LCD's:

- Require additional light sources
- Range of temperature is limited for operation
- Low reliability
- Speed is very low
- LCD's need an AC drive

Applications of Liquid Crystal Display

Liquid crystal technology has major applications in the field of science and engineering as well on electronic devices.

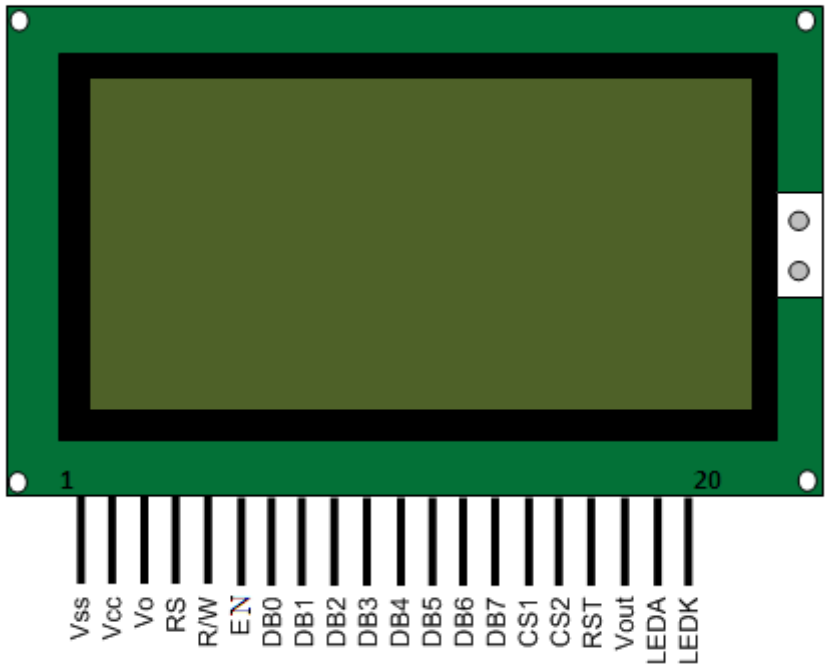
- Liquid crystal thermometer
- Optical imaging
- The liquid crystal display technique is also applicable in visualization of the radio frequency waves in the waveguide
- Used in the medical applications



Graphical LCD Display 128*64

The 16x2 Character LCDs have their own limitations; they can only display characters of certain dimensions. The Graphical LCDs are thus used to display customized characters and images. The Graphical LCDs find use in many applications; they are used in video games, mobile phones, lifts etc. as display units. Various graphical LCDs are available in the market with different sizes. Here JHD12864E Graphical LCD has been explained. This LCD has a display format of 128x64 dots and has yellow-green colour backlight. Each LCD needs a controller to execute its internal operations. This LCD uses two KS0108 controllers.

Pin Diagram:



The 128x64 LCD is divided into two equal halves with each half being controlled by a separate KS0108 controller. Such LCDs (using KS0108 controller) involve paging scheme, i.e., whole LCD is divided equally into pages.

The paging scheme of the graphical LCD can be easily understood from the following table.

1. 128x64 LCD implies 128 columns and 64 rows. In total there are (128x64 = 1024) pixels.

2. 128x64 LCD is divided equally into two halves. Each half is controlled by a separate controller and consists of 8 pages. In above diagram, CS stands for Controller Select.

3. Each page consists of 8 rows and 64 columns. So two horizontal pages make 128 (64x2) columns and 8 vertical pages make 64 rows (8x8).

Pin Description:[9]

Pin no.	Function	Name
1	Ground (0 V)	Vss
2	Supply voltage; 5V	Vcc
3	Contrast adjustment	Vo
4	High to display data; Low for instruction code	Register select (RS)
5	Low to write to the register; High to read from the register	Read/Write (R/W)
6	Reads data when high; Writes data at high to low transition (falling edge)	Enable (EN)
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Chip selection for IC1; Active high	CS1
16	Chip selection for IC2; Active high	CS2
17	Reset signal; Active low	RST
18	Output voltage for LCD driving	Vout
19	Backlight V_{CC} (5V)	LED A
20	Backlight Ground (0V)	LED K

RELAY

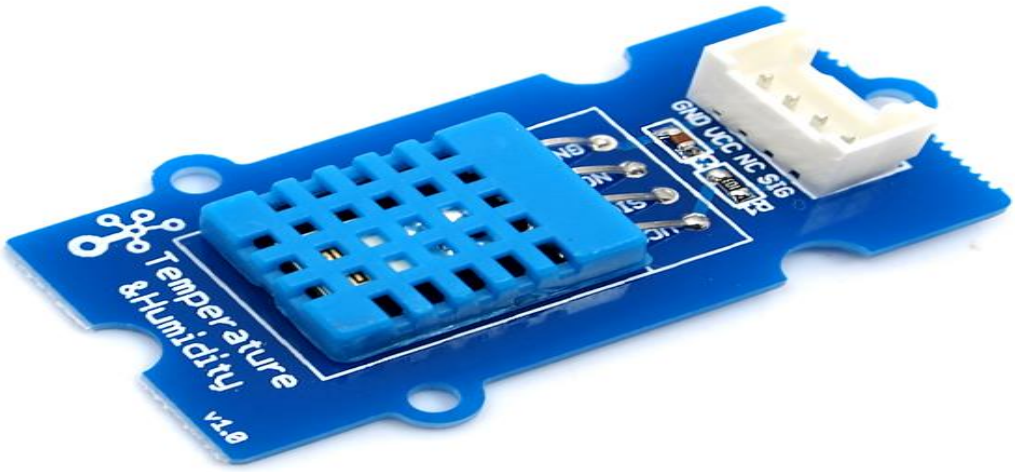
Relays are switches that open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit. As relay diagrams show, when a relay contact is normally open (NO),[10] there is an open contact when the relay is not energized. When a relay contact is Normally Closed (NC), there is a closed contact when the relay is not energized. In either case, applying electrical current to the contacts will change their state.

Relays are generally used to switch smaller currents in a control circuit and do not usually control power consuming devices except for small motors and Solenoids that draw low amps. Nonetheless, relays can "control" larger voltages and amperes by having an amplifying effect because a small voltage applied to a relays coil can result in a large voltage being switched by the contacts.

Protective relays can prevent equipment damage by detecting electrical abnormalities, including over current , undercurrent, overloads and reverse currents. In addition, relays are also widely used to switch starting coils, heating elements, pilot lights and audible alarms.

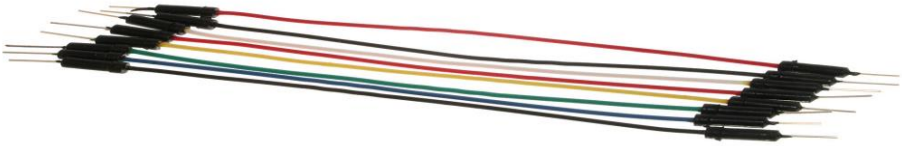
Grove - Temp & Humidity Sensor

Grove - Temp & Humidity Sensor is a multifunctional sensor that gives you temperature and relative humidity information at the same time. It utilizes a DHT11 sensor that can meet measurement needs of general purposes. It provides reliable readings when environment humidity condition in between 20% RH and 90% RH, and temperature condition inbetween 0°C and 50°C, covering needs in most home and daily applications that don't contain extreme conditions[1]. This DFRobot DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users'.



Jump wire

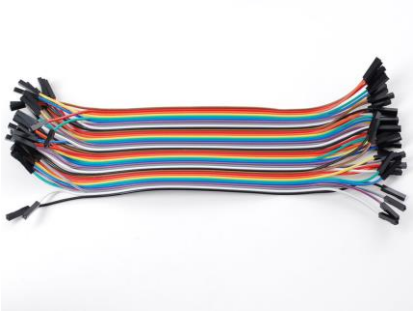
Jump Wires, commonly used with a breadboard, are used to transfer electrical signals from one part of the breadboard to the central microcontroller. Jump wires vary in size and color to distinguish what object they are working with. Sensors, buttons, and other such things all use jump wires to communicate with the microcontroller.[2]



We used here three types of jumper wires:

1.Male to Male Jumper Wire

2.Female to Female Jumper Wire



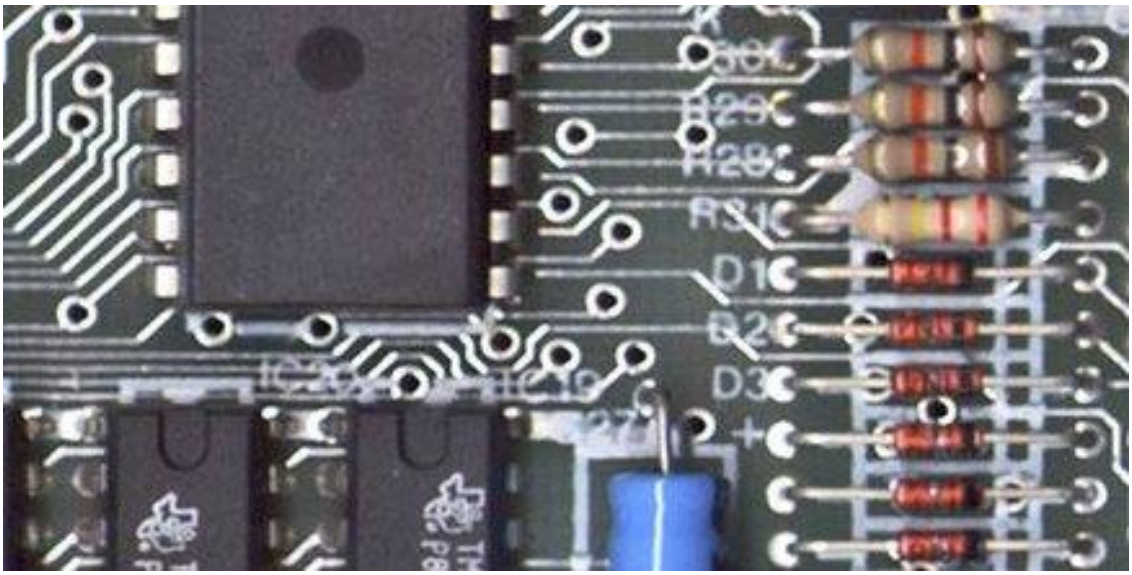
3.Male to Female Jumper Wire

Printed circuit board(PCB)

A printed circuit board (PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. PCBs can be single sided (one copper layer), double sided (two copper layers) or multi-layer. Conductors on different layers are connected with plated-through holes called vias. Advanced PCBs may contain components - capacitors, resistors or active devices - embedded in the substrate[6].

Printed circuit boards are used in all but the simplest electronic products. Alternatives to PCBs include wire wrap and point-to-point construction. PCBs require the additional design effort to lay out the circuit but manufacturing and assembly can be automated. Manufacturing circuits with PCBs is cheaper and faster than with other wiring methods as components are mounted and wired with one single part. Furthermore, operator wiring errors are eliminated.

When the board has only copper connections and no embedded components it is more correctly called a printed wiring board (PWB) or etched wiring board. Although more accurate, the term printed wiring board has fallen into disuse. A PCB populated with electronic components is called a printed circuit assembly (PCA), printed circuit board assembly or PCB assembly (PCBA). The IPC preferred term for assembled boards is circuit card assembly (CCA), for assembled backplanes it is backplane assemblies. The term PCB is used informally both for bare and assembled boards



Chapter - 4

Discussion

We explore and review the importance of various payment methods across various platforms. New possibilities for payment using digital mediums were explored during our work. A promising approach is to integrate online accounts or existing bank accounts of users into the system for registration. Possibilities for monitoring the vending machine wirelessly are being provided with the emergence of wireless sensor networks allied with the accessibility of the internet and the processing power of computers.

By using an application to read the QR code the authenticity of the purchased was ensured. However, sending that encrypted information is our future goal but during our work in order to better the security of the system it was applied that a pin number be manually inserted to the machine.

The limitations of using several programs in Arduino hindered us from using a more complex system. Thus it limited us from using the internet directly from the Arduino to generate a QR code for every new user.

Moreover, a simple database including user ids and passwords were built into the Arduino and the android application. Our research has showed that a php-based web server would have been ideal to store such information which is accessible from various networks.

Finally, various QR codes commencing with Version 1 (21 × 21 modules) up to Version 40 (177 × 177 modules) are being used around the world to date[14]. However due to simplicity of the data and the limitation of the display size for Graphical LCD, we chose the earlier versions. To further secure the system it was observed that more

information about the user, machine, location, product, and platform were required. Using a larger display and advanced platform all of the above mentioned information could have been properly encoded into one of the latest modules of QR codes and be implemented for the system.

By incorporating the system with various payment merchants and financial services corporation will enable us to process payment from various other existing platforms as well.

Chapter-5

Conclusion

By executing the proposed system along with the android application, a diverse set benefits for the payment emerges. In the future smarter systems will take over our basic needs one such as paying for goods and services. In addition, Bangladesh being an underdeveloped country could immensely be benefitted from the implementation of vending machines throughout the important infrastructures. In terms of inventory management and proper distribution of goods vending can be of large benefit.

Having a large number of phone users in the country [12], Bangladesh could be hugely benefitted using a non-cash payment such as this. In the wireless communication era smartphones have become a necessity in common man's life and so the necessity to incorporate applications and systems based on the smartphone is a top-priority and one that holds high demand.

Our goal was to show that it is possible to implement such a system very cheaply and still have the necessary components required for a sophisticated full-proof system. By using the already available technology of microcontrollers and smartphones, we implemented a system which adequately in the field.

In conclusion, this report provide tools for the payment method system and an insight into the possibilities that the existing technology holds. A successful implementation of the concept will provide a best payment method.

References:

[1]Grove- Temperature and Humidity Sensor: http://www.seeedstudio.com/wiki/Grove-_Temperature_and_Humidity_Sensor

[2]Jumper wire: http://en.wikipedia.org/wiki/Jump_wire

[3]Arduino Mega 2560: http://arduino.cc/en/Main/arduinoBoardMega2560

[4]Arduino UNO: http://en.wikipedia.org/wiki/Arduino

[5]Keypad: http://en.wikipedia.org/wiki/Keypad

[6]Printed circuit board(PCB): http://en.wikipedia.org/wiki/Printed_circuit_board

[7]Actuator: http://en.wikipedia.org/wiki/Actuator

[8]liquid crystal display(LCD) : http://en.wikipedia.org/wiki/Liquid-crystal_display

[9]Graphical LCD (GLCD): https://www.sparkfun.com/products/9351

[10]Relay: http://en.wikipedia.org/wiki/Relay

[11]The Growth of Mobile Financial Services in Bangladesh: http://www.cgap.org/blog/growth-mobile-financial-services-bangladesh

[12]mobile subscriber in Bangladesh : http://mefminute.com/2013/09/17/10-things-you-need-to-know-about-the-bangladesh-mobile-market/

[13] QR code versions : http://www.qrcode.com/en/about/version.html

[14]Generating QR code : http://www.qrcode.com/en/howto/generate.html

[15]Reading QR codes using applications: http://www.qr4.nl/QR-Code-Scanners.aspx

Appendices

Vending Machine operation test code with Arduino Mega:

```
#include <Password.h>
//http://www.arduino.cc/playground/uploads/Code/Password.zip
#include <Keypad.h>
//http://www.arduino.cc/playground/uploads/Code/Keypad.zip
#include <glcd.h>
#include <fonts/allFonts.h>
#include "bitmaps/allBitmaps.h"


Password password2 = Password( "1234" );
        // User ID Password
Password password = Password( "11221323" );
        // Pin Code


const byte ROWS = 4;
        // Four rows
const byte COLS = 4;
        //  columns

        // Define the Keymap
char keys[ROWS][COLS] = {
```

```
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};

byte rowPins[ROWS] = { 39,41,43,45 };
        // Connect keypad ROW0, ROW1, ROW2 and ROW3 to these Arduino pins.
byte colPins[COLS] = { 38,40,42,44 };
        // Connect keypad COL0, COL1 and COL2 to these Arduino pins.



        // Create the Keypad
Keypad keypad = Keypad( makeKeymap(keys), rowPins, colPins, ROWS, COLS );

//initializing the pin of three relays
int Relay_1 = 50;
int Relay_2 = 51;
int Relay_3 = 52;




void setup(){

  GLCD.Init();
```

```
  GLCD.SelectFont(System5x7);

 pinMode(Relay_1, OUTPUT);
 pinMode(Relay_2, OUTPUT);
 pinMode(Relay_3, OUTPUT);
GLCD.print(" Enter User ID ");
  Serial.begin(9600);
  keypad.addEventListener(keypadEvent);

//add an event listener for this keypad
}

void loop(){
//first one is Column and Second one is Row
  GLCD.CursorTo(0, 1);
  keypad.getKey();
}

//take care of some special events
void keypadEvent(KeypadEvent eKey){
  switch (keypad.getState()){
    case PRESSED:
    GLCD.print(eKey);
          Serial.print("Pressed: ");
          Serial.println(eKey);
          switch (eKey){
```

```
            case '*': checkPassword(); break;
            case '#': password2.reset();
          case 'A': password.reset();

GLCD.ClearScreen();
GLCD.CursorTo(0, 0);
GLCD.print(" Enter Code ");
break;
            default: password2.append(eKey);
                password.append(eKey);
    }
  }
}


void checkPassword(){
  if (password2.evaluate()){
    GLCD.ClearScreen();
    GLCD.CursorTo(0, 0);
    GLCD.print("ACCESS");
    GLCD.CursorTo(0, 1);
    GLCD.print("GRANTED");
    GLCD.CursorTo(0, 2);
    GLCD.print("Please Scan");
    GLCD.CursorTo(0, 3);
    GLCD.print("To Pay");
    GLCD.CursorTo(0, 4);
```

```
  GLCD.print("To Enter");
  GLCD.CursorTo(0, 5);
  GLCD.print("Code Press");
  GLCD.CursorTo(0, 6);
  GLCD.print(" Button A ");
  GLCD.DrawBitmap(tests, 70,0);
  Serial.println("Success");
  //Add code to run if it works
 }

else if (password.evaluate()){
  GLCD.ClearScreen();
  GLCD.CursorTo(0, 0);
  GLCD.print("ACCESS");
  GLCD.CursorTo(0, 1);
  GLCD.print("GRANTED");
  GLCD.CursorTo(0, 2);
  GLCD.print("Enjoy Your");
  GLCD.CursorTo(0, 3);
  GLCD.print("CocaCola");
  digitalWrite(Relay_1, HIGH);
  digitalWrite(Relay_3, LOW);
  delay(11000);
  digitalWrite(Relay_1, LOW);
  delay(1000);
  digitalWrite(Relay_2, HIGH);
  digitalWrite(Relay_3, HIGH);
```

```
   delay(16000);
   digitalWrite(Relay_2, LOW);
   digitalWrite(Relay_3, LOW);
   Serial.println("Success");
  }

  else{
   GLCD.CursorTo(0, 0);
   GLCD.print("WRONG PASSWORD");
   GLCD.CursorTo(0, 1);
   GLCD.print("TRY AGAIN PRESS#");
   Serial.println("Wrong");

  //add code to run if it did not work
  }
}
```

Temperature and humidity sensor Arduino code Test using Arduino Uno:

```
#include <LiquidCrystal.h>

#include <DHT11.h>

int pin=8;
DHT11 dht11(pin);
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
void setup()
{lcd.begin(16, 2);
   Serial.begin(9600);
  while (!Serial) {
     ; // wait for serial port to connect.
    }
}

void loop()
{
  int err;
  float temp, humi;
  if((err=dht11.read(humi, temp))==0)
  {
    Serial.print("temperature:");
    lcd.setCursor(0,0);
```

```
  lcd.print("Temp = ");
  lcd.setCursor(8,0);
  lcd.print(temp);
  Serial.print(temp);
  Serial.print(" humidity:");
   lcd.setCursor(0,1);
  lcd.print("Humidity = ");
  Serial.print(humi);
  lcd.setCursor(12,1);
  lcd.print(humi);
  Serial.println();
 }
 else
 {
  Serial.println();
  Serial.print("Error No :");
  Serial.print(err);
  Serial.println();
 }
 delay(DHT11_RETRY_DELAY); //delay for reread
}
```