CHAPTER ONE
INTRODUCTION

1.1 Overview

Water resources around the world are getting scarcer day after day. Climate, global warming, and irresponsible usage are major factors the make the situation even harder [1]. Tremendous population growth causes insufficient and uneven distribution of water. So measuring the water usage and providing it with proper amount will limit the wastage of water in society [2]. In the modern era of technology we came to know about various wireless control systems for our appliances or machines. Automatic meter reading is the technology of automatically collecting consumption, diagnostic, and status data from water meter or energy metering devices (gas, electric) and transferring that data to central database for billing, troubleshooting and analyzing [3].

Automatic recording of the data in the meter reading instrument has gradually become the target of people whose working, living, and home conditions are of increasingly high level of intelligence. Meanwhile, utilities also hope that the development of new technologies to solve the problems they encountered in the practical work about cumbersome meter reading and no reliable protection of accuracy and real time; and enable both user friendly and improving public sector efficiency and management level. Wires are more complex, detrimental to adjustment and maintenance of the system. The long-term indoor and outdoor installation easily leads to aging, resulting in a risk of short circuit and breakage. For these reasons, it has become the industry very unresolved problem to design a remote meter reading system, with long-term reliance and convenient installation & maintenance [4].

The study about the automation of water meter reading with GSM system have many benefit like provide water service utility companies to increased

performance in the data collection, less manpower and resources are needed in meter reading and data gathering; they only need to access the main database to get the information that they need for billing and analysis. That eliminates estimated meter reading, improves revenue collection and avoiding unpleasant bill surprises for customers. Further, to provide water service utility companies' costumer with Consumption information when requested. Also, consumers will be billed the amount that exactly corresponds to what they have used. The data will be sent in accordance to the volume of water consumed within time [5].

When it comes to water consumption management, there are certain issues that be to need considered: infrastructure and architecture costs, the costs of moving from manual (or other) meter reading technology to wireless automatic meter reading, the ability that automatic meter reading provides to reduce meter reading costs, better demand management and leakage detection. The environmental issues also have to be taken in to appreciation. Water scarcity due to lack of natural spring water, advancing pollution etc. is on of the major environmental issues. The water consumption has to be controlled on global and local basis [6].

1.2 Problem Statement

- The lack of justice in the calculation of the amount of water between users with different applications on each end.
- The accumulation of water charges even in the absence of the consumer and not to use water
- Lack of rationalization in the use of water due to the lack of restrictions for the consumer.
- The lack of custom invoice to calculate the amount of water.

1.3 Objectives

- Justice and accuracy in the calculation of the amount of water to distinguish between users consumption.
- Communication between the company and the user remotely without the need for in take which facilitates the payment process and reduce the time and effort.
- Showing the amount of water consumed in liters on the device's screen, allowing the consumer to know consumption thus rationalizing water consumption.

1.4 Methodology

The following points describe the research methodology to achieve the mention objectives:

- Used an arduino development board as central console of the system.
- Used GSM as wireless connection.
- Used flow sensor device to count the liters.
- Build complete system using proteus and visual basic 2010 software.
- Evaluate system performance based on simulation results.

1.5 Thesis Outline

This thesis is presented in five chapters. Chapter one gives an introduction to the research, including overview, problem statement, objectives and methodology. Chapter two present backgrounds of automatic meter reading for water, literature review for general automatic meter reading and mention some study using GSM as wireless communication, wireless network and its benefits. In chapter three simulation model of system. Chapter four presents the simulation result and discussion. Finally, chapter five provides the conclusion and recommendations.

CHAPTER TWO

BACKGROUND AND LITERATURE REVIEW

2.1 Introduction

Water is the renewable and an abundantly available natural resource on the earth. Water covers 70% of the Earth's surface. Out of this, only 3% of the water is portable. Water has its utility in domestic purposes, industrial usage, agricultural field etc. Population growth causes insufficient and uneven distribution of the water. Figure 2.1 shows the chart of water distribution on the earth's surface [7].

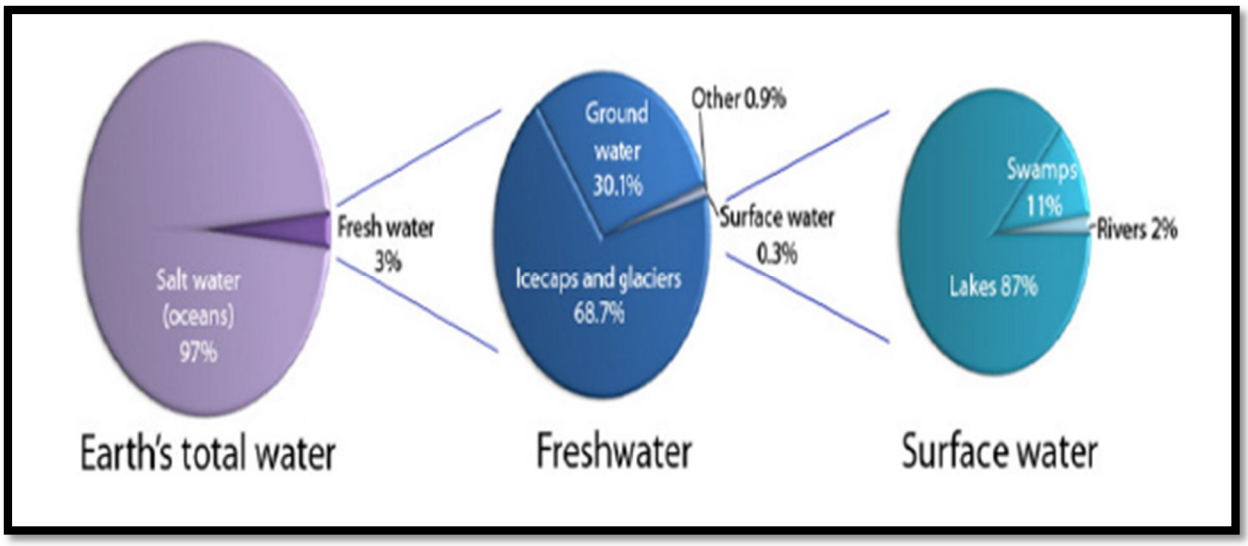

Figure 2.1: Water distribution on Earth's surface

Earth consists of 97% of salt water and 3% of fresh water in total. Of this 3% of fresh water, 68.7% constitutes of ice caps and the glaciers. 30.1% consists of ground water, 0.9% of other water and 0.3% of surface water. Of this 0.3%, 87% consists of lake water, 2% of river water and 11% for swamps [7].One of the world's major problems is the scarcity of water, mainly due to the unmeasured water consumption and the waste of this element. In the past water resources are very limited and nobody can afford its wastage. For managing and providing

water so many workers are required. Also to switch on valve and distribute water bill by going to home so many workers are required [8].

Meter is essential for our modern life. The metering system includes water supply, electricity and domestic fuel etc. the charges incurred by a user can be calculated by using metering system. For traditional typical metering system, four steps are usually involved. In the first step, a meter records the amount of water is consumed by customer. Then, a worker records the reading of meter for each user. After that the recorded readings input to a computer system to calculate the charge for each customer. Finally a bill is generated and mailed to each customer. Collecting the meter reading is the most difficult task. A worker from each supplier visits every house regularly to record the reading of meter. The classical approach is simply writing down the reading in a hardcopy and data entries are done manually to the computer system in step three. Some of the meters are installed inside the houses; the worker would encounter more difficulties for recording the reading due to nobody there. As result the worker needs to revisit the house. To collect the reading of every consumer, the worker also visits house by house. Visiting every customer to collect the reading of meter is the current majority approach for metering. Although the current approach has been used for very long time, it obtains room to improve. First, more man power is required for current systems because all customer are visited regularly to collect the readings. Secondly, the process is time consuming because the data collection may not be completed in first visit. Finally, accuracy cannot be assured due to human error of incorrect readings [9].

To improve the efficiency and accuracy of metering, Automatic Meter Reading (AMR) system has been discussed and used for along time. AMR is the technology of automatically collecting data from water meter or energy metering devices (water, gas, electricity) and transferring the data to central database for billing and/or analyzing. This means that billing can be based on actual

consumption rather than an estimate based on previous consumption, giving customers a better control of their use of water consumption, gas usage or electric energy [9].The AMR was first design in 1962 by AT and T, which was not successful. After successful experiments, AT and T presented to provide phone system-based AMR services at $2 per meter. The price was four times more as compare to the monthly cost of a person to read the meter-50 cents. Hence the program was considered inexpensively unfeasible in 1972, Theodore George "Ted" Paraskevakos, developed a sensor monitoring system which used foe meter reading capabilities for all utilities [9].

In 1974, Mr. Paraskevakos was awarded a U.S patent for this tecehonoylg. 1977, he launched Metretek Inc., which developed and produced the first fully automated, load management system and commercially available remote meter reading. The modern era of AMR began in 1985, when some major full-scale projects were implemented. Hackensack Water Co, and equitable Gas Go, Were the first to commit to full-scale implementation of AMR on water and gas meters. In 1986, minnegasco initiated a 450,000-point radio-based AMR system. In 1987, Philadelphia electric Co. faced with a large number of inaccessible meters, installed thousands of distribution line carrier AMR units to solve this problem. Thus, AMR is becoming more viable each day. Advances in solid-state electronics, microprocessor components and much low cost surface-mount technology assembly mechanisms have been the categories to produce reliable cost-effective products capable of providing the economic and human advantages which justify use of AMR system on a large, if not full-scale, basis[9].

AMR is also known as smart meters and associated network is called smart grid. AMR use a real time wireless communication network to connect meters with a central system. Public utilities are essential services that play a vital role in economic and social development. Quality utilities are a prerequisite for

effective poverty eradication. Increased competition in the utilities sector in recent years has entailed changes in regulatory frameworks and ownership structures of enterprises, in addition to business diversification and enhancing efficiency of delivery and reviewing tariffs and other sources of income collection remotely [10]

2.2 Wireless Network

The first wireless networks were developed in the pre-industrial age. These systems transmitted information over line-sight distances (later extend by telescopes) using smoke signals, torch signaling, flashing mirrors, signal flares, or semaphore flags. An elaborate set of signal combinations was developed to convey complex messages with this rudimentary signal. Observation stations were built on hilltops and along roads to relay these messages over large distances. These early communication network were replaced first by the telegraph network (invented by Samuel Mores in 1895) and later by the telephone. In 1895, a few decades after the telephone was invented, Marconi demonstrated the first radio transmission from the Isle of wight to a tugboat 18 miles away, and radio communications was born. Radio technology advanced rapidly to enable transmission over larger distances with better quality, less power, and smaller, cheaper devices, thereby enabling public and private radio communications, television, and wireless networking [11].

Early radio systems transmitted analog signals. Today most radio systems transmit digital signals composed of binary bits, where the bits are obtained directly from a data signal or by digitizing an analog signal [11]. Wireless communications is, by any measure, the fastest growing segment of the communications industry. As such, it has captured the attention of the media and the imagination of the public. Cellular systems have experienced exponential growth over the last decade and there are currently around two billion users worldwide. Indeed, cellular phones have become a critical business tool and part

of everyday life in most developed countries, and are rapidly supplanting antiquated wire line system in many developing countries. In addition, wireless local area networks currently supplement or replace wired networks in many homes, businesses, and campuses. Many new applications, including wireless sensor networks, automated highways and factories, smart homes and appliances, and remote telemedicine, are emerging from research ideas to concrete system. The explosive growth of wireless systems coupled with the proliferation of laptop and palmtop computers indicate a bright future for wireless networks, both as stand-alone systems and as part of the larger networking infrastructure. However, many technical challenges remain in designing robust wireless networks that deliver the performance necessary to support emerging applications [11].

2.3 Benefits of Using Wireless Technology

There are many reasons to choose wireless network over traditional wired network; customers commonly use more than one access technology to service various parts of their network and during the migration phase of their networks, when upgrading occurs on a scheduled basis. Wireless enables a fully comprehensive access technology portfolio to work with existing dial, cable, and DSL technologies. Also the inherent nature of wireless is that it doesn't require wires or lines to accommodate the data/voice/video pipeline. As such, the system will carry information across geographical areas that are prohibitive in terms of distance, cost, access, or time. Although paying fees for access to elevated areas such as masts, towers, and building tops is not unusual, these fees, the associated logistics, and contractual agreements are often minimal compared to the costs of trenching cable. Companies can generate revenue in less time through the deployment of wireless solutions than with comparable access technologies because a wireless system can be assembled and brought online in as little as two to three hours. This technology enables service providers to sell access without

having to wait for cable-trenching operations to complete or for incumbent providers to provide access or backhaul [11].

Wireless commonly both competes with and complements existing broadband access. Wireless technologies play a key role in extending the reach of cable, fiber, and DSL markets, and it does so quickly and reliably. It also commonly provides a competitive alternative to broadband wire line or provides access in geographies that don't qualify for loop access [11].Running additional wires or drilling new holes in a home or office could be prohibited (because of rental regulations), impractical (infrastructure limitations), or too expensive and flexibility of location and data ports is required. Roaming capability is desired; e.g., maintaining connectivity from almost anywhere inside a home or business. Network access is desired outdoors; e.g., outside a home or office building [11].

2.4 Evolution of Wireless Water Meter Reading Methods

The methodology and technology for reading water meters has evolved greatly since the 1980's, producing major improvements in the technology and concomitant increases in the quantity and quality of the information collected. Water meters have thus evolved from stand alone devices to networked devices working in a sometimes complex sensor network providing information services that the inventors of water meters decades ago never would have imagined was possible. This evolution of automatic reading methods for water meters explains in the following paragraphs:

2.4.1 Taking readings by eye from the register

This is the legacy method which requires a meter reader to physically enter the premises and read the meter, usually in the basement. The meter reader eyeballs the register and writes down the numbers on a sheet in a location corresponding to the customers account number. This information is then manually input into the utility's billing system database for calculating the charge for water usage for that billing period. Since this method is labor-intensive and expensive, such

readings have been made only quarterly, but in some places monthly, providing very few data points for each location. This information is usually more than sufficient to use to calculate the portion of the customers' water bill for that location for water usage, and to detect leaks [12].

2.4.2 Taking readings with help of handheld computer

The meter is connected with wires to a device located on the outside of the building, so even though a physical visit by a meter reader is still required to enter the building. Eliminating the problems caused by lack of access to the meter, the meter reader uses a handheld computer, which is either touched onto the touchpad of the external meter unit, or receives the information via infrared or radio frequency. The handheld computer records the water usage information for later download to the meter billing system. While this method reduces human error in the transcription, twice, of the information from the register in the eye method, billing system software are not compatible. This method does not increase the quantity or quality of the information collected, which is still just water usage for each quarter or month, which can be used for water billing purposes and leak detection [12].

2.4.3 Meter retrofitted with a radio frequency transmitter

The meter is retrofitted with, or already comes with, a radio frequency transmitter, that is read by the meter reader in his vehicle as he drives past all the metered buildings on his route. The information is collected on a laptop in the vehicle, which has vendor-supplied software which matches the account information, location, and meter register information and prepares it for download to the billing system when the vehicle returns to base. Drive-by does not by itself increase the amount of meter readings, because of the time and expense of driving the routes, but is usually employed on rural routes that are not cost effective to put into a fixed network [12].

2.4.4 Compilation of readings using fixed network

The fixed network is usually think of when talk about automatic meter reading. This implementation takes the full use of the capabilities of the wireless water meter and enables it to become a sensor network for the water utility that can allow almost continuous water usage readings for a number of purposes which will be discussed [12].

2.5 Previous Works

Zhu Hengjun and Zhu Yi Sheng [13] have proposed Wireless Remote Water Meter Design of Automatic Meter Reading System. A remote water metering system by wireless communication through GPRS internet with low cost, accuracy and adaptable to complex environment was designed. In this project the analysis on the scheme confirmation, the development of management software was carried out, and the integrated design of the system based on GPRS was studied. The general planning and the technical requirements on the user's water consumption detecting system were also put forward, based on the S3C2440 chip [13].

Young-Woo lee [14] have proposed a wireless Digital Water Meter with low power Consumption for Automatic Meter Reading in witch they used magnetic hole sensors to calculate the amount of water consumption and they had used Zigbee wireless protocol to transfer amount of water consumption to the gateway[14]

Li Quan-Xi and Li Gang [15] have proposed Design of remote automatic meter reading system based on ZigBee and GPRS. Household metering system design based on Zigbee and GPRS technologies. This system combines ZigBee technology with GPRS network. It is using PIC18LF4620 as important processor, by CC2430 to do communication in short distance and SIM300 to achieve communication function in long distance, using RS-232 link communication joint to connect the communication between ZigBee and GPRS

technologies. In this way it is convenient to copy the data of water, electricity and gas meter. It can full use the resources of networks. This system has low cost and a little power consumption, while it has great extension and security. It can be used in other areas widely [15].

Amruta Kotasthane and Hate S G [16], have proposed Implementation of Automatic Meter Reading System Using Wireless Sensor Network. They have designed and implemented wireless sensor network for measuring utilities such as water, electricity. The system is designed using electric meter, flow sensor for measuring utilities, AMR controller LPC2138 as core processor, and zigbee module in close communication with GSM for distant communication. This system performs tasks such as taking meter reading, distribution of bills, sending notice cutting the reconnection of flow automatically. This model can lead to great deal of costs saving in water and electricity metering. This system is low cost, less power consuming, secure and reliable [16].

Dr, Sidappa Naidu and S.Arun [17], have proposed Design and Implementation of Automatic Meter Reading System Using GSM, ZIGBEE through GPRS. An implementation methodology for a wireless automatic meter reading system (WAMRS) incorporating the widely used GSM and Zigbee network. Using GSM as the medium for WAMRS provides a cost-effective, wireless, always-connected, two-way data link between utility company and WAMRS, the WAMRS sends information of utility usage, power quality and outage alarm to utility company, tampering detection to the utility servers. The networked meter-reading system consists of terminal measure meters, sensors, intelligent terminals, management centre and wireless communication network. The energy consumption is being calculated using a standard calibrated energy meter [17].

Shoeb Sheikh[18] have proposed designs and implementation of wireless automatic meter reading system based on GSM, presented in the paper absorbed many advanced study results in computer technology and communication

technology. The meter-reading task can be finished at the Management Department of residence area by using this system. For the meantime, the energy resources management departments can monitor the consumption of power in order to improve the utility of power. It is the basic to realize automatic deliver of energy resources. The system has many significant excellences, such as wireless, low-workload, great quantity of data transmission high-veracity and low expenses. The using of embedded system improves the stability of wireless data transmission. For a long distance transmission GSM telecommunication has shown excellent performance at any conditions [18].

Adnan Rashdi, Rafia Malik, Sanam Rashid, Anam Ajmal, and Sulaiman Sadiq[19] have proposed a Remote Energy Monitoring Profiling and Control through GSM network, it has been developed which can efficiently utilize the existing digital meters and widespread GSM infrastructure. With the advent of digital technology, electromechanical meters are continuously being replaced by digital meters. Digital energy meters offer greater convenience to implement and to establish automatic meter reading system electronically. To develop an efficient, reliable and effective system of AMR, various technologies have been utilized. The developed project utilizes the widespread and already installed infrastructure of GSM network. The stored and forwarding features of SMS allow reliable meter reading delivery when the GSM signal is affected by poor weather conditions. The proposed remote energy monitoring system is an efficient, simple, compact, cost effective, and completely automated system which provides location monitoring with interactive web interface. System provides elaborate consumer profiling which helps transparent billing and consumption control of resources [19].

H.G Rodney Tan [20] have proposed Automatic Power Meter Reading System Using GSM Network. This study presented the advantage of the available GSM infrastructure nationwide coverage in the country and the Short Messaging

System cell broadcasting feature to request and retrieve individuals houses and building power consumption meter reading back to the energy provider wirelessly. The Store and forwarding features of SMS allow reliable meter reading delivery when GSM signal is affected by poor weather condition. The stored SMS is an archive in the mobile operator and can be retrieved for billing verification purpose [20].

CHAPTER THREE

SIMULATION MODEL

3.1 Introduction

The use of wireless automation in almost all the fields of water, gas and power generation, distribution and billing has come of age. Here with the inclusion of wireless communication with the automation may lead to paradigm change in the current trend. The work presented has developed a prepaid water meter system for prepaid billing of water consumption through remote monitoring without any human intervention. This system promises fast and accurate billing of water as well as preventing any misuse of it. Developed a water meter reading using GSM network that suitable for remote places to monitor the water meter reading, this could reduce the use of human resource for reading the meter and issuing a bill.

The design presents a modren methodology for avoiding the high construction and maintenance costs in the existing meter reading technology. Apart the use of wireless meter reading with network technologies has become need of the day. The designed system avoids the human intervention in power management. GSM network connected the control station with the water meter in consumer premises. The customer can buy water by send SMS carrying his data from his phone to the control station and automatically receive his bill in his phone and also recharge his water meter. This system provides efficient meter reading, avoiding the billing error and reduces the maintenance cost. Figure 3.1 show block diagram of the proposed system. At the control station (the water company) using Arduino development board as central console, using GSM module to receive data from customer; that he request to buy water; also using GSM module to send the bill to customer on his phone and send the amount of water to customer's water meter; which GSM connected with Arduino controller.

Using valve water pipes also connected with Arduino controller to control water flow through pipes. The block diagram for control station shown in figure 3.2

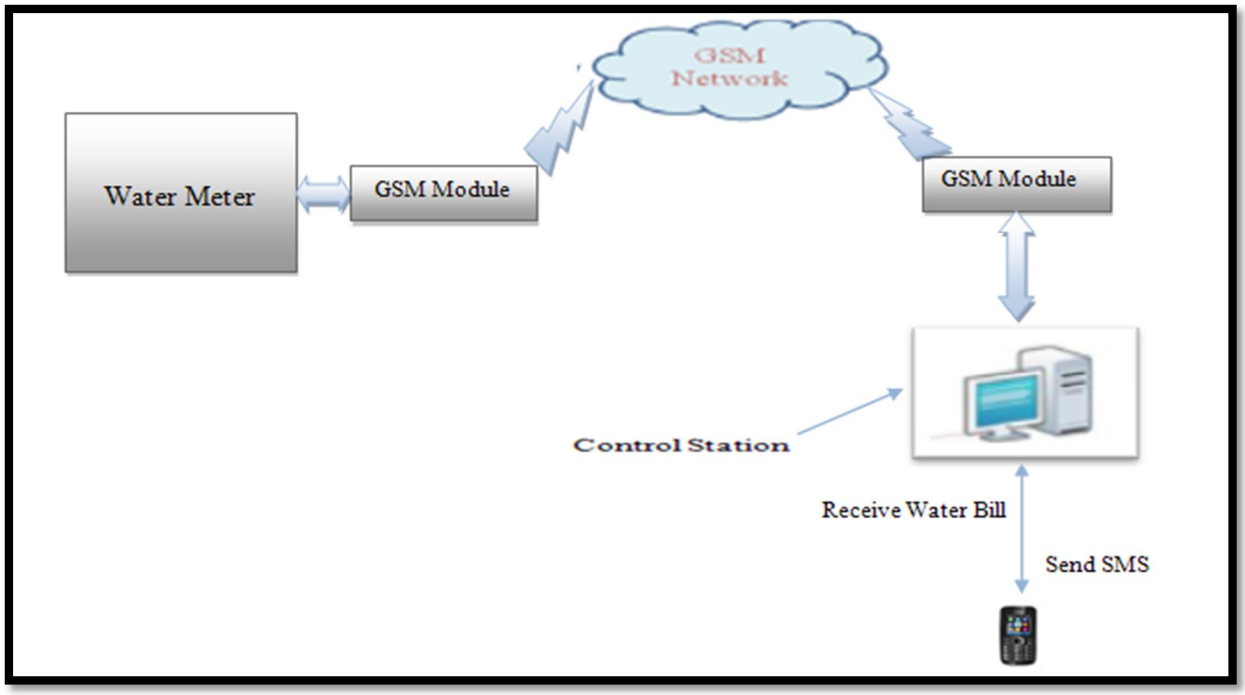

Figure 3.1: Block diagram of the system

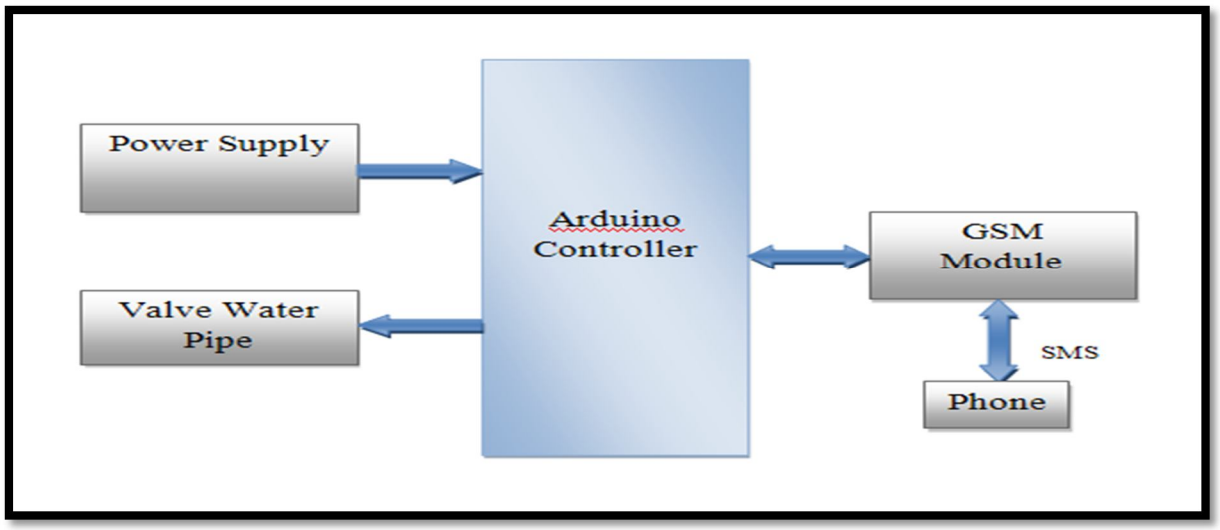

Figure 3.2: Block diagram for control station

At the customer premises water meter contain Arduino controller, GSM module to send and receive data, flow sensor also connected with Arduino to calculate liters used, and LCD to shows the amount of water. The block diagram for water meter in customer premises shown in Figure 3.3

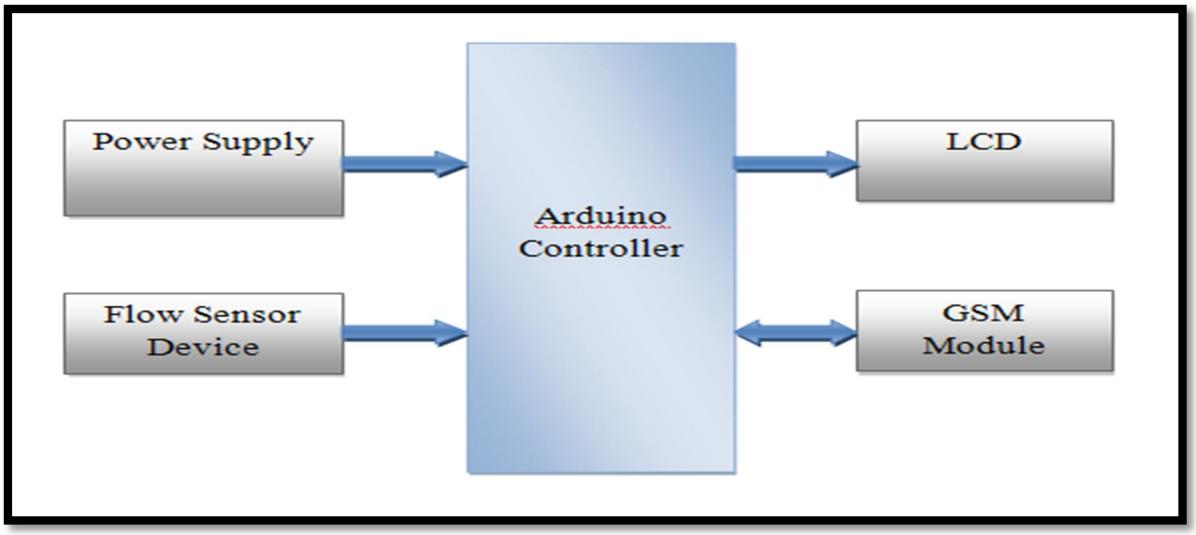

Figure 3.3: Block diagram for water meter

3.2 Flow Sensor Device

Flow sensor, the devices that detect and measure water flowing through pipes, are becoming necessary components of efficient water meter systems, giving it information to make operating decisions. Water meter basically works with the output of the flow sensor [21]. The VATS JT-121 flow sensor shown in Figure 3.4 is a robust and compact flow sensor, which generates frequency and signal proportional to the flow a ruggedly constructed range of paddle wheel flow sensors that is highly repeatable and delivers reliable performance. These paddle wheel flow sensors are powered from the meter that is driven by DC voltage for output signal. Suitable for low pressure systems, these sensors measure the liquid flow rates in full pipes. Set at proper insertion depth into the process flow. The VATS JT-121 flow sensor gives output proportional to flow in square wave

form; we can collect the output and can read by microcontroller (see Appendix A) [2].

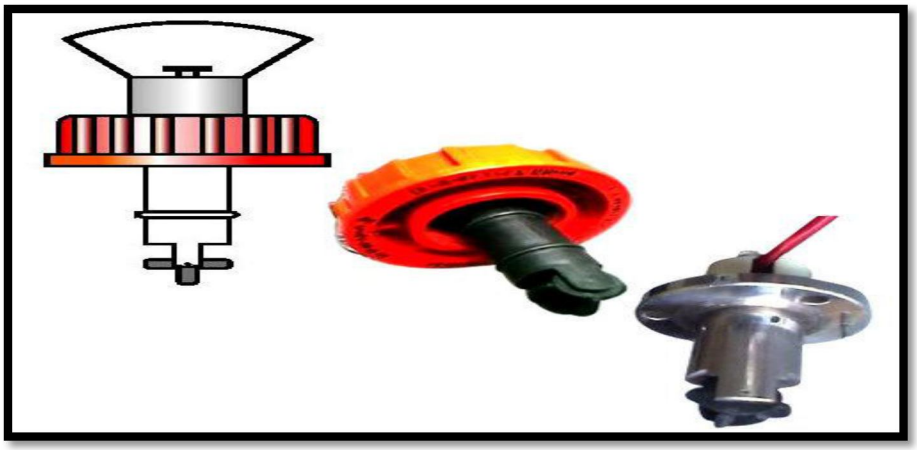

Figure 3.4: The VATS JT-121flow sensor

3.3 Wireless Communication Unit (Based on GSM)

During the present day's technology is all about the automation and wireless control of all the equipment used in industries, factories and households. Any equipment that can be controlled wirelessly is more easily maintained and it responds very fast comparing to the manual operation of the equipment. It increases safety as well as speed of operation in times of failure or damage [22].

The GSM standard was proposed by ETSI in 1989. The primary business administrations were launched in 1991 and after its initial presentation in Europe; the standard went worldwide in 1992. From that point forward GSM has turned into the most broadly embraced and quickly developing advanced standard, and it is situated to turn into the world's overwhelming cell standard. Today's third era GSM systems convey excellent and secure versatile voice and information administrations with full abilities over the world. GSM is a massively fruitful engineering and as uncommon story of worldwide accomplishment [22].

GSM implies worldwide framework for versatile correspondence. GSM is a global advanced cell telecommunication. GSM is used by over 1.5 billion people across more than 212 countries and territories. GSM also pioneered low-cost implementation of the Short Message Service (SMS) which allows parties to exchange delay-tolerant short text messages. The popularity and wide coverage of cellular networks have attracted researchers to consider the use of SMS service [17].

The advantages of GSM are coverage is all but pervasive, far outreaching the coverage of 802.11 networks. And wide acceptance of cellular phones makes them ideal conduits for the delivery of ubiquitous computing applications like WBAN. Localization system based on cellular signals, such as GSM, leverages the phone's existing hardware and removes the need for additional radio interfaces. Since cellular towers are dispersed across the covered and dense areas, a cellular based localization system would still work in situations where a building's electrical infrastructure has failed. Moreover, cellular systems are designed to tolerate power failures. Also GSM, unlike 802.11 networks, operators in a licensed band, and therefore does not suffer from interference from nearby devices transmitting on the same frequency [5]. In Figure 3.5 is a sample of data transmission though GSM which the in-built GSM SMS to directly send SMS (text) messages through a GSM phone or GSM modem, connected to the computer by serial cable, infrared or Bluetooth [5].

The GSM technology discourses unique needs of monitoring and network applications. Also, GSM devices can be located well inside containers without any visible external antennas it means that the data can pass on a closed area. Cellular towers, which the GSM relies, are dispersed across the covered and dense areas; a GSM system will still work in situations where a building's electrical infrastructure has failed. And, the benefit GSM infrastructure has capability of reading data wirelessly. In addition, the GSM is a popular wireless

choice for connectivity between the data-acquisition units and clients, and it has application remote accessibility of collecting and sending data. GSM has a capability to send large data transfer and occasional transmission of data, which the researchers will use to establish SMS application on data acquisition. Furthermore, GSM is known as the always on, always connected technology means that this communications has stability on consistent signal even on crowded places [5].

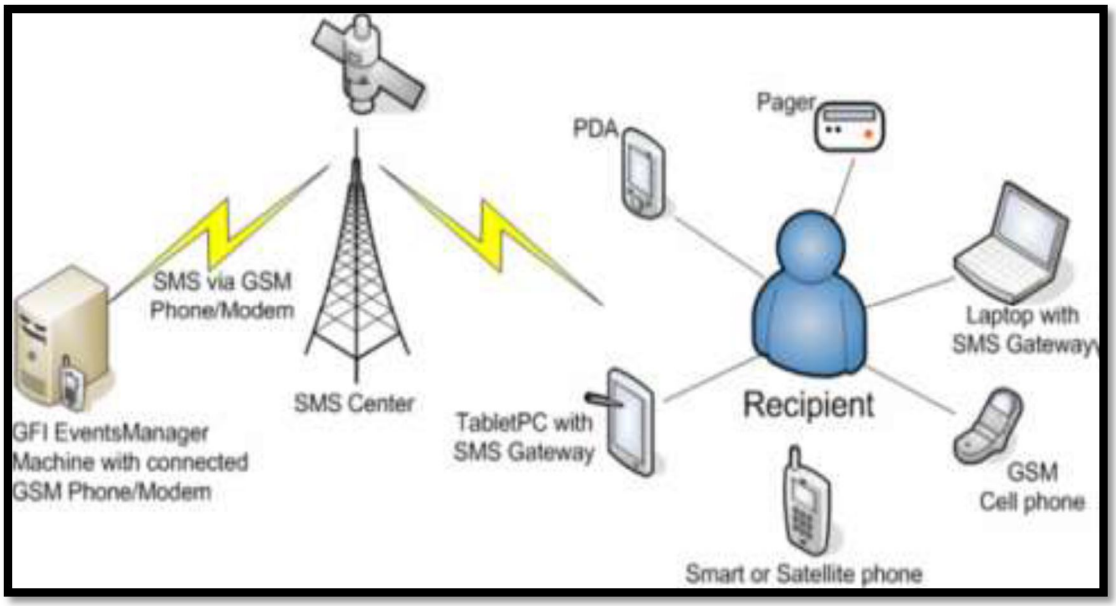

Figure 3.5**:** Sample of data transmission though GSM

The use of GSM technology on meter reading is possible to meet the objective which is to create a wide range of automatic water meter reading system that will improve the process of water meter consumption reading through wireless technology and will eliminate the time of collecting data on water consumption per house of consumer. On the Figure 3.6 the GSM- automatic water meter reading sends data to GSM monitoring device using GSM network provider [5].

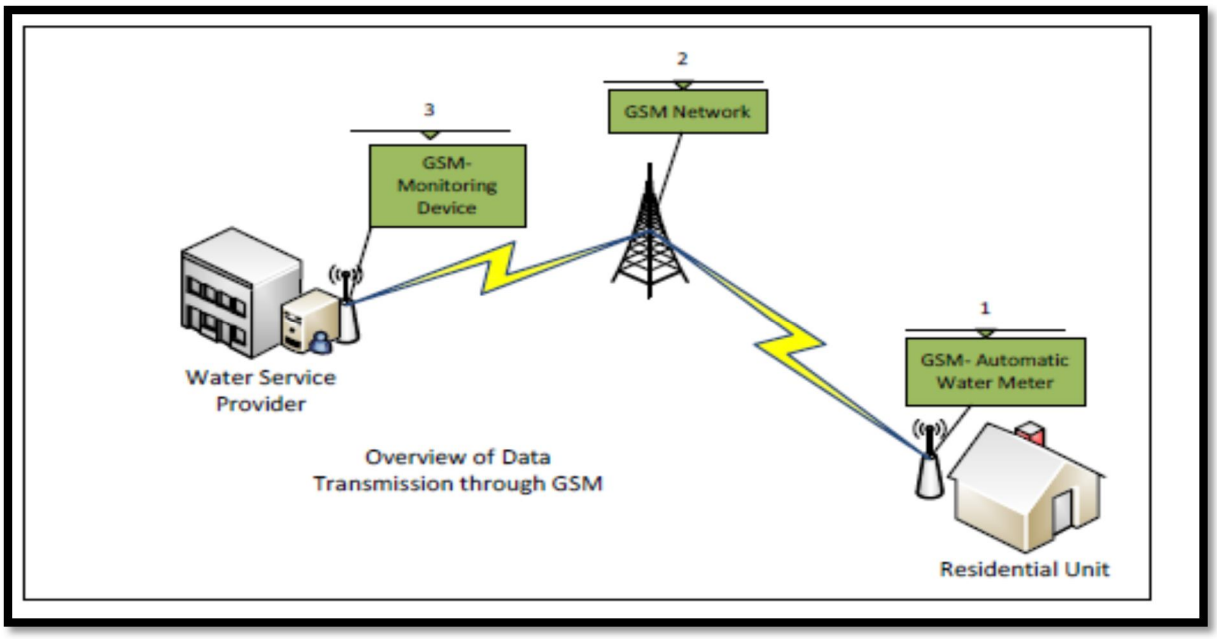

Figure 3.6**:** Overview of data transmission through GSM

Other generations of wireless technologies like Wi-fi, Zigbee, etc are good but it has limitations mainly the range of wireless data transmission. Therefore, the only one who will benefit is within the range of its wireless radius network. Using the GSM module, the researchers can eliminate this problem and enable a more sophisticated approach for wireless data transmission [5]. With the help of GSM module interfaced; we can send short text messages to the required authorities as per the application. GSM module is provided by SIM uses the mobile service provider and send SMS to the respective authorities as per programmed. This technology enables the system a wireless system with no specified range limits. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band [23]. GSM module SIM300 is just like a cell phone with all the facilities of sending

and receiving a message, sending and receiving calls. It's Tri-Band GSM/GPRS 900/1800/1900 MHz [22]

3.4 Processing and Storing Unit

An Arduino development board is used as a central processor because its capability to operate without other external components due to all necessary peripherals is already built into it. An Arduino development board is driven by the need to start managing the billing at the client side and to control the flow of water. An arduino controller was programmed by code based on Arduino C (for more information about programming code please refers to Appendix B). The interface of the water meter system with the external world, mainly the server application, is implemented using the GSM modem interfaced to the controller that is capable of sending command in which the controller can report the readings and related data. The GSM module will receive a command to change the status of the water meter system. An Arduino converts the control command into signals that pass through actuators, and physically change the status of the flow sensor. In addition, Arduino drives an LCD display to show the readings at a programmable pre-defined rate. Here in the following paragraphs a brief definition of the Arduino, its feature, and the type of Arduino used in this thesis project (Arduino Uno)

3.4.1 Arduino development board

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It’s intended for designers, artists, hobbyists, and anyone interested in creating interactive objects or environments. With Arduino, you can build objects that can respond to and/or control light, sound, touch, and movement. Arduino has been used to create an amazing variety of things, including musical instruments, robots, light sculptures, games, interactive furniture, and even interactive clothing. Though it is easy to use, Arduino’s underlying hardware works at the same level of sophistication that engineers

employ to build embedded devices. People already working with microcontrollers are also attracted to Arduino because of its agile development capabilities and its facility for quick implementation of ideas. Arduino is best known for its hardware, but you also need software to program that hardware. Both the hardware and the software are called Arduino, The combination enables you to create projects that sense and control the physical world. The software is free, open source, and cross-platform. The boards are inexpensive to buy, or you can build your own (the hardware designs are also open source) [24].

3.4.2 Arduino software

Software programs, called sketches, are created on a computer using the Arduino Integrated Development Environment (IDE). The IDE enables you to write and edit code and convert this code into instructions that Arduino hardware understands. The IDE also transfers those instructions to the Arduino board (a process called uploading) [24].

3.4.3 Arduino hardware

The Arduino board is where the code written is executed. The board can only control and respond to electricity, so specific components are attached to it to enable it to interact with the real world. These components can be sensors, which convert some aspect of the physical world to electricity so that the board can sense it, or actuators, which get electricity from the board and convert it into something that changes the world. Examples of sensors include switches, accelerometers, and ultrasound distance sensors. Actuators are things like lights and LEDs, speakers, motors, and displays [24].

3.4.4 Arduino feature

Schematic design of the open source development interface free download, and also according to the needs of their own changes, Download the program is simple and convenient. Also simply with the sensor, a wide range of electronic components connection (such as: LED light, buzzer, keypad, photo resistor, etc.),

make all sorts of interesting things. Using the high-speed micro-processing controller (ATMEGA328) and the development of language and development environment is very simple, easy to understand, very suitable for beginners to learn [24].

3.4.5 Arduino Uno

The current Arduino board model, the Uno, is quite small in size compared to the average human hand, as shown in Figure 3.5 [25].

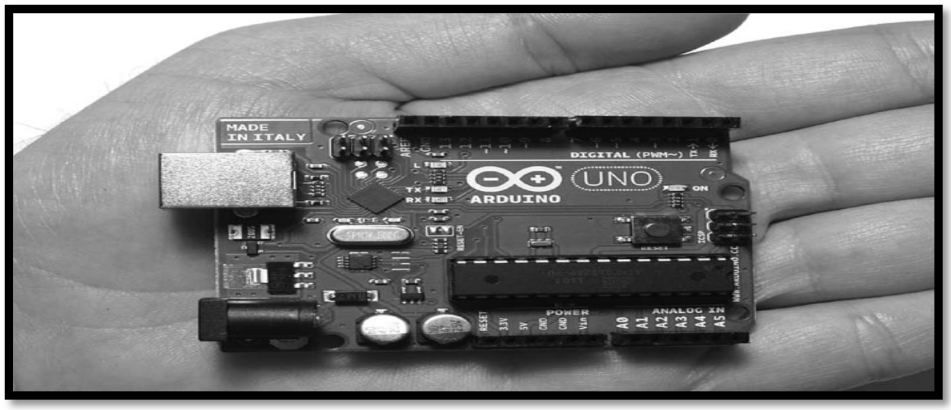

Figure 3.7: An Arduino Uno

Figure 3.8 shows the USB and power connector for arduino Uno [25].

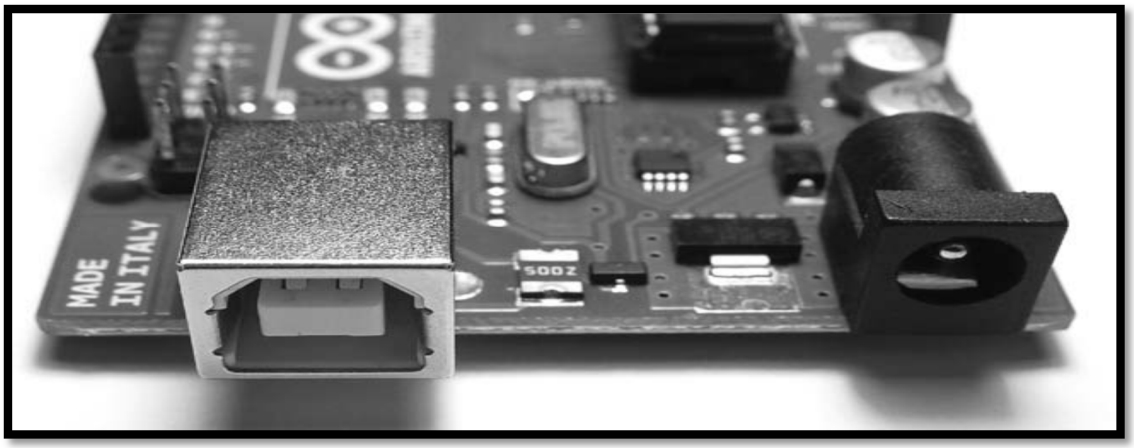

Figure 3.8: The USB and power connectors for arduino Uno

On the far left is the USB connector. This two connectors are used to connects for three reasons: to supply power to the board, to upload instructions to the Arduino, and to send data to and receive it from a computer. On the right is the power connector. Through this connector, you can power the Arduino with a standard mains power adapter. At the lower middle is the heart of the board: the microcontroller, as shown in Figure 3.9 [25].

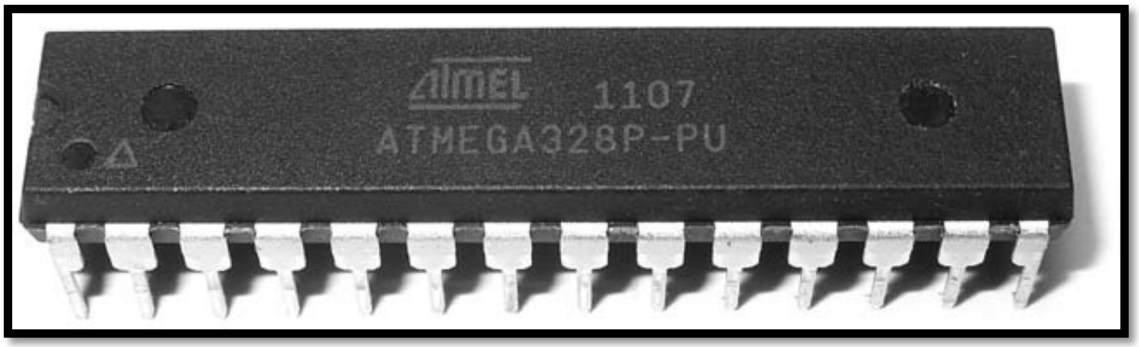

Figure 3.9: The microcontroller for arduino uno

The microcontroller is the “brains” of the Arduino. It is a tiny compute that contains a processor to execute instructions, includes various types of memory to hold data and instructions from our sketches, and provides various avenues of sending and receiving data. Just below the microcontroller are two rows of small sockets, as shown in Figure 3.10 [25]

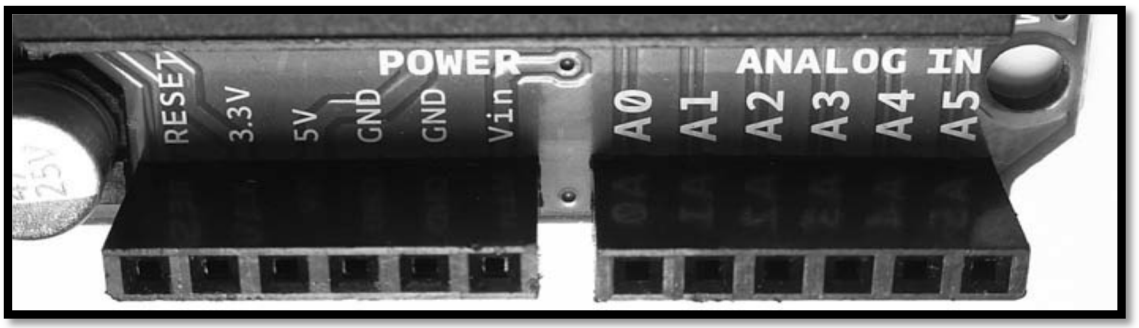

Figure 3.10: The power and analog sockets for arduino uno

The first row offers power connections and the ability to use an external RESET button. The second row offers six analog inputs that are used to measure electrical signals that vary in voltage. Furthermore, pins A4 and A5 can also be used for sending data to and receiving it from other devices. Along the top of the board are two more rows of sockets, as shown in Figure 3.11 [25].

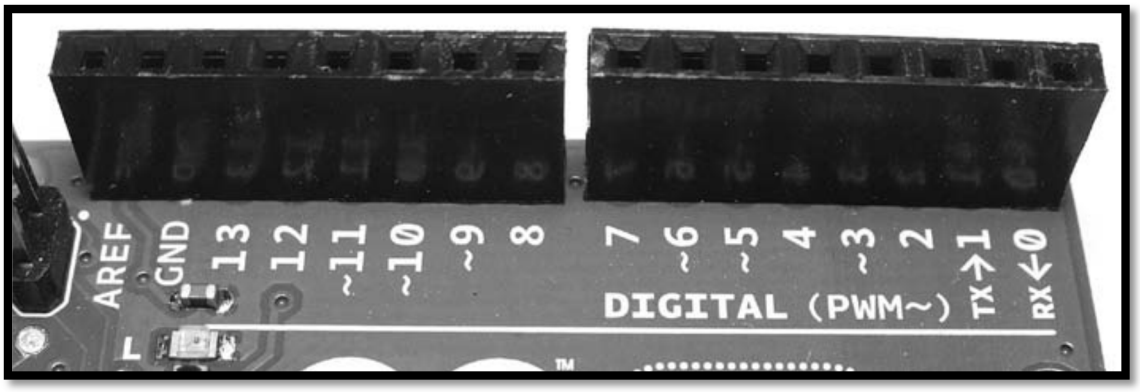

Figure 3.11: The digital input/output pins for arduino uno

Sockets (or pins) numbered 0 to 13 are digital input/output (I/O) pins. They can either detect whether or not an electrical signal is present or generate a signal on command. Pins 0 and 1 are also known as the serial port, which is used to send and receive data to other devices. The pins labeled with a tilde (~) can also generate a varying electrical signal.

Next are some very useful devices called light-emitting diodes (LEDs); these very tiny devices light up when a current passes through them. The Arduino board has four LEDs: one on the far right labeled ON, which indicates when the board has power, and three in another group, as shown in Figure 3.12. The LEDs labeled TX and RX light up when data is being transmitted or received between the Arduino and attached devices. The *L* LED is for your own use (it is connected to the digital I/O pin number 13). The little black square part to the left of the LEDs is a tiny microcontroller that controls the USB interface that

allows your Arduino to send data to and receive it from a computer [25]

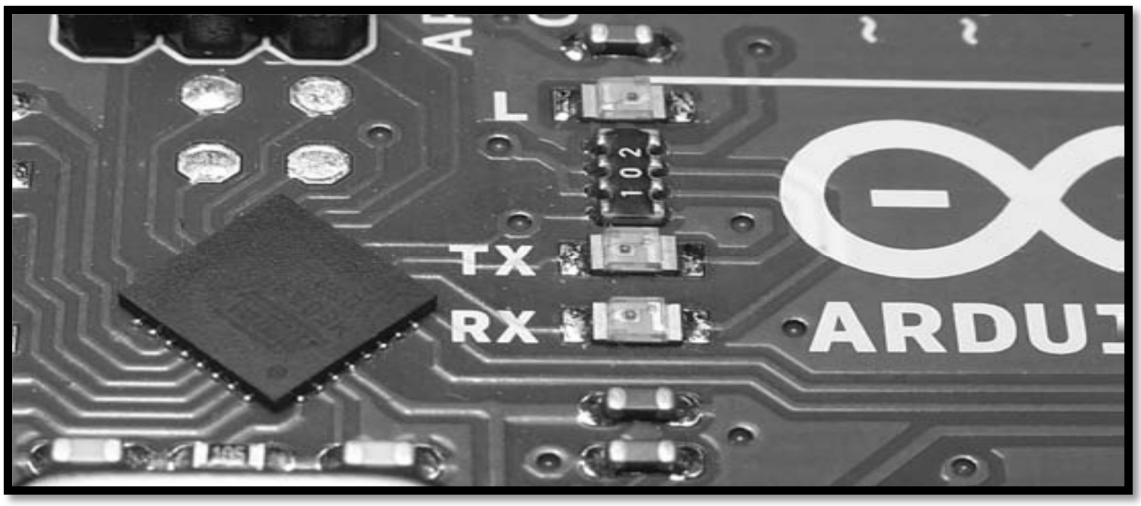

Figure 3.12: The onboard LEDs for arduino uno

And, finally, the RESET button is shown in Figure 3.13

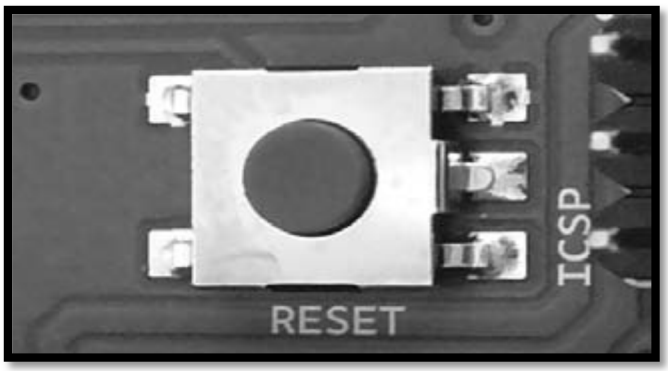

Figure 3.13: The RESET button for arduino uno

As with a normal computer, sometimes things can go wrong with the Arduino, and when all else fails, you might need to reset the system and restart your Arduino. This simple RESET button on the board (Figure 3.13) is used to restart the system to resolve these problems. One of the great advantages of the Arduino system is its ease of expandability—that is, it's easy to add more hardware

functions(for Hardware Specifications for arduino uno refers to appendix C) [25].

3.5 The Valve

A valve is a mechanical device that controls the flow of fluid and pressure within a system or process. A valve controls system or process fluid flow and pressure by performing many functions; like; stopping and starting fluid flow, or varying (throttling) the amount of fluid flow ,controlling the direction of fluid flow ,regulating downstream system or process pressure or relieving component or piping over pressure. A valve actuator (see Figure 3.12) is a pneumatic or electric mechanism used in process control systems to automatically open or close valves. In standard valves, when the valve is given a command to open to a certain point, there is no feedback to verify that it has opened to that position. Valve actuators can be used with either linear or rotary valves in industry and transportation applications [26].

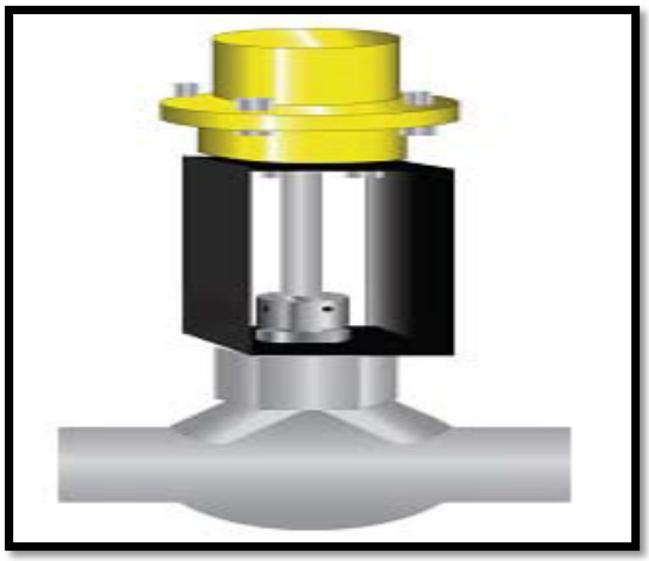

Figure 3.14: Valve actuator

3.6 Light-Emitting Diodes

A Light Emitting Diode (LED) also referred to as SSL (Solid State Lighting), is an electronic device (chip) that produces light when an electrical current is passed through it. The wavelength (or color) of light that is emitted is dependent on the LED materials. LEDs are available in many colors, including red, blue, amber, green. The Figure 3.15 show the green LED [23].

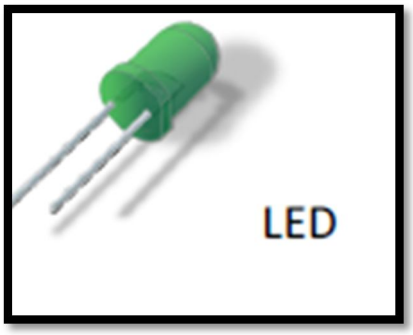

Figure 3.15: Green LED

3.7 Liquid Crystal Display

Liquid Crystal Display (LCD) 16*2 is used to check the output of different modules interfaced with the microcontroller. Thus LCD plays a vital role in a project to see the output [27].

3.8 Control Unit

In proposed system Arduino is used as master controller to managing and keep record of water consumed and calculation of bill and connecter to GSM module, which is send and receive data and command through it.

CHAPTER FOUR
RESULTS AND DISCUSSION

Water is an invaluable resource to the human. The use and consumption of it should therefore be used with much care to ensure that it is not wasted. The cases of vandalism and damage of water meters and pipes have become rampant. The aim of this thesis will be to help the water service providers to monitor the meter readings from the location and from their databases. The proposed system of AMR consists of three main components, water meter system, control station to manage the measurements and prepare bills, and communication medium that is based on the existing GSM networks.

The customer can buy water by send SMS from his phone to control station through GSM and automatically receive the bill in his phone. Linked the server of water company with the server of telecommunications; to be the amount paid for the purchase of water is deducted from the existing balance in the customer's phone, If customer haven't phone; he will go directly to water company to buy water. At the control station, billing software calculates bill based on equation programmed. The control station issued order to valve to be open. The number of liters of water is determined, and then it transmitted to water meter consumed through exiting GSM network. At the user premises, the water flow through the pipe is measured using the flow sensor device, when the amount of prepaid water is end and the LCD in meter show zero; the control station received a signal through GSM from water meter to close the valve. Build the simulation design for water meter using proteus software and build the simulation design for customer phone using visual basic 2010 software (for more information about programming code please refers to Appendix C).

4.2 Flowchart

The system is clarified using the flowchart; it is illustrate the entering operation and the exit operation in company (control station side) as shown in Figure 4.1 and in water meter in consumer premises as shown in figure 4.2.

In the company (control station); when the customer want to buy water the control station through GSM will receive SMS from customer, the SMS carry the customer counter number and the amount SDG, then calculate the a mount of water as programmed and extracted the water bill, then automatically the bill will send to customer's phone, control station issued a command to valve pipe of water to be open, and through GSM module send a signal to water meter in consumer premises to receive liters. When the water is end in consumer premises; control station will receive a signal through GSM from water meter in consumer premises to close a valve pipe.

In consumer premises a water meter wait a signal from control station, when a signal is arrive then flow sensor device will start count the liters, when count equal zero water meter through GSM send a signal to control station to close a valve pipe.

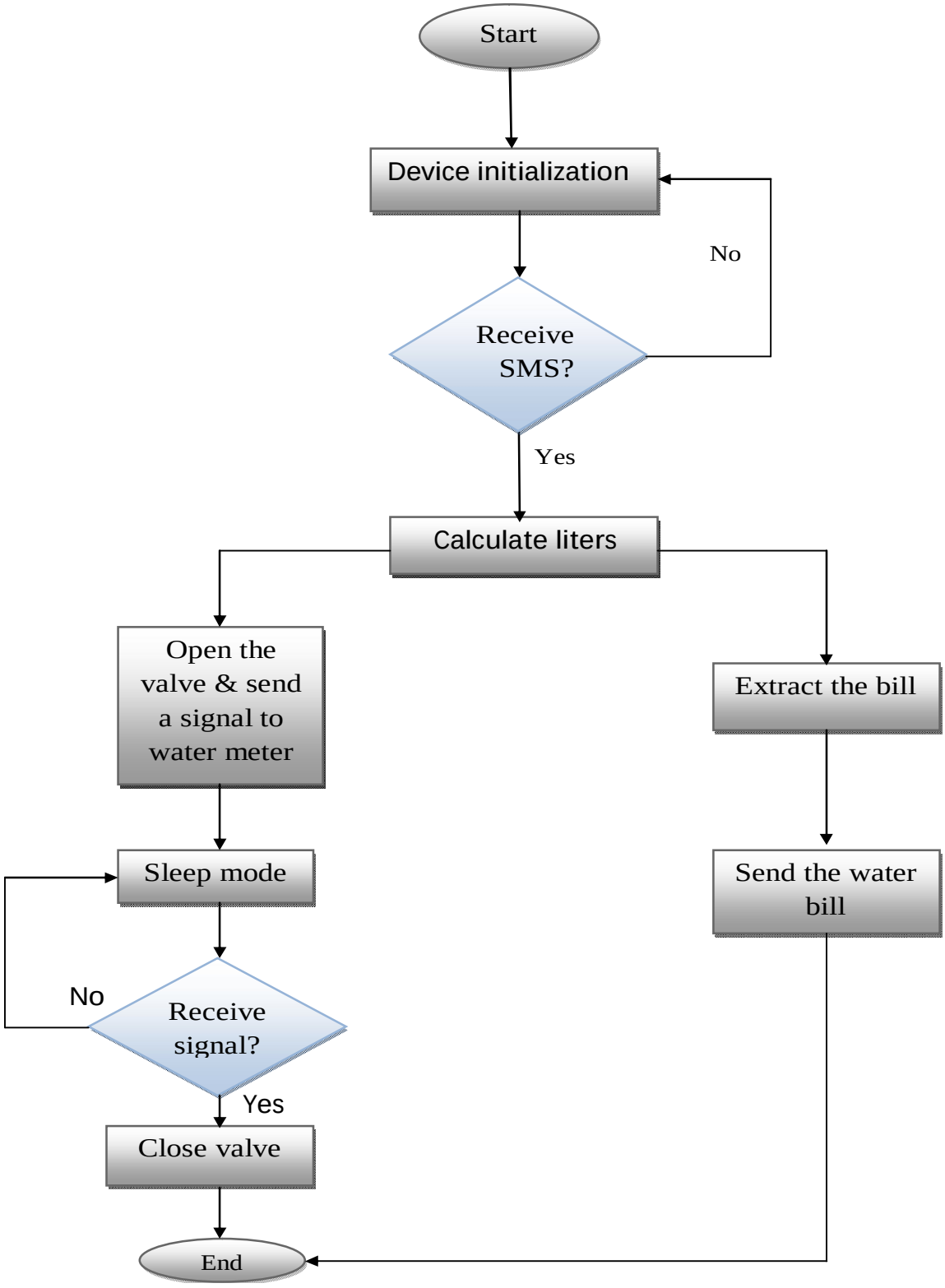

Figure 4.1: The flow chart for company (control station)

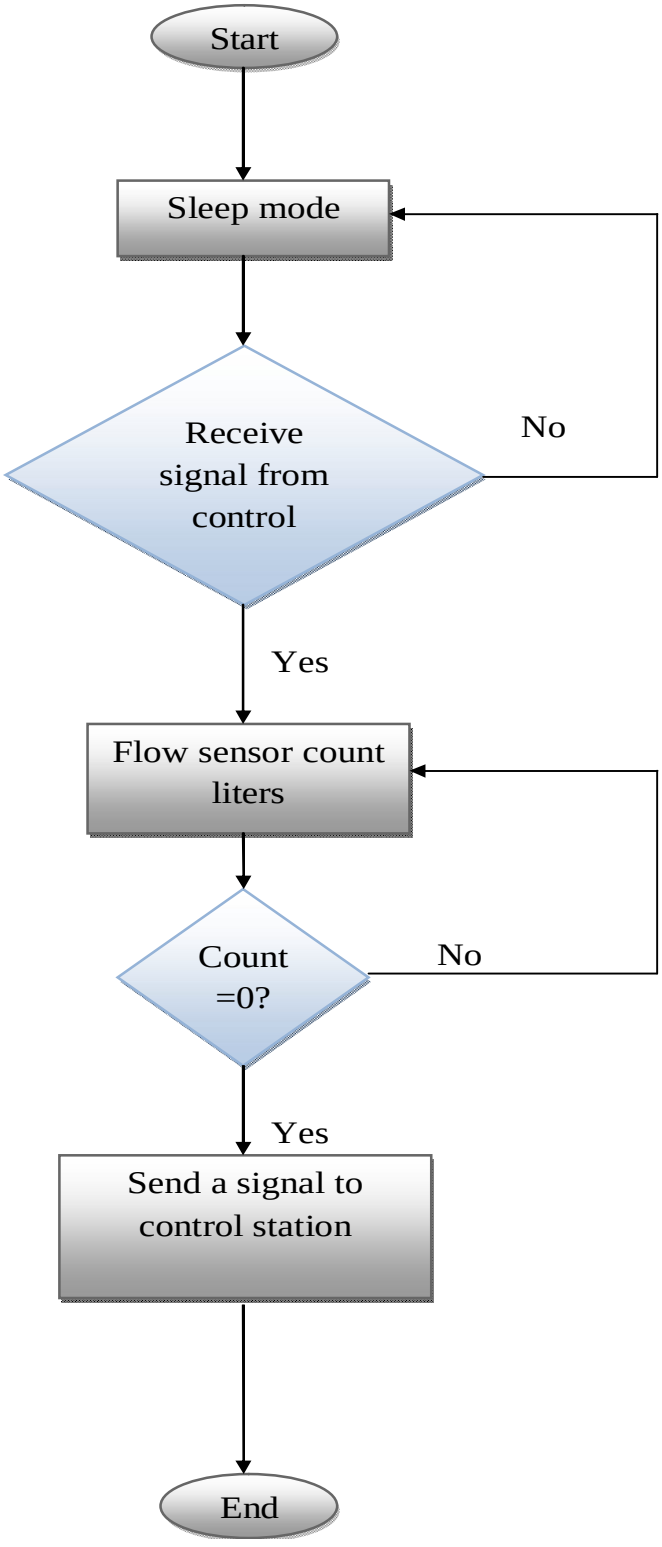

Figure 4.2: The follow chart for water meter

4.3 Operation of System

Here we have two sections; control station **N**EILOS company (suggested NEILOS name for the company) and consumer premises (water meter). At consumer premises water meter shown in Figure 4.3, it consists of: arduino development board, and flow sensor connected with arduino Uno controller (here in simulation system a pressure switch represents a flow sensor device), LCD connected with arduino Uno controller, GSM modem also connected with arduino Uno controller (here in simulation system serial board represents GSM modem) , and small green LED connected with arduino Uno controller. Arduino board control's and arranges the work of flow sensor, GSM, LCD and LED. The water comes through pipe arrive to user premises, then LED show green light, flow sensor start count liters, sensor is read by the arduino board. LCD shows the amount of water. The simulation system design of the water meter based on the proteus software, arduino programmed by arduino C (See Appendix B)

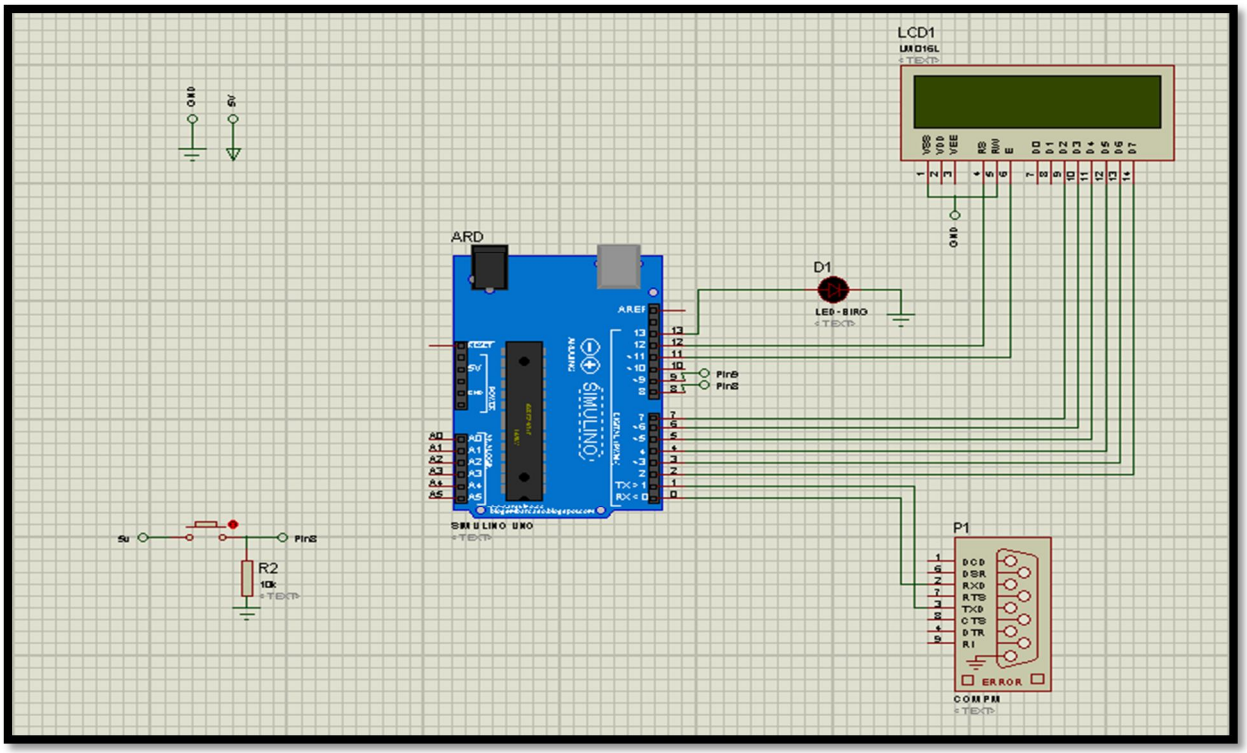

Figure 4.3: Water meter design

When the customer wants to buy water, sends SMS from his phone to the number 2020 (The water company specific the No. 2020 to receive the customer orders to buy water). In the database of company stored the user name and his counter NO. for the purposes of privacy and accuracy. In the SMS the customer write his counter No and the amount SDG. SMS format (counter NO# amount SDG). When customer sends the SMS to No 2020 will receive SMS carrying the water bill and the water meter will recharge. Let customer Ali wants to buy water, and his counter NO. 123, the amount is 20 SDG, send SMS from his phone to No. 2020 as shown in figure 4.4

Figure 4.4: The customer phone

Ali writes in the SMS his counter No. and the amount SDG as (123#20) and sends it as shown in Figure 4.5

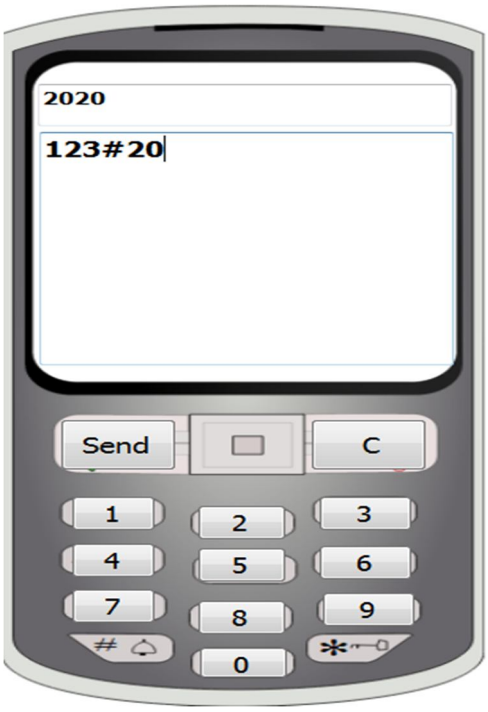

Figure 4.5: The customer Ali writes his counter No. and amount SDG

Then after a few seconds Ali will receive in his phone, the SMS carrying his water bill as shown in Figure 4.6

Figure 4.6: The customer Ali receive SMS

The water by liter is calculated by multiplying the number of coins in 100 as programmed. Ali wants to buy water by 20 SDG then the amount of liters equal 20*100=2000 liters. The bill show the company name (NEILOS), counter number (123), customer name (Ali), the amount of water by liters (2000) and the amount SDG (20) deducted from the existing balance in the customer's phone. The water bill shown Figure 4.7

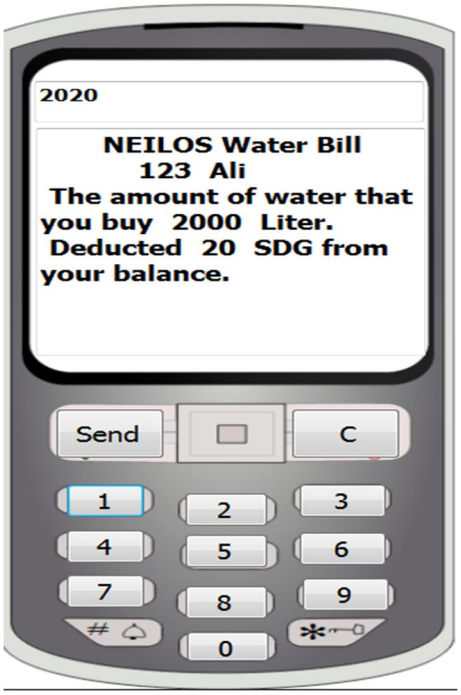

Figure 4.7: The water bill for the customer Ali

The customer will receive the bill and the water meter will recharge After the control station receive the customer order to buy water; then control station issued a command to valve to be open to allow the passage of water through pipes. In other side; in consumer premises the LCD of water meter show the number of liters and the LED show green light as shown in Figure 4.8

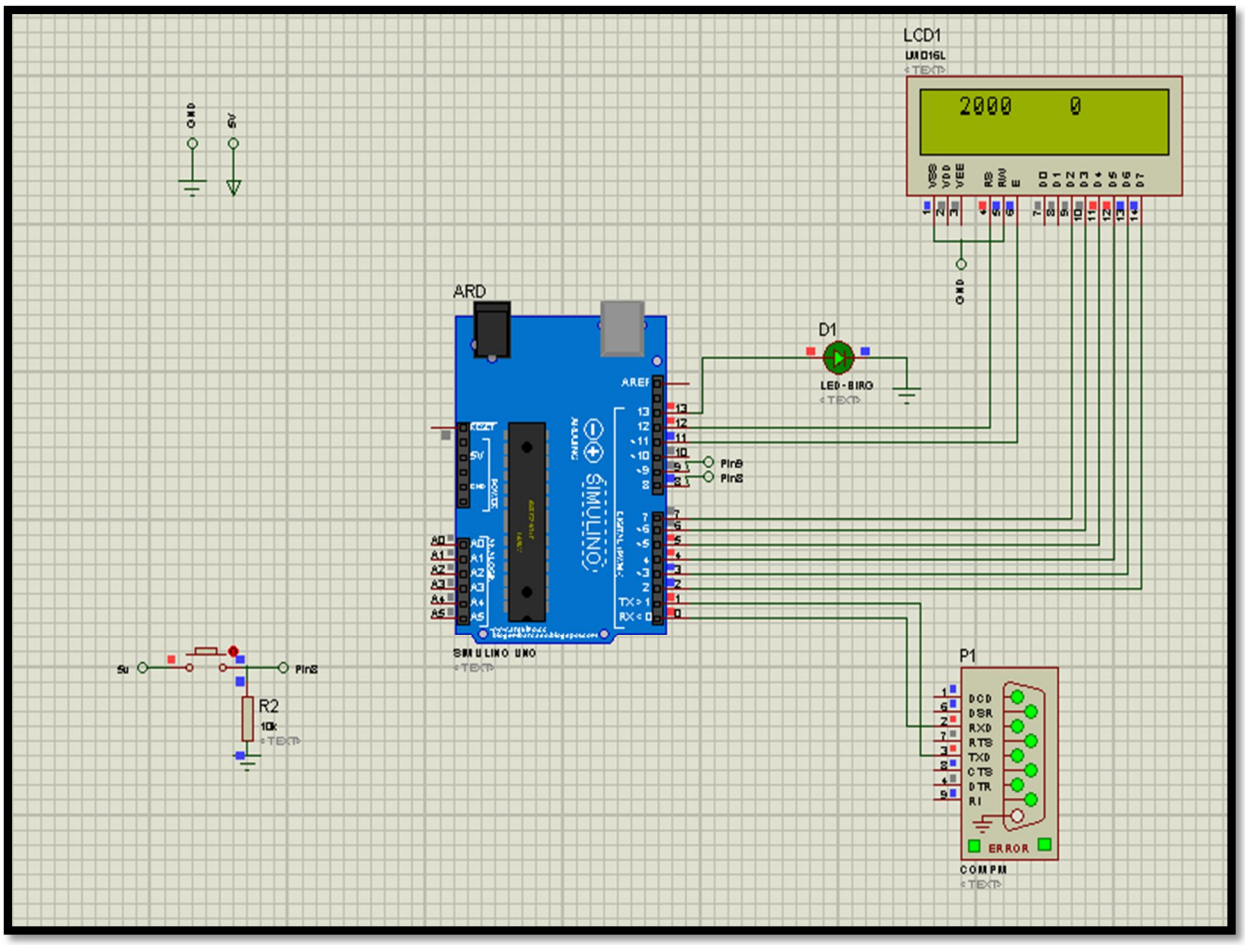

Figure 4.8: Water meter show the number of liters

Flow sensor start count the amount of water will use. Whenever one liter of water is used; the amount of water shown in LCD will decreases. When its end the LCD shows the number zero as shown in Figure 4.9; the user knows that the amount of water has ended and he must renew the purchase of water and water meter through GSM modem send a signal to control station to close the valve.

In database of company stored a customer name with his counter number. Every customer in this system his water bill shows his counter number and his name, here mention four examples for four customers bills (Mona & Ahmad & sara &Omar). When the customer Mona wants to buy water from her phone, Mona send SMS write her counter No.(124) and the amount SDG(30) in formula (124#30), then she will receive her water bill. The bill show the counter number

(124), customer name(Mona) , the a mount of water by liters (3000) and the amount SDG (30) deducted from the existing balance in Mona's phone. The bill shown in Figure 4.10

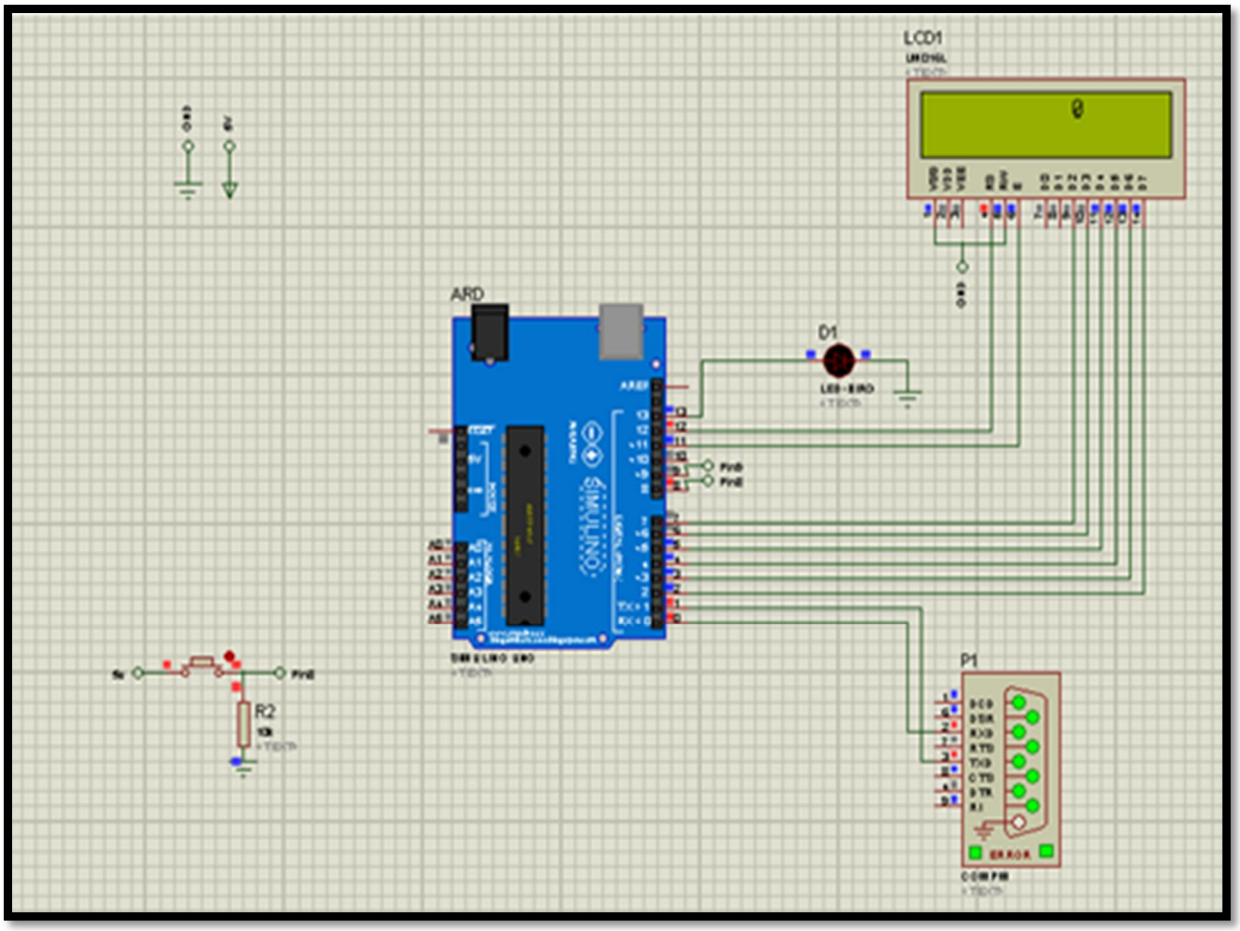

Figure 4.9: Water meter show zero liters

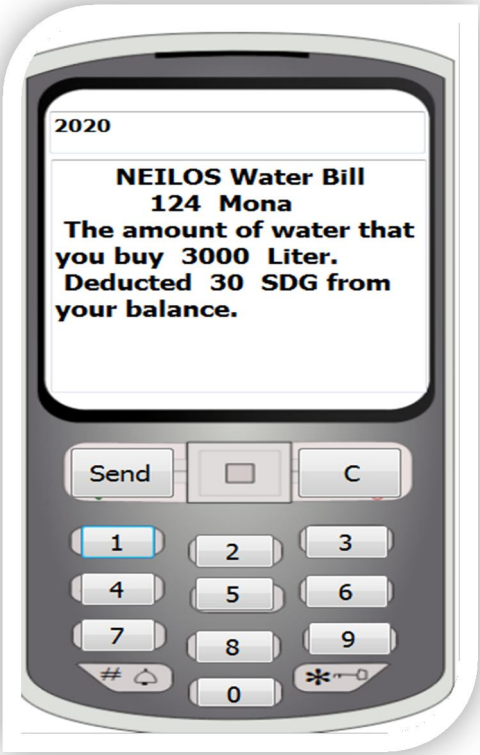

Figure 4.10: The water bill for the customer Mona

When the customer Ahmad wants to buy water from his phone from his phone, Ahmad send SMS write his counter No.(125) and the amount SDG(15) in formula (125#15), then he will receive his water bill. The bill show the counter number (125) ,customer name(Ahmad) , the a mount of water by liters (1500) and the amount SDG (15) deducted from the existing balance in ahmad's phone. The bill shown in Figure 4.11

When the customer Sara wants to buy water from her phone, Sara send SMS write her counter No.(126) and the amount SDG(35) in formula (125#35), then she will receive her water bill. the bill show the counter number (126) ,customer name(Sara) , the a mount of water by liters (3500) and the amount SDG (35) deducted from the existing balance in Sara's phone. The bill shown in Figure 4.12

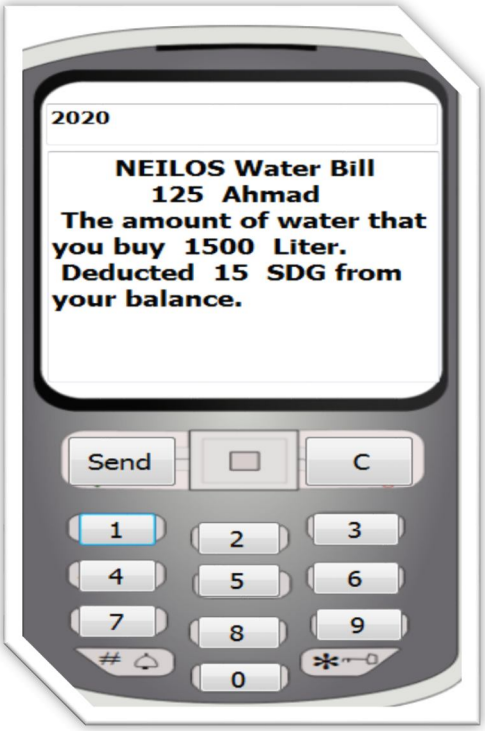

Figure 4.11: The water bill for the customer Ahmad

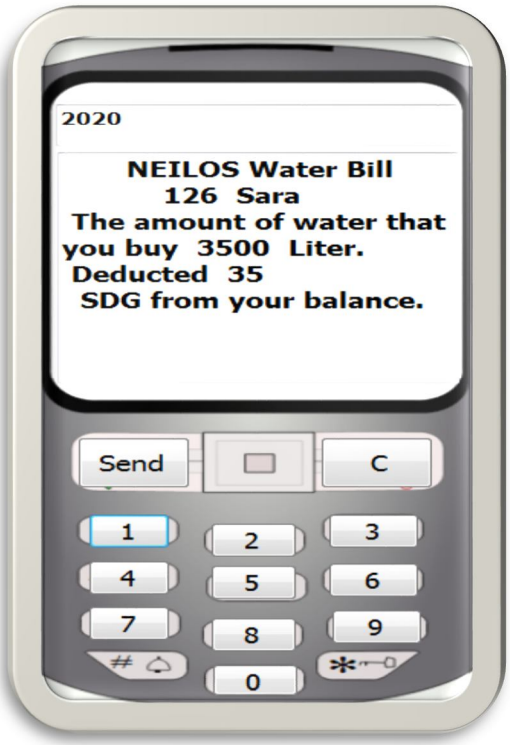

Figure 4.12: The water bill for the customer Sara

When the customer Omar wants to buy water from his phone from his phone, Omar send SMS write his counter No.(127) and the amount SDG(10) in formula (127#10), then he will receive his water bill. The bill show the counter number (127) ,customer name(Omer) , the a mount of water by liters (1000) and the amount SDG (10) deducted from the existing balance in Omer's phone. The bill shown in Figure 4.13

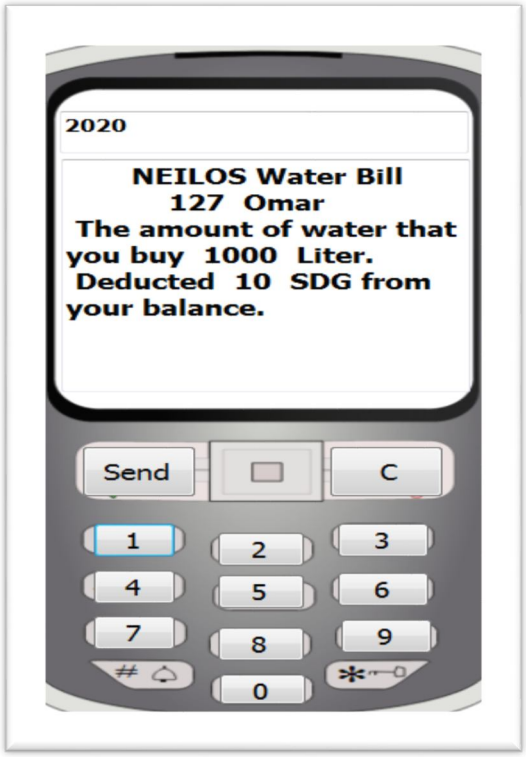

Figure 4.13: The water bill for the customer Omar

If the counter number is wrong and don’t stored in database the system asks the correct number. In the last example for customer Omar; his correct counter number 127, if he write another number 222 as shown in figure 4.14 and then send his order

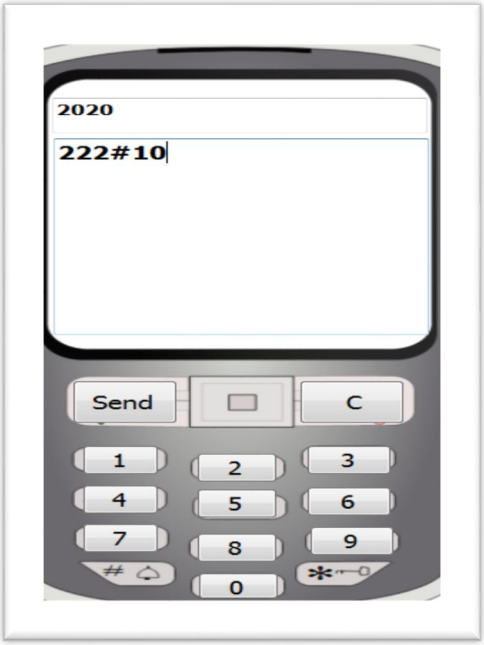

Figure 4.14: Entered wrong count number

Then the system asks the correct number as shown in Figure 4.15

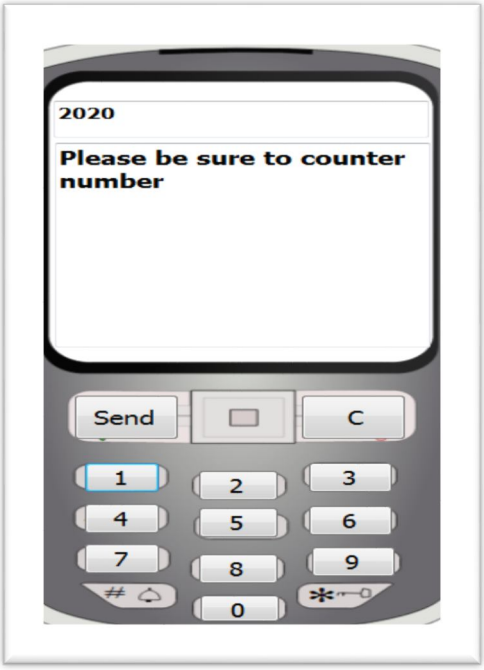

Figure 4.15: System ask correct count number

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Water day after day it becomes more scarce due to climate and rising temperature, and use it unwisely, billing system using Automatic water Meter reading help to preserved and rationalization consumption it. Automatic water Meter reading is one method reading and processing data automatically with computer and communication. The development of automatic water meter reading system utilized wireless technology using GSM module system for data transmission was proven. In the present work wireless meter reading system is designed to measure the amount of water used and to shut down the power supply remotely whenever the consumer did not renew the purchase of water. The deployment of the proposed system uses the existing GSM network, where the water meter system can send its readings directly to a server application using a GSM modem the process of monitoring water flow rate, transmitting the usage, calculating the bill etc. is through preprogrammed Arduino controller. Automatic water meter reading avoids the human intervention, provides efficient meter reading, avoid the billing error and reduce the maintenance cost. It displays the corresponding information on LCD for user notification.

5.2 Recommendations

This system developed with a capability to detect low level of the water, so that the customer does not come as a surprise interruption of water. Add system to monitoring drinking water; to be free of impurities and sediments. Also add scada system to connect between the water company and the water meter in customer premises.

REFERENCES

[1] Hesham H. Hallal, May Haidar, Taha Barake, Sami AlKhaldi, Mohammad AlOrayfij, Amal AlBalawi, Raneem Aljehani, " GSM-based Embedded Water Meter System" 2003.

[2] Yogendra P Joshi, M. B. Tadwalkar "Implementation of GSM Based Water Meter A Step towards Automation in Billing System", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), Volume 9, Issue 4, Jul - Aug. 2014.

[3] Ravinder Kaur, Pooja Verma, "GSM Based Automatic Meter Reading", Internationa Journal of Reserch in Electrical and Electronics Engineering (IJRREEE), Vol 2, Issue 2, pp. 91-94, April 2015.

[4] Hung-Cheng CHEN, "Design and Implementation of a ZigBee-Based Wireless Automatic Meter Reading System", PRZEGLĄD ELEKTROTECHNICZNY (Electrical Review), ISSN 0033-2097, R.88 NR1b/2012.

[5] Rainer N. Dita, Paolo Pedro C. Martinez, Chrish Adrian S Miranda," Remote Automatic Water Meter Reading System using Global System for Mobile Communications", March 2013.

[6] Gordan Struklec, Vedran Bilas "Wireless Automatic Water-meter Reading system", XVIII IMEKO World Congress- International Measurement Confederation, pp. 1-6. Barazil, 2006.

[7] Ravi Hosamani, Ravi Bagade, "Arduino based Water Billing System for Domestic Purpose", International Journal (IJMTER), volume 02, Issue 06, July, 2015.

[8] Pavankumar, Kumbhar A.B, Pol Prasad H, Shevale Prashant B, Pawar Akshay V, "Automatic Town Water Management System" International Journal of Research in Advent Technology, Vol.2, No.4, April 2014.

[9] Manisha V Shinde, Pradip W Kulkami, "New Development in Energy Meter Reading System" International Journal of Scientific Research and Management Studies (IJSRMS), Volume 1, Issue 4, pp 124-129, 2013.

[10] Raja Jitendra Nayaka and Rajashekekhar C. Biradar, "A Survey on Wireless Network Applications in Automated Public Utilities Control and Management" Journal of Telecommunications and Information Technology, March 2015.

[11] Andrea Goldsmith "Wireless Communications", Cambridge University Press, August 2005.

[12] John McNabb, "Vulnerabilities of Wireless Water Meter Networks" Journal of the New England Water Work Association, August 2011.

[13] Zhu Hengjun and Zhu Yi Sheng, "Wireless Remote Water Meter Design of Automatic Meter Reading System", International Journal of Smart Home, vol. 9, pp. 289-298, December (2015),

[14] Young-Woo lee, Seongbae Eum, Seung-Hyueb Oh, " Wireless Digital Water Meter with Low Power Consumption for Automatic Meter Reading", International Conference on Conference and Hybrid Information Technology IEEE, pp. 639-645, 2008.

[15] Li Quan-Xi1, Li Gang2," Design of Remote Automatic Meter Meading System based on ZigBee and GPRS", Proceedings of the Third International Symposium on Computer Science and Computational Technology (ISCSCT ’10), Jiaozuo, P. R. China, pp. 186-189 , August 2010.

[16] Amruta Kotasthane and Hate S G," Implementation of Automatic Meter Reading System Using Wireless Sensor Network", International Journal of Advance Research in Computer Engineering and Technology (IJARCET), Volume 2, Issue 12, December 2013.

[17] Sidappa Naidu and S.Arun" Design and Implementation of Automatic Meter Reading System Using GSM, ZIGBEE through GPRS", International

Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 5, May 2012.

[18] Shoeb Sheikh, "Designs and Implementation of Wireless Automatic Meter Reading System based on GSM", International Journal of Engineering Science and Technology, Jan 2011.

[19] Adnan Rashdi, Rafia Malik, Sanam Rashid, Anam Ajmal, and Sulaiman Sadiq, "Remote Energy Monitoring Profiling and Control through GSM network" Arabian Journal for science and Engineering, ,Volume 38, Issue 11, November 2013.

[20] H.G Rodney Tan, " Automatic Power Meter Reading System Using GSM Network" International Power Engineering Conference (IPEC2007), pp.465-469, 2007.

[21] Ria Sood, Manjit Kaur, Hemant Lenka"Design and Development of Automatic Water Flow Meter". International Journal of Computer Science, Engineering and applications (IJCSEA), Vol.3, No.3, June 2013.

[22] Vasumsetty Uday Aditya, "GSM Based Wireless Control of Electrical Appliances", Odisha, India May 2014.

[23] Abnave Pranita G., Dandage Rajeshwari G. ,Gawade anil N. , minal" GSM based water billing system" International Journal of Informative and Futuristic Research, Vol. 2, Issue 7, March 2015.

[24] Michael Margolis, "Arduino Cookbook", March 2011.

[25] John Boxall," Arduino Workshop", May 2013.

[26] Lawrence J. Marchetti ,"Valves", 2012.

[27] Ethan Biery, Thomas Shearer, Roland Ledyard, Dan Perkins and Manny Feris, " Controlling LEDs", Technical White Paper, May 2014.

APPENDIX A

Technical Specifications for the VATS JT-121 Flow Sensor

Flow rate range 0.5 to 5 m/sec

Accuracy -1, +1 of full scale

Input voltage 5-12 VDC

Output signal square wave of 5 to 12 volt amplitude, 15-17.5 Hz/m/sec

Cable Length 3 meters

APPENDIX B

The code for Water Meter

```
#include <SoftwareSerial.h>
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
int cont =0; // conter
int n=0;
int ledPin = 13; // the number of the LED pin
const int pin8 = 8;
const int pin9 = 9;
void setup() {
  pinMode(ledPin, OUTPUT); // set LED as output
  digitalWrite(ledPin, LOW); //turn off LED
  pinMode(pin8, INPUT);
  pinMode(pin9, INPUT);
  Serial.begin(9600);
  lcd.begin(2,1);
}

void loop() {
  String content = "";
char character;
 if(cont >0){
  if (digitalRead(pin8) == HIGH) {
    digitalWrite(ledPin, HIGH); // LED ON
    delay(450);
```

```
lcd.setCursor(2,1);
lcd.print(cont);
 cont--;
}
if (digitalRead(pin8) == LOW) {
lcd.setCursor(2,1);
lcd.print(cont);
}
}
if(cont==0){
lcd.setCursor(10,2);
lcd.print(cont);
//cont=-1;
digitalWrite(ledPin, LOW); //LED OFF
}
 while(Serial.available())
{ character = Serial.read();
content.concat(character);
delay (10); }
if (content != "") { Serial.println(content);
cont =cont + content.toInt();

}
Serial.flush(); // clear serial port
}
```

APPENDIX C

Hardware Specifications for arduino uno

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended):7-12V
- Input Voltage (limits):5-20V
- 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 (ATmega328)
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

APPENDIX D

The code for mobile design

```
Imports System.IO.Ports
Imports System.IO
Public Class Form1
    Dim smsRecive As String

    Private Sub Form1_Load(ByVal sender As Object, ByVal e As EventArgs)
Handles MyBase.Load, Button11.TabIndexChanged, Button11.TextChanged
        Button13.Hide()
    End Sub

    Private Sub Button11_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button11.Click
        Dim sms() As String
        Dim A As String
        Dim counter As String
        Dim SD As String
        Dim liter As String
        Dim Name As String
        If TextBox1.Text = "2020" Then
            A = TextBox2.Text
            sms = A.Split("#")
            counter = sms(0)
            SD = sms(1)
            liter = SD * 100
```

```
        Select Case counter
            Case "123"


                Name = "Ali"
                If SerialPort2.IsOpen Then
                    SerialPort2.Close()
                End If
                SerialPort2.Open()
                SerialPort2.Write(liter + 1)
                SerialPort2.Close()
            Case "124"
                Name = "Mona"
            Case "125"
                Name = "Ahmad"
            Case "126"
                Name = "Sara"
            Case "127"
                Name = "Omar"
            Case Else
                smsRecive = "Please be sure to counter number"
        End Select
        smsRecive = "       NEILOS Water Bill" + vbNewLine + "          " +
counter + "  " + Name + vbNewLine + " The amount of water that you buy  " +
liter + "  Liter." + vbNewLine + " Deducted  " + SD + "  SDG from your
balance."
        Button13.Show()
        A = ""
        counter = ""
```

```
            SD = ""
            liter = ""
            Name = ""

        End If
    End Sub

    Private Sub Button1_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button1.Click, Button11.Resize

        TextBox1.Text = TextBox1.Text + "1"
    End Sub

    Private Sub Button2_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button2.Click
        TextBox1.Text = TextBox1.Text + "2"
    End Sub

    Private Sub Button3_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button3.Click
        TextBox1.Text = TextBox1.Text + "3"
    End Sub

    Private Sub Button4_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button4.Click
        TextBox1.Text = TextBox1.Text + "4"
    End Sub
```

```
    Private Sub Button5_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button5.Click
        TextBox1.Text = TextBox1.Text + "5"
    End Sub

    Private Sub Button6_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button6.Click
        TextBox1.Text = TextBox1.Text + "6"
    End Sub

    Private Sub Button7_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button7.Click
        TextBox1.Text = TextBox1.Text + "7"
    End Sub

    Private Sub Button8_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button8.Click
        TextBox1.Text = TextBox1.Text + "8"
    End Sub

    Private Sub Button9_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button9.Click
        TextBox1.Text = TextBox1.Text + "9"
    End Sub

    Private Sub Button10_Click(ByVal sender As Object, ByVal e As EventArgs)
Handles Button10.Click
        TextBox1.Text = TextBox1.Text + "0"
```

```
    End Sub
    Private Sub Button12_Click(ByVal sender As Object, ByVal e As EventArgs)
        TextBox1.Text = ""
    End Sub

    Private Sub Button13_Click(ByVal sender As Object, ByVal e As EventArgs)

    End Sub

    Private Sub Button12_Click_1(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button12.Click
        Me.Close()
    End Sub

    Private Sub TextBox1_TextChanged(ByVal sender As System.Object, ByVal
e As System.EventArgs) Handles TextBox1.Click
        TextBox1.Text = ""
    End Sub

    Private Sub Button1_StyleChanged(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button1.StyleChanged,
Button1.ClientSizeChanged

    End Sub


    Private Sub Button13_Click_1(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button13.Click
```

```
        Button13.Hide()
        TextBox2.Text = smsRecive
        smsRecive = ""
    End Sub

    Private Sub TextBox2_TextChanged_1(ByVal sender As System.Object,
ByVal e As System.EventArgs) Handles TextBox2.TextChanged

    End Sub
End Class
```