# AUTOMATED LIQUID DISPENSER

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# DEDICATION

This project work is dedicated to God Almighty for his immeasurable show of love towards me that has kept me thus far and to my wonderful and loving parents Mr and Mrs David Onuoha whose support and constant encouragement made this project a reality.

# DECLARATION

I Theophilus Onuoha, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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To our Project Supervisor, Bala A. Salihu whose assistance, objective criticism and useful suggestions made this project a success.

We also want to remember our colleagues and friends whose companionship has made the whole programme an easy journey.

# ABSTRACT

Automated Liquid Dispenser is a device mainly to dispense liquid based on a means of pre-paid payment. Payment process involves buying a scratch card with the service pin code. The device has an input unit (key pad), an output unit (LCD) and a dedicated personal computer to generate the service pins and to perform pin validation. If the service pin is correct, the dispenser dispenses, otherwise it doesn't.

This project provides an effective controlling means for liquid dispensing especially for commercial establishments. Among the benefits are: it provides a 24 hour service, profit is maximized due to increase in sales, just to mention a few.

The design process was broken down into sub units, each sub units was implemented separately and coupled to make up the Automated Liquid Dispenser.

A level of intelligence has been added to the device by way of a microcontroller hence making the device act independently.

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# CHAPTER ONE

# INTRODUCTION

## 1.1 BACK GROUND INFORMATION

The aim of engineering process is to solve social problems and ultimately make life easy for all. To this effect technological advancement has indeed proven that there is no limits to inventions, no ending point to discoveries and no boundaries to thoughts and ideas.

Over the past years, the concepts of dispensing has been such that it spans through the various states matter in the surrounding exit, ranging from liquid, solids and gases. The subject in whom this project report relates is liquid. Any substance which flows freely at room temperature and atmospheric pressure is referred to as Liquid [1]. There are various forms liquid exits; milk, oil, water etc. There are basically six elements which are liquid at room temperature and pressure: Bromine, Mercury, Francium, cesium, Gallium and Rubidium. This implies that when heated, elements do change their status and conversion takes place from one form to another. It is therefore realistic to say that all of nature's composition must belong to one of these classes.

The concept of liquid dispensing actually originated many decades ago, putting into consideration areas where usage can be applicable: residential, commercial and even for industrial intentions. One of the earliest types of liquid dispensers still notable today was for the purpose of soap dispensing [4]. This invention patented by Bobrick way back in the $18^{th}$ century, was to bring about a way to develop a soap dispenser for a Chemical Company involved in manufacturing various commercial products (waxes, ammonia, etc) for their railway passenger cars. What can be observed now is that liquid dispensers are breaking forth into having more powerful and sophisticated designs to meet a host of other types of liquid and applications.

However, true that liquid dispenser are gaining grounds in such a manner that they are now used for diverse purposes such as: refreshing aids (juice, wine etc), health care tools (hygiene), cosmetics (lotion, shampoo etc), scientific experiment assistants (Led re-filling), fuelling (gas stations) etc. It is therefore imperative, that being in a world like ours, with increasing needs of the insatiable man, more thoughts on how to see things been done in a better way is inevitable.

This project which is an Automated Liquid Dispenser is an embedded system designed for dispensing a fixed quantity of liquid to a buyer based on a means of prepaid payment.

It receives the numbers entered by a customer, validates the number and if valid, dispenses a commensurate quantity of the liquid to the customer.

For the validation process, the microcontroller communicates with the personal computer through its serial port. The microcontroller receives the pin code through the keypad and forwards the codes to the software running on the PC through the serial link between it and the computer. The application software checks through its data base of pin codes to find a match for the entered pin code. If there is a match, a response is sent to the dispenser to dispense and the corresponding pin code in the data base is deleted to avoid reuse of the same pin. Otherwise, the dispenser will not dispense.

For the sake of this project, every pin codes have been assigned the same quantity of liquid to be dispensed upon validation and water has been chosen as the test liquid since it shares similar properties with many other liquids.

Looking through what has being, this project is a step ahead on the context of "automation". Automation is taken to mean independent, self-directed and self-controlled. The notion of the dispenser is not actually new, but the systematic approach employed by it, is what makes the difference.

## 1.2 AIMS AND OBJECTIVES

This project work aims at developing a more reliable monitoring and controlling system for effective liquid dispensing, especially at petrol stations. Among the objectives are;

- Providing a 24 hours service. This enables customers to be served at any time of the day and at their convenience.
- Maximizing profit. Profit is limited to hours of services especially in Nigeria where most petrol station resumes operation by 7.00am and close at 8.00pm. Due to increased sales as a result of 24 hours services more profit accrues to the management. More so, since there is less or no human (sales man) intervention in the sales process, there is less or no room for fraudulent activities.
- Customers get exactly what was paid for. The problem of fuel attendant adjusting pump rates for selfish interest is eliminated. Since the time of flow of the liquid is programmed into the chip, it is therefore difficult and almost impossible for anyone to alter that rate.

## 1.3 METHODOLOGY

The operation of the liquid dispenser is governed mainly by a microcontroller and a dedicated personal computer system, with other units designed and constructed separately and attached to the microcontroller unit. The list below typically illustrates the procedures/steps employed to actualise this project.

1. Microcontroller circuit (this is the prime unit with all other circuits interfaced to it).
2. The Liquid Crystal Display (LCD) sub-circuit.
3. The keypad sub-circuit.
4. The pump control interfacing sub-circuit.
5. Serial link sub-circuit for link to the PC.
6. Power supply unit

## 1.4 SCOPE OF THE PROJECT

This project is mainly concerned with the dispensing of liquid. A little of intelligence has being added to it, making the whole machine to act independently. Access to machine is granted only via the pin codes on the cards making the microcontroller scan through the database residing in the personal computer each time a code is entered. The codes are entered through the key pad. The machine has a liquid crystal display (LCD) to serve as a sense of direction to the customer. There is a serial port attached to the machine which allows the microcontroller to communicate with the personal computer and also provide a means for controlling the activities of the machine.

Microcontroller being the heart of this project design makes possible for other features to be incorporated into it and making it more flexible.

## 1.5 PROJECT WORK ORGANISATION

This project work is organized as follows:

**CHAPTER ONE**

This chapter comprises the general introduction of the remote device and an overview of the entire project work.

**CHAPTER TWO**

Literature review of the existing technology, background study and the functionality of the Liquid Dispenser. The literature review gives an insight into what the project entails and its relevance with respect to previous works on the project. A review of previous literatures on the topic will be treated here with emphasis on the problems encountered, how to solve them and the best option among alternatives.

**CHAPTER THREE**

This chapter contains the design and construction of the hardware of the Liquid Dispenser, application development and justification of methodology employed. The chapter will include the system requirements that were derived for this project, and include important design considerations. Justifications and diagrams of these design considerations will also be included,

**CHAPTER FOUR**

This chapter involves mainly the implementation and testing of design, functionality and interoperability of functional parts. This will give details of the iterative prototyping method of implementation used, including details of each of the prototypes made, and improvements or otherwise of each prototype against the previous versions. The final architecture design will be shown in detail, with justification for certain decisions. It is also in this chapter that implementation problems and solutions will be discussed, which will highlight some of the common problems, encountered during project development. The results from this testing will also be discussed and lastly

**CHAPTER FIVE**

The Conclusion, recommendation and limitations of this project are stated in here. This chapter will sum up all aims set out in the introduction, indicating if the overall aims of the project have been met, and if the system was as it was expected. Learning outcomes from the project will be identified, and specified in the areas of limitations and recommendations. To be included in this chapter, are considerations for future research.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 INTRODUCTION

This chapter is aimed at exploring existing literature of previous works on the subject of this thesis. It examines previously related technology, schemes and methods involved, thereby stating areas of variation as opposed to that of the projects'.

## 2.2 MICROCONTROLLER TECHNOLOGY

As earlier mentioned in the previous chapter, the project, liquid dispenser is microcontroller based, this therefore brings us to the subject of microcontrollers.

The first recognizably modern embedded system was the Apollo Guidance Computer, developed by Charles Stark Draper at the MIT Instrumentation Laboratory. Again the first mass-produced embedded system was the Automatics D-17 guidance computer for the Minuteman missile, released in 1961[2]. By the mid-1980s, most of the previously external system components had been integrated into the same chip as the processor, resulting in integrated circuits called microcontrollers.

Microcontrollers generally have an architecture shown in the figure below known as Harvard as opposed to the more common Von Neumann architecture. The Harvard architecture is a computer configuration in which the memory area that contains the program instructions for the computer is separated from the memory area in which data is stored.

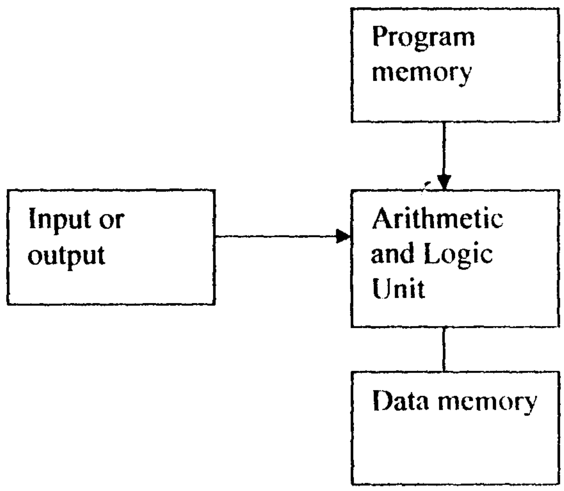



Figure 2.1 Block Diagram of a Microcontroller

Microcontroller technology has made many applications possible since they can be used as stand alone devices. They can be described as embedded systems which are simply special-purpose systems in which all the features present in a computer system are completely encapsulated in them. The use of Microcontrollers have been the order of the day, for the many advantages they have, one of which is, reduced cost since they are often mass-produced, their relatively small sizes, others lie in the ability of the features they poses. This includes:

- The central processing unit - ranging from small and simple 4-bit processors to sophisticated 32- or 64-bit processors
- RAM for data storage, ROM, EPROM, EEPROM or Flash memory for program storage
- Input/output interfaces such as serial ports (UARTs)
- Clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit.

- Programmability- all the necessary control and functions are already embedded in it, so all that is left is for the programmer to know its instruction set since the system is dedicated for specific tasks.

They are best used when there is a need for automatic controlling. For example: in cellular telephones and telephone switches, engine management systems in automobiles, electronic measurement instruments (such as digital multimeters, frequency synthesisers, and oscilloscopes), Printers, automated dispensers, Televisions, radios, CD players, tape recording equipment, Hearing aids, Security alarm systems, fire alarm systems, building services systems, engine controllers and antilock brake controllers for automobiles, home automation products, such as thermostats, air conditioners, sprinklers, security monitoring systems, Handheld computers or PDAs, automatic teller machines(ATMs) etc.

Having specified numerous applications, it is important therefore to cite instances relating to the project where this very most recent and intriguing technology has found itself been used.

## 2.3 MICROCONTROLLER BASED LIQUID DISPENSERS

### 2.3.1 JUICE DISPENSER

This invention is based on a work of some university students for their final year project [3].This is a microcontroller based machine for dispensing juice. The dispenser has a compartment for placing a glass or a cup for collecting the juice. This device has a pump for sucking in the juice from the stored container and releasing it through a fine tap head. The composition is such that when a certain number of combination keys are toggled the machine starts the dispensing. In order to have a share of what is in the reserved container any individual who desires to access it must know the right combination of the keys. This is more of a security based invention that only permits persons who know the key lock to access the device. The microcontroller understands the various key combinations and so whenever it encounters the wrong settings it does nothing. The pump has a relay which is interfaced with the microcontroller for controlling the pumping action in order to start it or cut it off. The device is powered by a regulator (AC to DC converter). The platform on which the glass is mounted uses a CD-ROM (crude) which can receive and eject automatically when the glass is filled, a button is pressed to implement any of these two actions. The casing is made up of an insulated material, since the dispensing is for liquid bearing in mind that water is a conductor.

### 2.3.2 MOTORIZED HOUSEHOLD LIQUID DISPENSER

This dispenser was invented by David Boll, Jeffery kalman, Michael Schiavoni, Craig m. Saunders [4]. The motorized household liquid dispenser has a container to hold a household liquid and a pump to pump liquid out of the container. This pump contains a pump chamber, a dip tube which is positioned in the container and it communicates with the pump chamber. An exhaust tube communicates with the pump chamber and an outlet for the household liquid. The pump is driven mechanically by a pump actuator. With a motor which engages the pump actuator. The motor is electrically connected to a power source with the aid of a switch that has a trigger assembly connected to the switch to control the power delivered to the motor. The trigger assembly is positioned under the outlet for the household liquid. This type of dispenser is applied in public restrooms, household bathrooms and kitchen where sanitation is important. Hand washing can greatly reduce the spread of germs. Liquid soap is usually dispensed through a hand pump that delivers the liquid soap from a bottle. The user pump the handle using one hand and the liquid soap is delivered onto the user's other hand.

## 2.4 NON MICROCONTROLLER BASED LIQUID DISPENSERS

### 2.4.1 LIQUID SOAP DISPENSER

Bobrick conceived the idea of the first liquid soap dispenser and was awarded a U.S. Patent for it in 1908[5]. This started when a company known as Pullman Car Company asked him to develop soap dispensers for use in their railway passenger cars. By the 1920's, Bobrick had sold some 250,000 soap dispensers throughout the United States, and the Company's two-page catalog listed a dozen models In 1997[4], Bobrick introduced the "Matrix Series" offering an attractive design-integrated family of durable, surface-mounted plastic washroom accessories, priced for low to moderate budgets.

In 2001 Bobrick, started a new century with the introduction of a new concept in soap dispensers with the introduction of its SureFlo™ Soap Dispensing System and SureFlo™ Hand Soaps. The new system links a single under-the-counter soap cartridge with multiple lavatory mounted soap dispensers. The system can deliver up to 13,000 hand washes and includes a reservoir, which supplies 2,000 additional hand washes. Up till date Liquid soap dispensers are still gaining grounds as a result of this scope.

It has further widened to involve basically two forms, these are: Automatic liquid soap dispenser and manually controlled liquid soap dispenser.

- Automatic liquid soap dispenser: Automatic here connotes a touch-less based mechanism. Liquid soap can be obtained by way of placing one's hands close to the device. In other words the dispenser is an intelligent system that can sense the presence of a person's palm. This means that already incorporated into this device is a sensor that is capable of sensing motion under the nozzle.

**Figure 2.2**: An Automatic Liquid Soap Dispenser

An example of this type of sensor can be a photocell or infra red. This piece of equipment ejects liquids in a predetermined quantity. Recently they have been enhanced using squirm pump over a piston pump structure to include features like:

- Adjustable liquid soap dispensed per motion freely
- Classic design
- Perfect and high quality performance
- Stable and high precision micro-controller
- Low noisy structure design

❖ Manually controlled liquid soap dispenser: This involves touching the dispenser in order to expel liquids, this can be done either by pressing a lever or pushing a button depending on the nature of the design. A limitation of the dispenser is in the inconvenience of having to refill the liquid soap dispenser.

The technology can be used for liquid soap or foam soap, liquid shampoo, hand lotion and conditioners which can be implemented for office, home, hotel, hospital etc. In essence automatic or manually controlled liquid soap dispensers are good, useful and helpful depending on the individual's choice of use.

### 2.4.2 LIQUID DISPENSER

This is a United States patent in the early sixties, the mother invention of liquid dispensers in it's crudest form, it was patented by Douglas F. Corsette[6]. The dispensing unit is such that it incorporates a hand actuated pump made up of moldable plastic material which also has a stationary unit including a barrel or cylinder for direct contact with the container. This stationary unit has a plunger or piston included in it to bring about the discharge of the contents of the container. The most fascinating aspect of this invention is that it dispenses liquids in the form of a fine spray or mist which is made possible as it has a spin compartment on the external surface of the plunger in which the discharge head seats. The invention is such that it has a suction tube connected to a cylinder, it also has a design that enables the refilling of liquids and discharge without leakage. The materials associated with the dispenser is thermoplastic (e.g polyethylene or polypropylene) in order for it to be able to withstand any form of temperature or pressure variation i.e hot or cold liquids. A ball bearing method is implemented.

The mechanism for operation here is rather too cumbersome which is its major set back.

### 2.4.3 LIQUID DISPENSER FOR STERILE SOLUTIONS

This is another intriguing invention that guarantees liquid hygiene, using a sterilized approach [7]. The dispenser has a nozzle connected to a container, in this container which is polymer elastic lies the stored liquid. In order to obtain the liquid, pressure has to be exerted on the container it self.

**Figure 2.3:** A Hand-Held dispenser for Sterile Solutions

Anti-germ control is made possible through filtration. Filtration is included in the design by having a filter that has pores to preclude the entry of micro organisms. The filter is also coated with bacteriostatic or bacteriocidal as well as with a non-metallic compound that has an anti-viral or anti-bacterial property attached to the nozzle which makes it accessible to the stored liquid .The pore sizes differ usually for the end that starts the dispensing process is about 0.22 to 0.65 microns, while at the receiving end from the stored liquid container is within a range of 0.1 and 1.2 microns this is so in order to prevent any micro organism that may have escaped through the first end from getting into the final output place.

This type of dispenser finds application especially for sanitary purposes:

- Eye care liquid for an organism: This is to be put into the eye of an organism or onto an object that is to be put into the eye of an organism.
- Contact lens care
- Medicine

A limitation of this dispenser is in the body of the container which is made to be flexible. There could be a situation whereby if so much pressure is exerted the resulting effect may not be favourable and consecutive pressure may deform the shape of the container.

The device takes in gas or air which consists of some chemical compositions that may react with the coated metallic material compositions, although it is sterilized by the filter, there can still be a chance of an anomaly. This air can get into the device when it tries to return back to its original state after being pressed.

### 2.4.4 LIQUID DISPENSER (CLINICAL AID)

This is an invention of the bearer Marshall S. Levine, an American [8]. It aims at dispensing of liquid biological specimens onto a target surface on microscope slides having a specific quantity of fluid being obtained from a closed specimen tube and transferred to a microscope slide in a small amount.

This dispenser consists of a container which holds a specific quantity of liquid biological specimen that has a stopper at its end which is air tight. The stopper is rubber like in nature, and it, provides an enlarged portion which is adjacent to an open end. The dispenser is constructed to dispense from a moderately large supply. It has an entry tip useful for piercing and an exit tube with a dispensing tip. There is a pathway from the entry tip to the dispensing tube which communicates fluid. The dispenser is assembled to the rubber stopper by pressing the entry tip through the center of the stopper when the container is in the upright position enabling any form of pressure difference which might exist between the inside volume and the atmosphere to be neutralized. The dispenser may be made of molded material assembled, which may be made of stainless steel. A transparent target surface is used for example a microscope slide, a back surfaced mirror is positioned underneath the microscope slide and viewed from above at a convenient angle. The thickness of the mirror glass is apt to the required viewing angle, wherein thicker glass transposes the image of dispensed fluid a greater distance away from underneath the target location.

The design is such that it has a typical optical path portrayed from the eye of the viewer through the back surfaced mirror through the microscope slide to the dispensed fluid. For the purpose of usage, the user can observe when transfer occurs by viewing through the openings between the support segments which are specifically cut away at all corresponding locations. As described earlier, a back surface mirror may also be used for viewing when the target surface is transparent. When the user observes that drop has transferred to the target surface, he or she discontinues force, thereby stopping further flow of fluid. The closed tube container has an attached device in an inverted operating position, in the inverted position the closed container and the dispenser permit no air to enter so that any attempt by the liquid to escape by force of gravity would have to overcome a partial vacuum which could obviously develop inside closed container.

Design Achievements;

- To provide exact quantitative control of very small amounts of biological specimens and more generally other liquids as well.
- To ensure that convenient surfaces are able to grasp the device when inserting and removing from the rubber stopper.
- To provide a means for easy viewing of the specimen as it is dispensed.

- The dispensing tip s beveled to provide a minimum sized lip surface at the exit, thereby minimizing contamination due to specimen which may remain after use.
- Air passages surrounding the gap, guards against reversal of flow due to suction.

The container of the dispenser is pressed by manual force against a target surface, such as glass microscope slide with a target surface supported by optional intermediate member(back surfaced mirror) which in turn is supported by fixed surface such as a counter top, the downward force is resisted by the target surface. This creates an internal compression force within the rubber stopper which deforms the stopper, thereby reducing the volume inside container.

## 2.5 CONCLUSION

Microcontrollers are though not so recent but can be an option if control is of utmost importance for a desired device to be constructed. It can be observed that the various forms of liquid dispensers cited in this chapter, have a common thing in practice, which is an inlet container, an outlet container, and a pump for conveying the liquid. Where this project differs with most of the others mentioned is in the components that make up the overall device and the operation in practice.

# CHAPTER THREE

# DESIGN ANALYSIS

## 3.1 INTRODUCTION

This chapter provides the technical details of the working principle and design of the liquid dispenser. It would give an overview of the different circuits which form sub systems, their description and how these circuits are interconnected to make up the liquid dispenser as illustrated in the block diagram below in figure 3.1

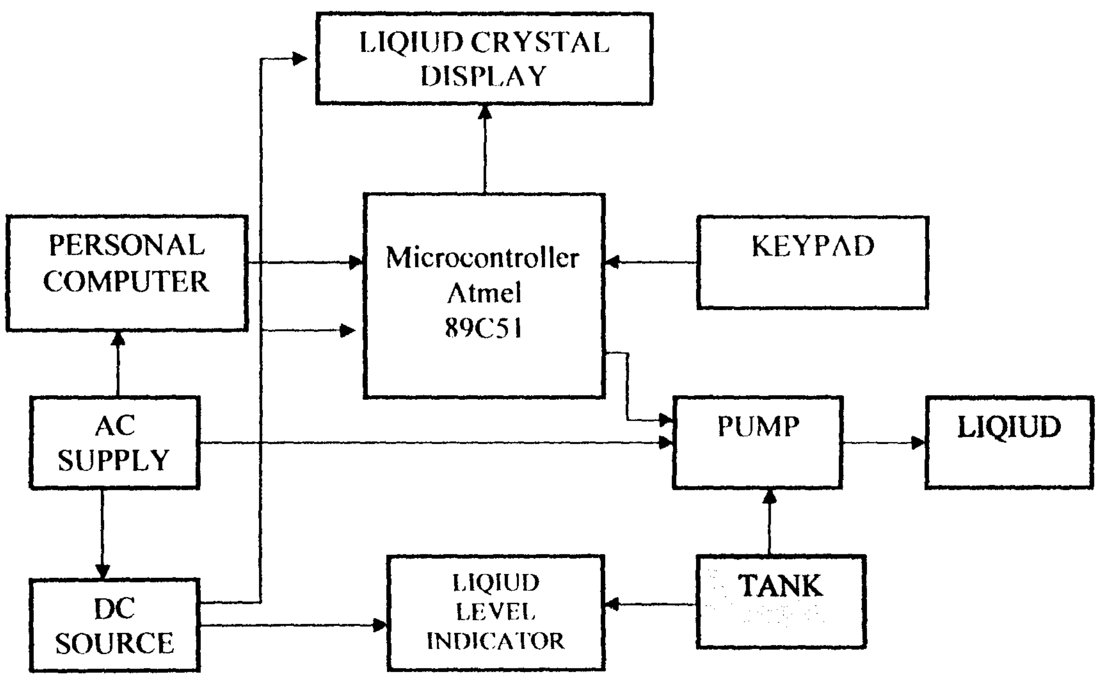



**Fig** 3.1 Block diagram of the automated liquid dispenser

These details would include system specifications and special features as provided in two major branches:

- Hardware
- Software

## 3.2 HARDWARE

This comprises all the physical components of the liquid dispenser that can be felt and touched and includes the following subsystems;

- 8 Bit System Controller
- 4 * 3 matrix keypad
- RS 232 Logic Level Converter
- 40x2 character Liquid Crystal Display (LCD)
- Pump control circuit
- Personal computer
- Liquid Level indicator
- Power supply

### 3.2.1 SYSTEM CONTROLLER

An 8 Bit 89C51 microcontroller was used to coordinate system functions. The microcontroller, as used in this design performs the following;

- Displays message prompt to the customer/user over the LCD
- Scans the keypad for user data entry.
- Sends the user's data to the PC holding the service pins.
- Executes the command codes sent from the PC system.

The AT89C51 provides the following standard features; 4K bytes of flash, 128bytes of RAM, 32 I/O lines, two 16-bit timer/counters, a five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry. In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The idle mode stops the CPU while allowing the RAM, time/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware resets. The figure below shows the pin configuration of AT89C51.

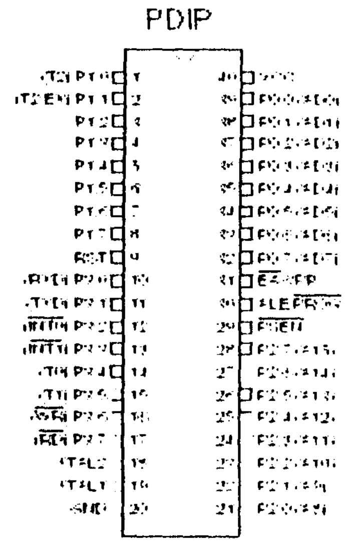



Fig 3.2 pin configuration of AT89C51

### 3.2.2 MICROCONTROLLER INTERFACES

The controller was interfaced with the LCD over P0, the keypad over P2, P3.0 and P3.1 were used for microcontroller to PC system communication via MAX 232 logic level translator. The 6v DC relay was also interfaced to the microcontroller on P3.7

The microcontroller to PC system communication speed was fixed at 9600bps, corresponding to 960 character per second.

### 3.2.2.1 LCD INTERFACE

Liquid Crystal Display are one of the most used devices for alphanumeric output in microcontroller-based circuits. Their advantages are: their reduced size, low Cost and the convenience of mounting the LCD directly on the circuit board.

Liquid Crystal Displays are classified according to their interface into:

- Serial and
- Parallel.

*Serial* LCD requires less I/O resources but execute slower than their parallel counterparts and they are considerably more expensive.

In this section the interfacing of the parallel-driven LCD based on the HD44780 character-based controller, will be discussed.

The HD44780 is a *dot-matrix* liquid crystal display controller and driver. The device displays ASCII alphanumeric characters, Japanese kana characters, and some other symbols. A single HD44780 can display up to two 28-character lines. An available extension driver makes possible addressing up to 80 characters. The HD44780U contains a 9,920 bit character-generator ROM that produces a total of 240 characters: 208 characters with a 5 × 8 dot resolution and 32 characters at a 5 × 10 dot resolution. The device is capable of storing 64 x 8-bit character data in its character generator RAM. This corresponds to eight custom characters in 5 x 8-dot resolution or four characters in 5 x 10-dot resolution. The controller is programmable to three different duty cycles: 1/8 for one line of 5 × 8 dots with cursor, 1/11 for one line of 5

× 10 dots with cursor, and 1/16 for two lines of 5 × 8 dots with cursor. The built-in commands include clearing the display, homing the cursor, turning the display on and off, turning the cursor on and off, setting display characters to blink, shifting the cursor and the display left-to-right or right-to-left, and reading and writing data to the character generator and to display data ROM. The following hardware elements form part of the HD44780 controller:

- two internal registers labelled
    - the data register and
    - the instruction register,
- a busy flag,
- an address counter,
- a RAM area of display data (DDRAM),
- a character generator ROM,
- a character generator RAM,
- a timing generation circuit,
- a liquid crystal display driver circuit,
- and a cursor and blink control circuit.

Generally, the LCD can be operated in one of two modes:

- 8 bit Mode, where all eight data lines of the LCD are used to send both data and command signals
- 4 bit Mode, where only the four lines of the upper nibble of the data lines are used to send both data and command signals to the LCD. Operating in the mode is slower than the former because an 8 bit data is written to the LCD in two steps of 4 bits each.

The circuit is powered by a regulated 5V supply. Pin 3 (contrast pin) is connected to -5v via a potentiometer for adjusting the contrast.

The RS pin is the Register select pin which is used to indicate whether signals being sent to the LCD are data or command. It selects either of:

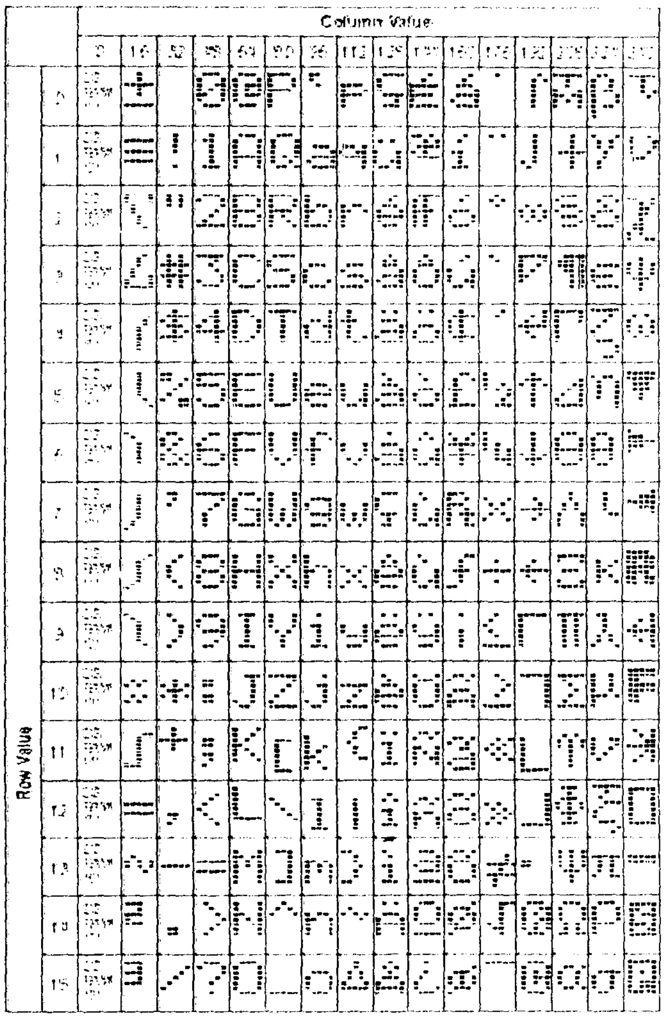
- Data register
- Command register

The R/W pin is the Read / Write pin to indicate either reading from the LCD or Writing to the LCD.

The E pin is the Enable pin which is used to activate the LCD.

The character set is given in the table below

**Table 3.1** LCD Character set



The communication protocol was implemented using ASCII codes. This was used in place of plain binary because it prevents the usage of special control codes (non-printing characters). Moreover, Visual Basic is optimised for string operations.

The microcontroller to LCD interface is shown below in fig 3.3

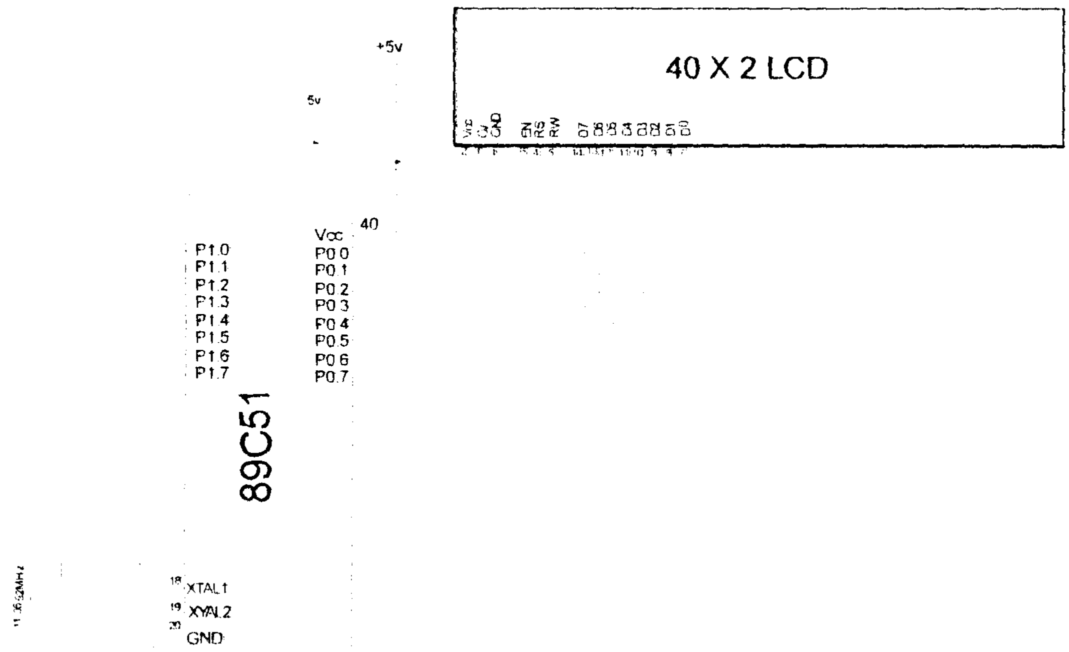



**Fig 3.3** microcontroller to LCD interface

### 3.2.2.2 KEYPAD INTERFACE

A 4 x 3, 12-key keypad was used to input data into the system. From figure 3.4, D1 to D4 are used to provide an active low logic when a key pressed, other than scanning the keypad periodically for a pressed key.

The keypad port initialises with P2.7, P2.6, P2.5, and P2.4 being high, and P2.3, P2.1, P2.0 being low. P3.6 is thus held high.

When a key is pressed, the corresponding pin on the upper nibble is forced low, and P3.6 also goes low. The software detects the low logic on P3.6 and immediately does a keypad scan. The key code is sent to the accumulator.

Data entry continues until # (enter) is pressed. The controller displays VALIDATING PIN and forwards the data to the PC.

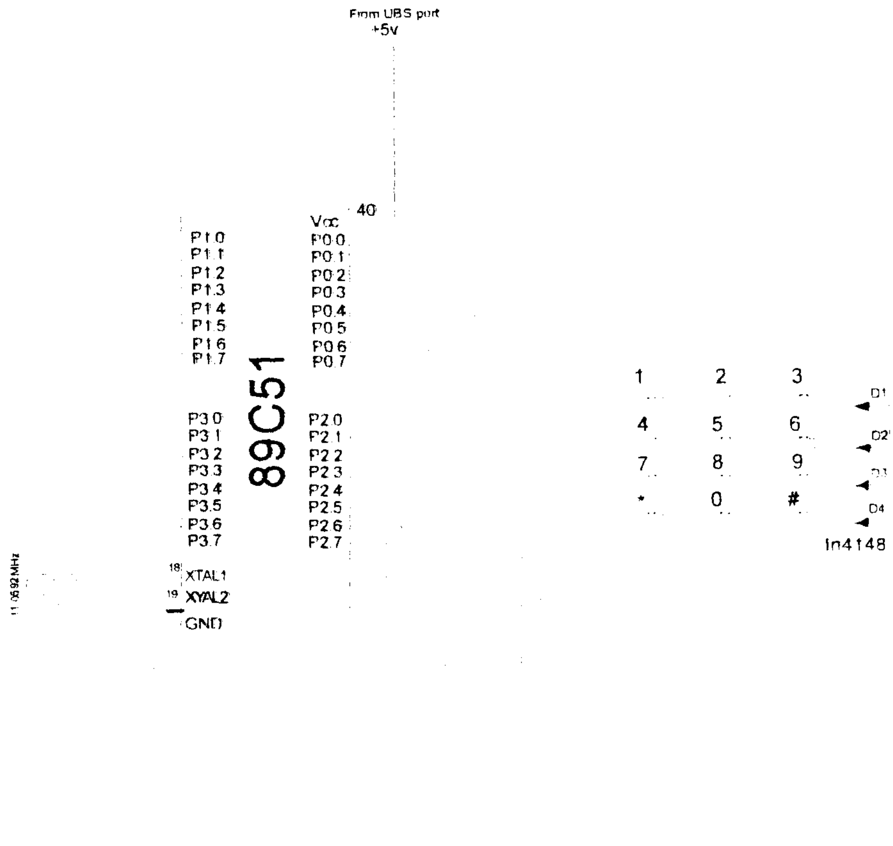



**Fig 3.4** microcontroller to keypad interface

### 3.2.2.3 MAX 232 TRANSCIEVER INTERFACE

This section focuses on the digital communications technique used to interface the microcontroller with the PC. Communication in general, refers to the exchange of information following rules, called a *protocol*. Digital and computer communications come in two different types:

- Serial
- Parallel

Serial communications take place when the data is sent one bit at a time over the communications channel. While in parallel communications all the bits that compose a single symbol or character are sent simultaneously. It can hence be inferred that serial communications is slower than parallel communications but with improvements in serial communication technologies this is often not the case, since serial techniques have been found to match or even excel parallel methods in terms of speed and performance. The preference for serial over parallel communications is related to hardware, since parallel transmissions require more communication lines than serial transmissions.

The serial communication being used is the RS-232-C serial protocol whose voltage level is not compatible with that of the 89C51 microcontroller. Adding an RS-232C interface to the system is easy. The 89C51 microcontroller incorporates an AUSART within the chip, so all that is required is an external level shifter to convert the serial transmissions to and from RS-232C levels. Hence an RS-232-C Transceiver is employed to shift between the TTL voltage levels on the microcontroller to the CMOS voltage Level on the serial port of a PC. There are many RS-232-C Transceivers in the market supplied by various vendors, but the MAX232 was chosen for this application because:

- It is readily available in our local electronics market
- It is cheap
- It requires minimum external components to effectively include it in an application such as this.
- And there are lots of documentation available

The MAX232 has two (2) RS-232-C Transceivers in it. The only external support components required are capacitors for the chip.

To effect communication with the host PC over the serial port, the unipolarity signalling voltages from the microcontroller had to be translated into the bipolarity signalling voltages. This was done by the MAX 232 TTL/CMOS – 232 logic level translator.

The circuit diagram is shown on figure 3.3,

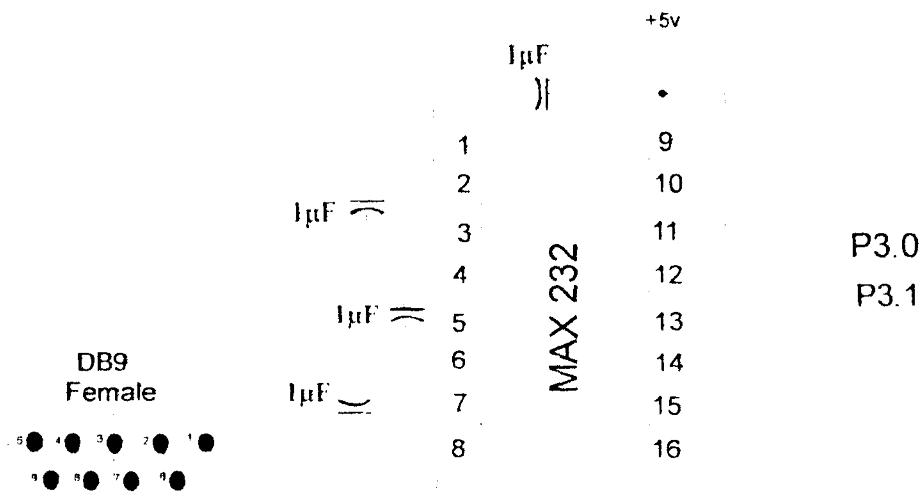



**Fig 3.5** Max 232 interface

The interface uses the flying capacitor technique to produce the negative voltages required on the interface.

### 3.2.2.4 PUMP CONTROL INTERFACE

The pump in use is a submersible pump powered by 220v AC 50Hz. The microcontroller is not capable of driving this pump directly, because the microcontroller operates on a DC Voltage and it is a Transistor - Transistor Logic (TTL) based chip. Since the pump requires voltages and currents not compatible with digital circuitry. A simple interface circuitry is all that is required. Here a transistor switched relay circuit is appropriate because the transistor can be switched on by the 5V supplied by the microcontroller. This is in turn used to switch the magnetically coupled relay that controls the ON / OFF state of the pump.

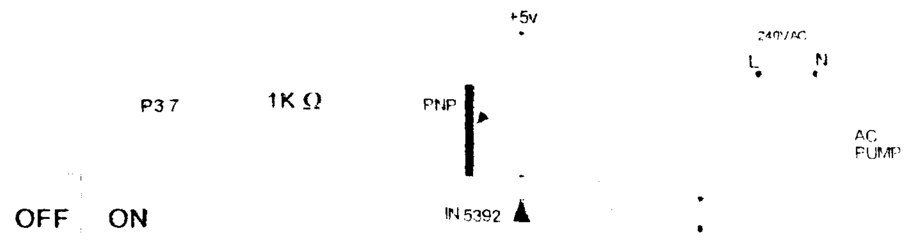



**Fig 3.6** pump control interface

The relay is powered by a 6v DC supply. The IN5392 diode serves as a free wheeling diode to protect the circuit (transistor) from the very high reverse voltage produced by the relay coil when it is de-energized.

The relay is turned on every time the logic level on P3.7 goes low. The transistor used has a gain of 200.

The relay has a coil resistance of 100Ω. On a 5v dc supply, this corresponds to a coil current of;

I = 5v/100Ω

= 50 mv

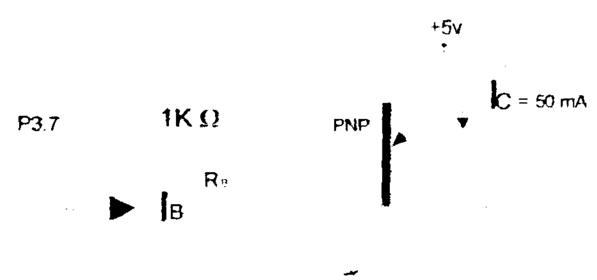



**Fig 3.7** transistor circuit diagram

For a gain of 200,

$I_B = I_C/H_{FE}$

$= (50 \times 10^{-3}) / (2 \times 10^{2})$

$= 2.5 \times 10^{-4}$ A

$R_B = (V_{CC} - V_{BE}) / I_B$

$= (5.0 - 0.7) / (2.5 \times 10^{-4})$

$= 17$ KΩ

It was reduced to 1KΩ to ensure switching at all conditions.

### 3.2.2.5 SYSTEM POWER

This unit supplies power to all the sub circuits. The 240v AC from the mains was stepped down to 12v AC with the use of a 240 – 12V step down transformer. A full wave bridge rectifier converts the 12v AC to 12 V DC. The capacitors are for filtering purposes. The LM7805 IC is a voltage regulator that regulates the 12V DC to a 5V DC. The power circuit was designed to output a 5V, since almost all the sub circuit requires 5V to operate.

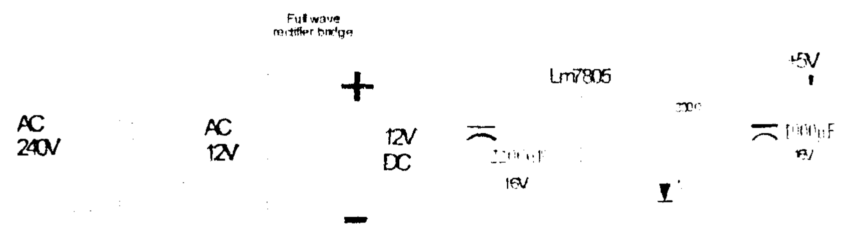



Fig 3.8 power supply circuit diagram

### 3.2.3 LIQUID LEVEL INDICATOR

One thing that makes this project stand out, making it different from other related works is the inclusion of this circuit. The essence of this is the ability to monitor the content of the liquid in the container without having to look into it, or having to check its' content time after time. The layout is such that it comprises of five transistors, five LEDs and five resistors connected via conductors to the container. The transistor, acts like a switch that receives current coming in from the liquid through its base. A voltage of five is applied to the base which generates a current that closes the emitter and collector letting in the 5v.


**Fig** 3.8 liquid level indicator

## 3.3 SOFTWARE

This part of the project comprises all the software programs written to achieve the goals of the project. These are classified into two, based on their deployment. These are:

- Visual Basic
- Assembly Language

### 3.3.1 VISUAL BASIC

Application written for remote access and monitoring of the operation of the Liquid Dispenser. This application is written in Microsoft Visual Basic language.

The choice of VB6 is because of its ease of use and familiarity with the language. VB6 is an event-driven programming language that has many elements of an object-oriented language such as Java. Event-driven means that the program is not procedural (does not follow a sequential logic). An application is developed using VB6 by putting controls on forms and linking the forms together. The MSCOMM control is used for serial communication, it is activated (the OnComm event of MSComm) when the timer control is activated at the instance of the command button linked to it. The OnComm event of the MSComm sends the pre-defined hexadecimal number through the serial port. The OnComm event also retrieves information (in hexadecimal value) on the status of the power generator parameters and changes the colour property of the labels used by the monitor aspect of the application based on the received byte.

This application provides the following functions:

- It establishes a link between the liquid dispenser and the PC via the Serial port.
- It generates the service pin and stores them in its data base.
- It receives data from the microcontroller ( the pin pressed from the keypad).
- The application software performs pin validation
- It sends a response back to the controller to either activate the pump or not depending on whether the pin was valid or not.
- The application deletes any used pin code to avoid reuse.

The program source codes are included in the Appendix3 of this report.

### 3.3.2 ASSEMBLY LANGUAGE

Refer to [9] page 31.

## 3.4 LIST OF COMPONENTS

| | |
|---|---|
| Light Emitting Diode (LED) | 6 |
| NPN Transistors (2N2222) | 5 |
| PNP Transistors | 1 |
| Resistor (330Ω) | 6 |
| Resistor (1KΩ) | 1 |
| Transformer (240 – 12) | 1 |
| Diodes (IN4001) | 4 |
| Diodes (IN5392) | 1 |
| Diodes (IN4148) | 4 |
| Capacitors | 6 |
| Regulator (LM7805) | 1 |
| LCD (40*2) | 1 |
| Microcontroller (AT89C51) | 1 |
| Crystal (11.0592MHZ) | 1 |
| Max 232 | 1 |
| Push Buttons | 12 |
| Pump | 1 |
| Relay (6V) | 1 |
| Potentiometer | 1 |

# CHAPTER FOUR

# TESTING, RESULT AND DISCUSSION

## 4.1 INTRODUCTION

In the course of actualizing this project, various testing methods were employed to guarantee the functionality of the various parts that makes up the whole system. This chapter explains the procedures and techniques that were employed to carry out the testing.

## 4.2 HARDWARE TESTING AND IMPLEMENTATION

The hardware consists of all the components that make up the complete circuitry that can be touched and felt. They include the following; the microcontroller chip, the oscillator, the liquid crystal display (LCD), the keypad (an array of push buttons), the serial port (RS 232), the MAX 232, the relay, transistor, diodes, resistors, capacitors, the USB port,

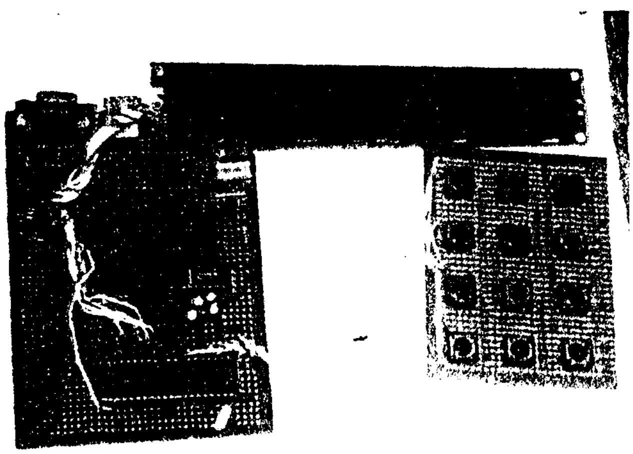


Fig 4.1 Main circuit board

Figure 4.1 shows the main completed circuit board. Common to all electronic and electrical components current and voltage is the driving force. A digital multimeter was used to carry out the testing needed to confirm the state of most components. Since a digital multimeter can measure both current and voltage and much more, it was used to confirm that components get the rated current or voltage input and the corresponding output current or voltage. A photograph of the digital multimeter is shown below.

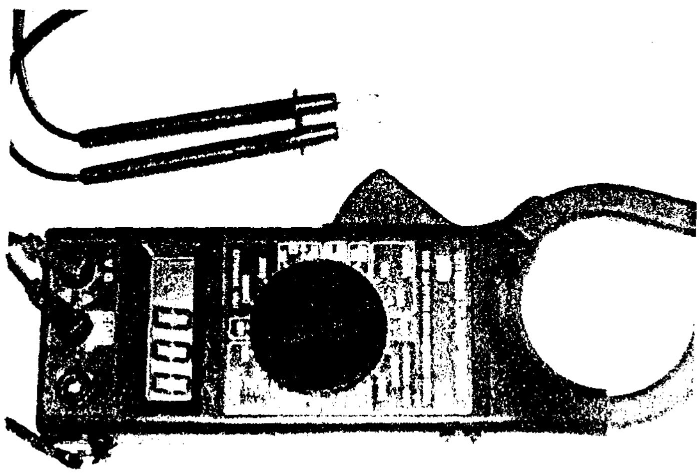


**Fig4.2** A photograph of Digital Multimeter

Prior to the completion of the main circuit board, the microcontroller which is the chief component in this project and the LCD was tested. The test was simply connecting the LCD to the main microcontroller circuit as shown below, for the purposes of confirming the functionality of the microcontroller chip and the display device 'the LCD'.

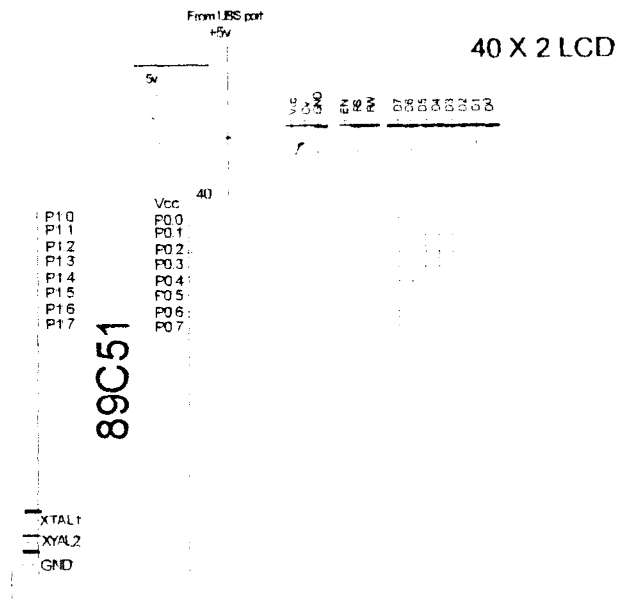



**Fig 4.3** Microcontroller chip with LCD circuit

A small program was written to display the text 'welcome to our final year project'. This was just to confirm that the chip and the LCD were working and were in a good state. To avoid soldering and de-soldering and probably damaging any sensitive component, a bread board was used to carry out this test.

## 4.3 SOFTWARE TESTING

Generally for this project, software are of two types; Assembly Language for programming the microcontroller chip and Visual Basic for writing the program that generates the pin codes, stores them in its data base and also perform pin validation.

At start up the project definition is displayed before the system enters into the service mode. In the service mode, TERMINAL READY is displayed continuously until a key is pressed. SERVICE PIN is then displayed whenever a key is pressed and the user's keyed service pin (pin codes) is also displayed.

The PIN can be wiped (deleted) in case an error is made while inputting the pins, this is achieved by pressing the '*' button. The correct pins can then be inputted. A service pin is terminated by a '#'. This terminator marker signals the microcontroller that the entire string has been inputted. At this point, the microcontroller assembles the user data into a stream as $01<10 pin>#.

The assembled data packet is sent to the PC system over the Max 232 interface for comparison against the generated service pins stored in its database.

If the host system is up and running, the VB script on the system decodes the data stream and executes the corresponding action of:

1 Open a file in which are the stored pins

2 Matches the user's pin with the stored pin

3 If a match is found, the system pins in the file is replaced by a space symbol and hence prohibiting further re-use of same pin.

4 If a match is made, the VB sends '$A' to the microcontroller which then displays 'PUMPING IN 4 SECONDS' on the display. After a 4 second timeout the pumping commences for an approximate of 13 seconds and ceases.

5 If no match is made, VB returns 'INVALID PIN" to the user via the LCD

### 4.3.1 ASSEMBLY LANGUAGE

Refer to [9] page 36.

### 4.3.2 VISUAL BASIC

This is a high level programming language that was used to design the program that generates the pin code, serve as a data base for the pin codes and perform pin validation. This software was written and compiled in a personal computer. These forms indicate the software is functioning and good to go.

## 4.4 TEST OF THE ENTIRE PROJECT WORK

The photograph below shows the picture of the completed project 'Automated Liquid Dispenser. The major test carried out here was to get an average time for the pump to dispense two (2) liters of the liquid at different height of liquid in the tank. The tank height is divided into four levels; full, ¾ full, ½ full and ¼ full as indicated by the level indicator.

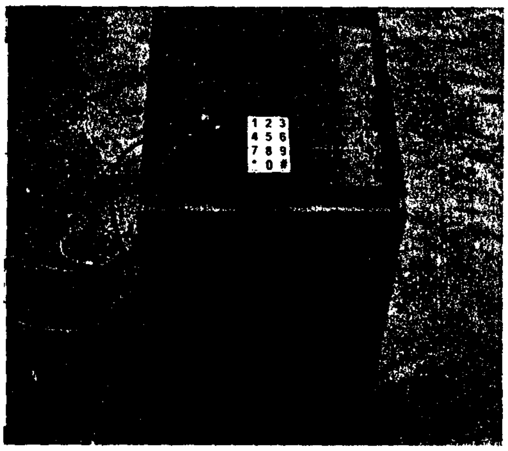


**Fig 4.4 front and rear view** Liquid Dispenser

**Table 4.1** data value at full calibrations

| No. of samples | Time (seconds) required to fill up to 2 liters |
|---|---|
| 1 | 12.10 |
| 2 | 12.00 |
| 3 | 12.30 |

Average time =∑(Times)/ ∑(No. of samples)

= 36.40/3

= 12.13 seconds

**Table 4.2** data value at ¾ full calibrations

| No. of samples | Time (seconds) required to fill up to 2 liters |
|---|---|
| 1 | 13.70 |
| 2 | 13.00 |
| 3 | 12.60 |

Average time =∑(Times)/ ∑(No. of samples

=39.3/3

=13.1 seconds

**Table 4.3** data value at ½ full calibrations

| No. of samples | Time (seconds) required to fill up to 2 liters |
|---|---|
| 1 | 14.80 |
| 2 | 14.80 |

| | |
|---|---|
| 3 | 14.60 |

Average time =∑(Times)/ ∑(No. of samples

=44.2/3

=14.73 seconds

For the fourth calibration which is ¼ full, the pressure and the liquid level was too low for the pump to dispense.

Therefore, the total average time needed to dispense 2 liters of the liquid at any height of the liquid in the tank is thus calculated;

Total average time $A_T$ = (12.13 +13.1 + 14.73)/3

= 39.96/3

=13.32 seconds

This is the time (13.2 seconds) that was program into the microcontroller chip for the pump to dispense an approximate of 1 ½ liters of the liquid.

## 4.5 LIMITATIONS OBSERVED DURING THE TESTING

It was observed earlier that whenever the height of the liquid in the tank is about one quarter full, the pressure due to the liquid height in the tank reduces drastically. The pump cannot no longer dispense at this stage.

In addition, whenever the host connecting the nozzle is lifted too high enough, the pump might not have enough power to dispense the liquid through that height.

## 4.6 TROUBLESHOOTING

To provide an efficient service to the public, the liquid level in the tank should not be allowed to get down to about ¼ so that pump will not stop dispensing when it is running. The tank should be refilled immediately the liquid level indicates ¼ full.

The nozzle should be held low enough to ensure that the liquid flows through the hose freely than doing much work when it is held higher.

# CHAPTER FIVE

# CONCLUSION

## 5.1 INTRODUCTION

The aim of this chapter is to summarize the highlights of previous chapters. Achievements of the project and other possible recommendations for advanced implementation and improvement are also included.

## 5.2 SUMMARY

The Automated Liquid Dispenser designed is committed to adding value in the aspect of sale and supply of liquid for the benefit of humanity. In line with this commitment, the challenge of long queues of automobiles at filling stations is addressed. The project also critically looks into the issue of fraudulence and suggests ways that this menace can be tackled.

## 5.3 ACHIEVEMENTS

Since the applications of the Automated Liquid Dispenser device in the modern world are innumerable, the achievement of its design and construction is a landslide. Any kind of fluid (edible or otherwise) can now be dispensed without supervision. The project can be seen as a further contribution to the world's civilization.

## 5.4 RECOMMENDATIONS

Even with the extent of creativity applied in the design of the automated liquid dispensing device presented, it is still considered as a prototype. Various aspects of the design can be modified or altered for maximum performance, especially for commercial purposes.

Concerning security, the wooden frame housing the various parts that make up the system can be scrapped and replaced with aluminium, steel or any element that provides a considerable amount of security.

The scratch card algorithm generation is another serious area. Renowned cryptographic principles should be used in the key generation. It should be noted that the longer the digits of the key, the lower the chances of decryption. This is to ensure that the key card is hacker proof.

It can also be observed that each card is assigned the same monetary value. commercializing it may require various card denomination each corresponding to a unique quantity of fuel.

The provision of a serial port for communication with a PC system can bring about remote access capability, hence the activities of device can be monitored from anywhere depending on the communication link like computer networks, internet etc. Also the sales at any particular time can be determined

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Lecture note, (2008).

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4) http://www.freshpatents.com/#: 20070119873 ''Motorized household liquid dispenser '' SEP.24, 2003.

5) http://www.bobrick.com: "Liquid soap dispenser" MacGrayhill company, 2004.

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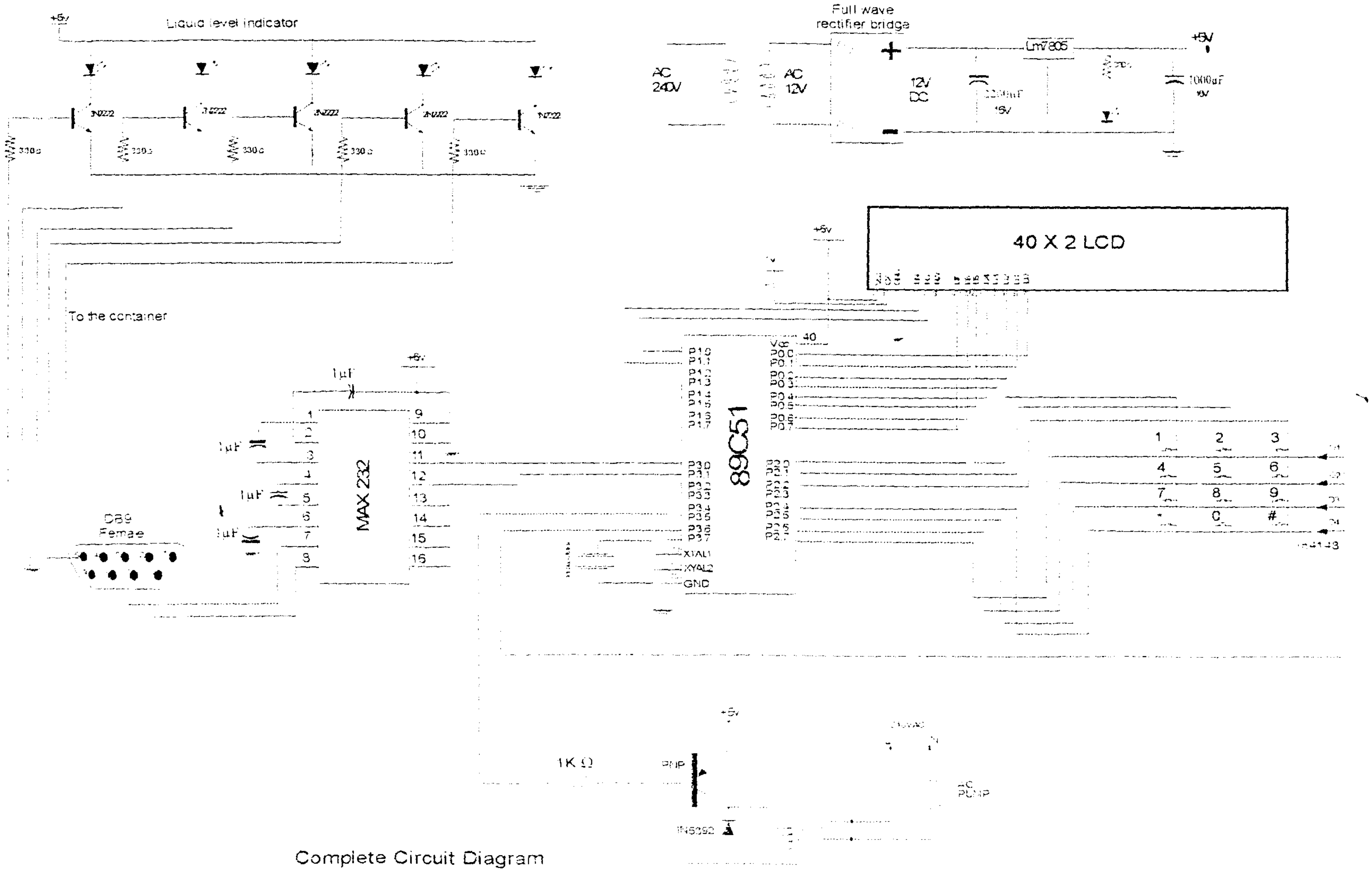
9) Hannah Onoji (colleague), "Automated Liquid Dispenser", November, 2008

# APPENDIX 1




Complete Circuit Diagram

# APPENDIX 3

## VB SOURCE CODE

### FORM1:

```
Private Sub Command1_Click()
Load Form3
Form3.Show
Form1.Hide
End Sub

Private Sub Command2_Click()
Load Form2
Form2.Show
Form1.Hide
End Sub

Private Sub Command3_Click()

End Sub

Private Sub Command4_Click()
End
End Sub
```

### FORM2:

```
Private Sub Command1_Click()
Unload Form2
Form1.Show
End Sub
```

### FORM3:

```
Dim ADMIN_PASSWORD As Long
Dim USER_PASSWORD As Long
Dim PASSWORD_vALID As Boolean

Private Sub Command1_Click()
ID = 1
Open "C:\THEO_HANNAH\ACCESS" For Random As #1 Le
Get #1, ID, PASSWORD                                    )RD)
```

```
ADMIN_PASSWORD = PASSWORD.CODE
Close #1


If ((ADMIN_PASSWORD = Val(" ")) Or (ADMIN_PASSWORD = 0)) Then
ADMIN_PASSWORD = 147893
PASSWORD.CODE = ADMIN_PASSWORD
ID = 1
Open "C:\THEO_HANNAH\ACCESS" For Random As #1 Len = Len(PASSWORD)
Put #1, ID, PASSWORD
Close #1
End If


If Text1.Text = " " Then
MsgBox ("ERROR - INPUT PASSWORD")
GoTo EXIT_A
End If

USER_PASSWORD = Val(Text1.Text)
If USER_PASSWORD = ADMIN_PASSWORD Then
Text1.Text = " "
Load Form4
Form4.Show
Unload Form3
Else
If USER_PASSWORD <> ADMIN_PASSWORD Then
MsgBox ("ERROR - WRONG PASSWORD!")
Text1.Text = ""
End If
End If
EXIT_A:
End Sub

Private Sub Command4_Click()
Unload Form3
Form1.Show
End Sub

Private Sub Form_Load()
Text1.Text = ""
End Sub
```

**FORM4:**

```
Private Sub Command1_Click()
```

```
Load Form5
Form5.Show
End Sub

Private Sub Command3_Click()
Load Form6
Form6.Show
Form4.Hide
End Sub

Private Sub Command4_Click()
Load Form8
Form8.Show
Form4.Hide
End Sub

Private Sub Command5_Click()
MsgBox ("APPLICATION NOT CONNECTED TO PRINTER SERVICE!")
End Sub

Private Sub Command6_Click()
Unload Form4
Form1.Show
End Sub
```

**FORM5:**

```
Private Sub Command1_Click()
If Text1.Text = "" Then
MsgBox ("ERROR - INPUT PIN!")
GoTo EXIT_A
End If

If Text2.Text = "" Then
MsgBox ("ERROR - CONFIRM PIN!")
GoTo EXIT_A
End If

NEW_PIN = Val(Text1.Text)
PIN_TEMP = Val(Text2.Text)

If NEW_PIN = PIN_TEMP Then
Text1.Text = ""
Text2.Text = ""
ID = 1
Open "C:\THEO_HANNAH\ACCESS" For Random As #1 Len = Len(PASSWORD)
```

```
PASSWORD.CODE = NEW_PIN
Put #1, ID, PASSWORD
Close #1
Else
MsgBox ("AMBIGOUS PINS!")
Text1.Text = ""
Text2.Text = ""
End If

EXIT_A:
End Sub



Private Sub Command2_Click()
Unload Form5
Form4.Show
End Sub

Private Sub Form_Load()
Text1.Text = ""
Text2.Text = ""
End Sub
```

**FORM6:**

```
Dim COUNT3 As Long
Dim count1 As Long
Private Sub Command1_Click()
count1 = 0
Label1.Caption = "GENERATING PINS"
generate_now
SHOW_PIN
End Sub

Private Sub Command2_Click()
Unload Form6
Unload Form7
Form4.Show
End Sub

Private Sub Form_Load()
count1 = 0
Label1.Caption = "SERVICE PIN GENERATOR"
End Sub
```

```
End Sub

Public Sub LOAD_PIN()
id = 1
Open "c:\theo_hannah\pin1" For Random As #1 Len = Len(list1)
Get #1, id, list1
For count2 = 1 To 3270

If SERVICE_PIN = list1.PIN(count2) Then GoTo pin_match
'If list1.PIN(count2) = (" ") Then GoTo USED_PIN
Next count2
PIN_ERROR
GoTo exit_here

USED_PIN:
PIN_USED
GoTo exit_here
pin_match:
list1.PIN(count2) = " "
Put #1, id, list1
PIN_OK

exit_here:
Close #1
End Sub

Public Sub PIN_OK()
MSComm1.Output = "$" + "A"
Debug.Print count1
'MsgBox ("pin ok")
count1 = 0
Debug.Print count1
End Sub

Public Sub PIN_ERROR()
MSComm1.Output = "$" + "Z"
Debug.Print count1
'MsgBox ("pin error")
count1 = 0
Debug.Print count1
End Sub

Public Sub PIN_USED()
MSComm1.Output = "$" + "U"
MsgBox ("PIN USED!")
End Sub
```