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كلية تكنولوجيا المعلومات وهندسه الحاسوب

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Mobile Based Water Level Management and Controlling System

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This project was submitted in partial fulfillment computer engineering and communication engineering.

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Graduation Project Report

Mobile Based Water Level Management and Control System

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Dedication

(الإهداء)

بدأنا المشوار معاً وقاسينا أكثر من هم وها نحن اليوم بحمد الله نطوي جزءاً من سهر الليالي بين دفتي هذا العمل المتواضع .

إلى منارة العلم والإمام المصطفى سيد الخلق إلى رسولنا الكريم صلى الله عليه وسلم.

إلى من كنا لهم الأمل فسعوا وبذلوا الغالي والرخيص ولم يبخلوا علينا بالعطاء فعلمونا كيف الارتقاء على سلم النجاح إلى أهالينا الأعزاء.

إلى من حبهم يجري في عروقنا ويلج بذكراهم الفؤاد إلى إخواننا وأخواتنا الأحباء.

إلى من ساروا معنا وشققنا بعزيمتهم طريق النجاح والإبداع إلى كل الأصدقاء والزملاء
إلى من علمونا الحروف من ذهب والكلمات الدرر إلى من جادوا في عطاء أفكارهم إلى مشرفنا العزيز وأساتذتنا الكرام.

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And finally our great parents for supporting us in every way.

Doha Nasser Fatafta Mohamad Jamal Hamed Maram Atiya Dababseh

Abstract

One of the challenges facing the residents of homes, is to know to control the water level in the reservoirs at any time and without effort , what followed from filling the reservoir in automatic manner, as well as to avoid increasing or decreasing the water from the desired limits.

For large buildings or homes, we have many water sources as wells and water company lines, so we have many choices to fill the small tanks. Also we can manage the incoming water from the water company line to be reserved in the wells or to fill the small tanks directly.

Through this project, we will seek to solve the problem for managing and controlling water levels by finding an easy way that enables the user to find out, fill, and control the water levels. And so to save the water , time and effort.This controlling system can also be accessed using user mobiles and can be used in buildings with multiple floors, houses (big, small), and in all the institutions that use the water reservoirs.

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The work will be done through using sensors, which senses about the water level in the reservoirs as well as in the wells, then sending this information to the managing and controlling system which uses microcontroller and mobiles through the GSM network to take the proper action, such as: checking, filling, stop filling, etc.

الملخص:

سيتم تطبيق المشروع في البنايات متعددة الطوابق والمؤسسات بكافة أنواعها والمنازل الكبيرة منها والصغيرة حيث أن هذا المشروع يستهدف كل الأبنية التي تستخدم خزانات الماء (والتي لا يخلو منهابناء) وكذلك الآبار.

تعد مشكلة ارتفاع أو نقصان الماء في الخزانات و الآبار من المشاكل المتواجدة بكثرة والتي بدورها تشكل عبئا على الناس وكذلك إن ازدياد الماء في الخزانات و الآبار وفيضانه مشكلة في هدر المياه ومن هنا كان التفكير في حل هذه المشكلة وتوفير المياه.

الطريقة المستخدمة في هذا المشروع عبارة عن استخدام مجسات توضع في الخزانات أو الآبار لمراقبة مستوى المياهوتطبيق ذلك على الهاتف المحمول لمتابعة وضع المياه في الخزانات والآبار.

من خلال المشروع سيتم حل مشاكل نقصان منسوب المياه بالخزانات والآبار وتعبئتها مما يشكل عبئاً علىمستخدمي الخزانات والآبار ومراقبة الخزانات و الآبار خاصتهم بشكل مستمر لكي لا ينقص مستوى المياه، كذلك زيادة مستوى الماء عن الحد المطلوب بالخزان وذلك من خلال مجسّات للمراقبة مما يؤدي الى توفير المياه.كما أن تطبيق هذه الفكرة سيؤدي إلى توفير الجهد والوقت وتوفير الكهرباء ذلك كله من خلال المتابعة من خلال الهاتف المحمول.

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Table of Contents:

CHAPTER SIX : Testing

CHAPTER SEVEN : Implementation and Results

Table of Tables:

Table of Figures:

Table Of Abbreviations:

GSM	Global System of Mobile Communication
Modem	Modulation and Demodulation
µC	Microcontroller
MCU	Microcontroller Unit
WIFI	Wait For Interrupt
NOR	Logic Gate
OTP	One-Time Programmable
ROM	Read Only Memory
TDMA	Time Division Multiple Access
CDMA	Code Division Multiple Access
SIM	Subscriber Identity Module
BTS	Base Transceiver Stations
UI	User Interface
PHP	Hypertext Preprocessor
IDE	Integrated Development Environment
OS	Operating System
GUI	Graphical User Interface
OHT	Overhead Tank
LCD	Liquid Crystal Display
Pc	Personal Computer
PIC	Peripheral Interface Controller
ADK	Android Development Kit
USB	Universal Serial Bus
PWM	POST Memory Manager
UART	Universal Asynchronous Receiver/ Transmitter
ICSP	In Circuit Serial Programming
SRAM	Static Random Access Memory
EEPROM	Electronically Erasable Programmable Read-Only Memory

AT	Attention
AC	Alternating Current
DC	Direct Current
CRC	Class Responsibility Collaborator
SRS	Software Requirement Specification
I/O	Input/ Output
ID	Identification
SMS	Short Message Service
SCR	Silicon-controlled rectifiers
TRIAC	Triode for Alternating Current
SSR	Solid State Relay
EMR	Electromagnetic Relay
GND	Ground
SIG	Signal
Kbps	Kilo Bits Per Second
TX	Transmitter
RX	Receiver
PWRKEY	Power Key

1

CHAPTER ONE

Introduction

1.1. Overview.

1.2. Project Idea Description.

1.3. Motivation.

1.4. Project Scope.

1.5. Chapter Summary.

Chapter One : Introduction.

1.1 Overview:

In this chapter, we will talk about our project idea in details, motivations behind this project will also be discussed. Then we will show the project importance at the community level and on personal level. A description of the project scope, including content, inputs, outputs, implementation locations as well as main functions will be demonstrated.

1.2 Project Idea Description:

One of the main challenges facing homes residents is to know, manage and control the water levels/limits in the reservoirs at any time and with minimum effort. Another challenge can be automatic reservoir filling as well as water sources management.

For large buildings or homes, we have many water inlets from different sources and wells. So we want to manage these incoming water inlets from these different sources to be reserved in the wells or to fill the small roof tanks directly.

Through this project, we will seek to solve the problem of managing and controlling water levels by finding an easy way that enables the user to find out, fill, and control the water levels so as to save water, time and effort.

This controlling system can also be managed and accessed using user mobiles.

The work will be done through using sensors, which senses the water levels in the reservoirs and wells, then sending this information to the managing and controlling system which uses microcontroller and mobiles through the WIFI/GSM network to take the proper action (just checking, filling, stop filling,…).

This project can be used in buildings with multiple floors, houses (big, small), and in all the Institutions that use the water inlet sources and reservoirs.

Our General goals is to analyze and implement a fully automatic water level management and controlling system for large buildings with multiple homes, floors, reservoirs and wells. The design system will integrated with a mobile applications/interface.

1.3 Motivations:

Water shortage is one of the most challenging problems in our society. Filling tanks and wells without managing and controlling water levels in these reservoirs may result in loosing excess amounts of water; this would increase the water shortage problem. So find several ways to keep the water levels under controls and without wasting can be one of the most important social and municipal tasks.

Accordingly, in this project, we will analyze design and implement a mobile based management and control system that will satisfy the requirements of a large buildings water sources and levels system.

Through this project we will study the different components that are used in water sources and levels management and control system. Then we will implement and test the

designed system on a sample building. This system will be integrated with mobile application using WIFI/GSM networks.

This project can add a lot to our skills, such as microcontroller and mobile programming as well as water resources and environmental related issues.

1.4 Project Scope:

This project can be used in buildings with multiple floors, houses (big, small), and in all the Institutions that use the water reservoirs, and have multi water source.

Functions:

1. Collecting Data:
    - 1.1- Meeting with instructor and studying the problem.
    - 1.2- Study previous projects.
    - 1.3- Search for information about the problem and the solution.

2. Publishing The Idea Of The Project To All Buildings And Homes (Big/Small):
    - 2.1- We targeted buildings that have many floors and small buildings and homes.
    - 2.2-We want to apply the project to buildings of have three floors as a model for the system.

3- Sensing Water Level:

- 3.1-Put sensors in tanks and wells to supply us the level of water
- 3.2 Sense the pressure of water from company water line.

4-Oprating Pumps and Motors:

4.1-After sensing the water level in tank, take the decision to operate pumps and motors to fill the tanks from any water source.

4.2- After sensing the pressure of water from company water line if poor flow of water then takes decision to operate pumps and motors.

5-Using Multiple Controlling Components (WIFI/GSM, mobile, microcontroller, and computer):

5.1-The microcontroller takes state of water from sensors and send it to computer and WIFI/GSM, then WIFI/GSM send it to mobile application

5.2-Mobile application and computer software shows the states of water.

6- Take Decisions:

6.1-When users see the states of water, and then can take different decisions.

1.5 Chapter Summary.

We described our project idea, the benefits stand behind it, our motivations to have this project, and the main functions for it.

2

CHAPTER TWO

Literature Review and Theoretical Background

2.1 Overview

2.2 Theoretical Back Ground

2.3 Literature Review

2.4 Chapter Summary.

2.5 Chapter Reference.

Chapter Two: Literature Review and Theoretical Background

2.1Overview:

At this chapter we will talk about the theoretical back ground for our project, the different technologies will be used, also we will talk about the literature review, or the previous projects and the works had been done, what goals had they achieved, and how can they be beneficial for our work as will as their improvement, also the main differences between our work and the previous efforts.

2.2 Theoretical Back Ground:

2.2.1 Hardware Components .

In this section we will talk about hardware components that will be used in implements our system.

1- **Microcontrollers:**

Overview:

A microcontroller (sometimes abbreviated µC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable

input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. [1]

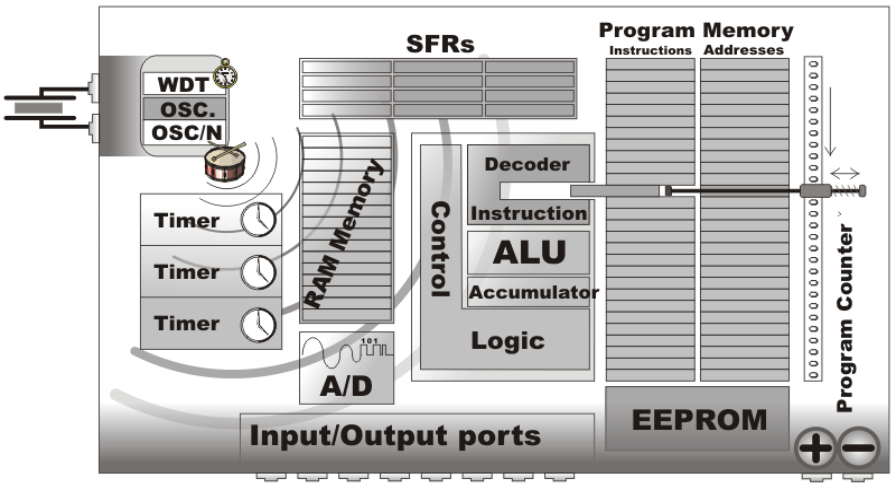


Figure (2.1): Microcontroller's Components [2]

2- Sensors:

Ultrasonic Sensor:

Whether your application is position detection, distance measurement, or the detection of solid, or liquid media: ultrasonic sensors are precise all-rounder. Regardless of the color, transparency, and surface texture, they always perform really well.

Their detection range is between 25 mm and 6 m, so larger object gaps are no problem. Their high resolution and small blind zones ensure top precision. Ultrasonic sensors are distinguished by their output signal. Thanks to a switching and an analogue design, benefits:

1. Contact-free detection
2. Irrespective of the color, transparency, reflection properties, and surface texture of the object
3. Accurate detection even of small objects
4- Extra reliability and lower costs.[4]

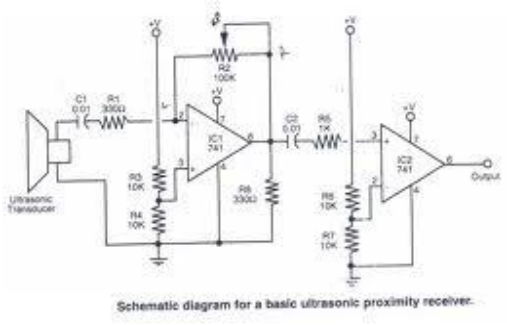


Figure (2.2): Ultrasonic Sensor

Figure (2.3): Schematic Diagram For Ultrasonic[18]

3- GSM:

GSM (Global System for Mobile communication) is a digital mobile telephony system that is widely used in many parts of the world. GSM uses narrowband TDMA, which allows eight simultaneous calls on the same radio frequency [2]. 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.

Since many GSM network operators have roaming agreements with foreign operators, users can often continue to use their mobile phones when they travel to other countries. SIM cards (Subscriber Identity Module) holding home network access configurations may be switched to those will metered local access, significantly reducing roaming costs while experiencing no reductions in service. [5]

Figure (2.4): GSM Modem .

How Does GSM Work?

GSM is the network these cell phones use. This means each of these phones search for a cell in the area in which they're being used. This means there must be a GSM network to handle all GSM-based phone calls. [6]

4- Pump:

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.

Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis. [7]

Figure (2.5): Pump [19]

5- Valves:

A butterfly valve is a valve which can be used for isolating or regulating flow. The closing mechanism takes the form of a disk. Operation is similar to that of a ball valve, which allows for quick shut off. Butterfly valves are generally favored because they are lower in cost to other valve designs as well as being lighter in weight, meaning less support is required. The disc is positioned in the center of the pipe, passing through the disc is a rod connected to an actuator on the outside of the valve. Rotating the actuator turns the disc either parallel or perpendicular to the flow. Unlike a ball valve, the disc is always present within the flow; therefore a pressure drop is always induced in the flow, regardless of valve position. [2]

2.2.2 Software Components:

Overview:

Now a day's computers are able to perform different tasks in different fields, but it can't do that by itself! It needs detailed procedures for each task. That what we call a computer program. There is a lot of programming languages that is used to build out a computer program, choosing any language depends on the tasks of the program.

1- Android:

Android is a Linux-based operating system designed primarily for touch screen mobile devices such as Smartphone's and tablet computers.

Android gives you a world-class platform for creating apps and games for Android users everywhere, as well as an open marketplace for distributing to them instantly.

Powerful development framework

Android gives you everything you need to build best-in-class app experiences. It gives you a single application model that lets you deploy your apps broadly to hundreds of millions of users across a wide range of devices—from phones to tablets and beyond.

Android also gives you tools for creating apps that look great and take advantage of the hardware capabilities available on each device. It automatically adapts your UI to look its best on each device, while giving you as much control as you want over your UI on different device types. [8]

2 - C# language:

(Pronounced 'see sharp'), is one of the C family programming languages (C, Objective C, C++, etc.) and therefore share a similar syntax [10]. It inherits many of the best features of C++ and Microsoft Visual Basic, but few of inconsistencies, and anachronisms, resulting in a cleaner and more logical language. Its build process is simple compared to C++ and more flexible than in Java. There are no separate header files, and no requirement that methods and types be declared in a particular order.

You can use C# to create traditional windows client applications, XML Web services, distributed components, client-server applications, database applications, and much more . It allows you to overload operators, as well as to create structure and build a variety of robust applications that run on the .NET framework.

Visual C# is an implementation of the C# language by Microsoft. Visual studio supports visual C# with a full-featured code editor, compiler, project templates, designers, and other tools.

The use of the C# and visual studio has several features:

1) Build an application, fast.

2) Design a great looking user interface.

3) Create and interact with database. It integrates seamlessly with SQL Server Compact Edition, and many other popular database systems. [2]

3- Arduino :

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, MaxMSP.) .

2.3 Litrutre Review:

At this part, we will talk about the related works, the previous projects or the scientific papers which relates to our project.

1- WATER-LEVEL CONTROLLERCUM-MOTOR PROTECTOR:

Overview

Many a time we forget to switch off the motor pushing water into the overhead tank (OHT) in our households. As a result, water keeps overflowing until we notice the overflow and switch the pump off. As the OHT is usually kept on the top most floor, it is cumbersome to go up frequently to check the water level in the OHT. Here's a microcontroller-based water- level controller-cum-motor protector to solve this problem. It controls 'on' and 'off' conditions of the motor depending upon the level of water in the tank. The status is displayed on an LCD module.

Operation:

When water in the tank is below sensor A(the sensor at the bottom), the motor will switch on to fill water in the tank. The LCD module will show 'motor on.' The controller is programmed for a 10- minute time interval to check the dry-run condition of the motor. If water reaches sensor B(above sensor A by 2cm) within 10 minutes, the microcontroller comes out of the dry-run condition and allows the motor to keep pushing water in the tank.

The motor will remain ‘on’ until water reaches sensor C (the sensor at the top). Then it will stop automatically and the microcontroller will go into the standby mode. The LCD module will show ‘tank full’ followed by ‘standby mode’ after a few seconds. The ‘standby mode’ message is displayed until water in the tank goes below sensor A.

In case water does not reach sensor B within 10 minutes, the microcontroller will go into the dry-running mode and stop the motor for 5 minutes, allowing it to cool down. The LCD module will show ‘drysump1 after five minutes, the microcontroller will again switch on the motor for 10 minutes and check the status at sensor B. If water is still below sensor B, it will go into the dry-running mode and the LCD module will show ‘dry-sump2.’

As we can see from the previous explanation, the project is automatically working, it depends on the lower level (the tank is empty) and the upper level (the tank is full) to switch the motor. Also it saves the motor if there is no water through the ‘standby mode’, also the display of the tank situation will be on LCD module.

But this project differs from our project that it doesn’t give any indication about the water level on the tank at any time, also the management and controlling on our project is done through mobile application on the GSM network, in which we can chick the water level for any reservoir as well as any water source, and the mobile will receive messages to indicate wither the reservoir or the well is empty or full.

Another feature will be added, when the tank is full and the user doesn’t attend to the mobile or the pc to deactivate the motor, the system will wait for a few minutes and then stop automatically.Also the application can be integrated to pc.

2- WATER LEVEL CONTROLLER:

Overview

Water level controller is equipment used to control the water level in a field. The level of the water is controlled by using a microcontroller. Main components are PIC micro controller, sensor, motor etc... The sensors sense the presence of water and give indication to the microcontroller. The microcontroller produces the control signals to drive the motor.

If there is no water then microcontroller gives control signal to start the motor and if there is sufficient water in the field then the microcontroller give control signal to stop the motor. And also the microcontroller enables the display and displayed as "THE MOTOR IS ON" when the motor starts and disable the display when the motor is off. Hence the level of water in a field can be automatically controlled. The main components used in this equipment are PIC microcontroller, sensor and motor. [13]

BLOCK DIAGRAM:

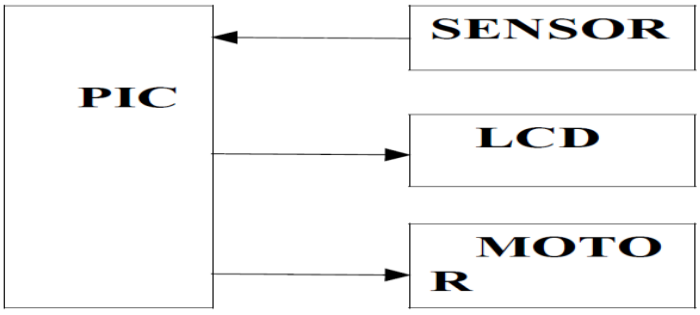


Figure (2.6): BLOCK DIAGRAM [13]

As we can see from the previous explanation, the project is automatically working, it depends on the lower level (the tank is empty) and the upper level (the tank is full) to switch the motor, also the display of the tank situation will be on LCD display.

But this project differs from our project that it doesn't give any indication about the water level on the tank at any time, also the management and controlling on our project is done through mobile application on the GSM network, in which we can chick the water level for any reservoir as well as any water source, and the mobile will receive messages to indicate wither the reservoir or the well is empty or full.
Another feature will be added, when the tank is full and the user doesn't attend to the mobile or the pc to deactivate the motor, the system will wait for a few minutes and then stop automatically.
Also our project provides the management and controlling for multiple water sources to multiple buildings.

3- Microcontroller Based Automated Water Level Sensing and Controlling: Design and Implementation Issue:

Overview:

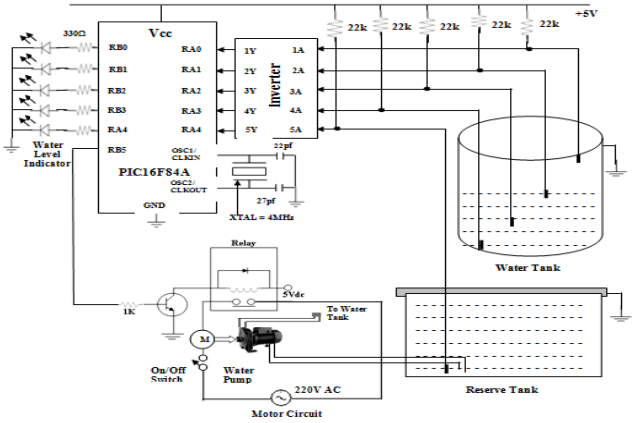
This paper introduces the notion of water level monitoring and management within the context of electrical conductivity of the water. More specifically, we investigate the microcontroller based water level sensing and controlling in a wired and wireless environment.

Water Level management approach would help in reducing the home power consumption and as well as water overflow. Furthermore, it can indicate the amount of

water in the tank that can support Global Water types including cellular dataloggers, satellite data transmission systems for remote water monitoring system.

Moreover, cellular phones with relative high computation power and high quality graphical user interface became available recently. From the users perspective it is required to reuse such valuable resource in a mobile application. Finally, it proposed a web and cellular based monitoring service protocol would determine and senses water level globally.

At the first stage of design a water level sensor is been made for sensing water level accurately. Microcontroller is used to control the overall system automatically that reduces the design and control complexity. Microcontroller takes input from the sensor unit which senses the water level through inverter. After processing input variables, resultant output decides the water pump's action (on/off) with respect to current water status of the tank. The whole design flow chart is shown in Fig 2.12



Fig(2.7): Microcontroller Based Automated Water Level Sensing and Controlling FlowChart .[9]

Proposed Water Level Monitoring Network:

This proposed system guarantees to accumulate a good amount of usable water every day. This monitoring and controlling system uses daily life device like laptop or mobile phone. Due to the fact of controlling remotely we introduced a useful wireless automated controlling system. This proposed web based monitoring and controlling network can work with the existing water controlling system successfully. This whole proposed wireless network described in the following manner. [10]

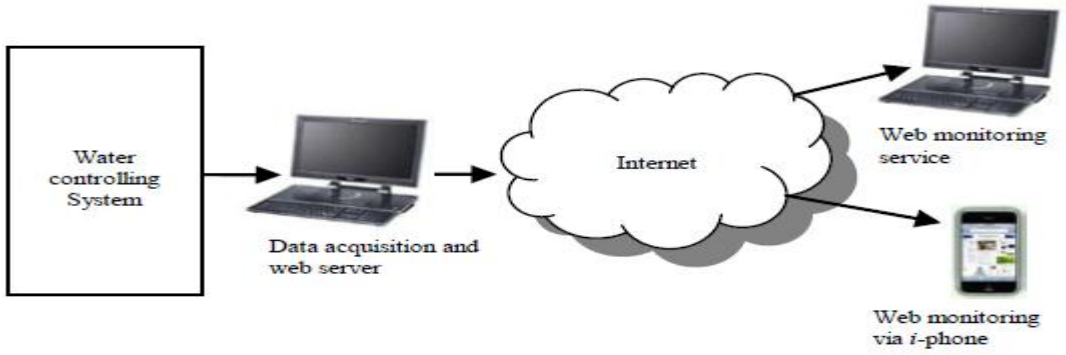


Figure (2.8): Proposed Wireless Network Diagram [10]

As we can see from the previous explanation, the paper is divided into two parts , the first one is automatically working, it depends on the water levels on the tank, only four levels can be achieved, the lower and the upper levels are the dominant for switching the motor. And so the operation will be initiated depending on the arrival values to the microcontroller to determine the arrival voltage value to the motor finally.

For the second part, which talks about implementing the monitoring and controlling network which can work with the existing water controlling system successfully by using the internet, and interfacing through daily life device like laptop or mobile phone.

But this project differs from our project that it doesn't give any indication about the water level on the tank at any time, also the management and controlling on our project is done through mobile application on the GSM network, in which we can chick the water level for any reservoir as well as any water source, and the mobile will receive messages to indicate wither the reservoir or the well is empty or full.

Another feature will be added, when the tank is full and the user doesn't attend to the mobile or the pc to deactivate the motor, the system will wait for a few minutes and then stop automatically. Also the application can be integrated to pc.

And without the need of the internet,also our project provides the management and controlling for multiple water sources to multiple buildings.

4- GPRS Based Water Tele-Control System:

Overview

In this project, they intend to build a system that can control and manage the water network using GPRS wireless technology and it can do the following tasks:

1. Control the water distribution operation over the city by measuring the amount of water in the tanks and distribute the suitable amount of water to each zone by controlling the water valves.
2. Calculating the distance and the height that the water can reach away from the nearest main pipeline valve.
3. Informing the central office by amount of water that each consumer consumes monthly.

4. Allowing the user to get different kinds of information from the network like the status of every valve in the network, the instantaneous reading of any counter in the network, the amount of water in each tank, and the water pressure at any main pipeline in the network.
5. Also offers the user several alarm types. When the pressure of water in any main pipeline exceeds a specific threshold or decreases than a specific threshold. When the amount of water in the tank decreases than a threshold or exceeds a threshold. When a consumer attempts to change anything in his water counter. When there is a leakage of water in any area of the network, when there is a theft of water in any subscription line.

The project's software is written using C++ programming language. The software will be able to communicate to the GPRS modem through the network card, and will have a database for the nodes of the network. The software allows the user to order different types of data depending on the tasks of each node in the network.

The main advantages that the nodes can accomplish are:
1. Measuring the height of the water in the tank, by using a pressure sensor at the bottom of the tank to calculate the height of the water and amount of it.

2. The amount of water that each customer consumes:
By using a flow sensor and counting the time of consumption, we can calculate the amount of water consumed since the diameter of the pipeline is known.

3. Theft and water leakage alarm depends on comparing the amount of the water that supplied to a specific area and the amount of water the consumers consume. The theft

alarm depends on the consumption rate of the consumer in case of water leakage in the area.

The microcontroller acts as the interface between the sensors and the modem. It translates the received orders from the GPRS modem and forward it to the suitable sensor, also it feeds back the data from the node's sensors to the modem in order to send it to the central office. [2]

But this project differs from our project that it doesn't give any indication about the water level on the tank at any time, also the management and controlling on our project is done through mobile application on the GSM network, in which we can chick the water level for any reservoir as well as any water source, and the mobile will receive messages to indicate wither the reservoir or the well is empty or full.

Another feature will be added, when the tank is full and the user doesn't attend to the mobile or the pc to deactivate the motor, the system will wait for a few minutes and then stop automatically.Also the application can be integrated to pc.

Also our project provides the management and controlling for multiple water sources to multiple buildings simultaneously.

2.4 Chapter Summary:

We talked about theoretical back ground for our project, such as WIFI/GSM technology, PIC microcontroller, Sensors and any other part may need. Also, we talked about the previous projects or any related subject to our system, what they have done and what are the differences between us, and the additional goals we will achieve over them.

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3

CHAPTER THREE

Project Management Plan

3.1 Overview.

3.2 Project Management Plan.

3.3 Project Methodology.

3.4 Project Components.

3.5 Chapter Summary.

Chapter Three: Project Management Plan

3.1 Overview

In this chapter we will talk about project management plan, then we will go in details for the set of tasks and time estimation for every task and talk about many risks that exist, then decide the project resources and total estimated cost. The project methodology and observation choices will be analyzed with their different choices, talk about component that we will use.

3.2 Project Management Plan

For any system the team must follow a list of tasks step by step, and estimating the time required for each task. This section showing the tasks should be followed to develop the project and the Gantt chart for it.

3.2.1Task Set.

Task [A]: General Project Analysis.

1- Collect different types of information about the idea, and discuss them between the project members, then choose the idea to be applied as a graduation project.

2-Search and study any valuable information about related projects or about subsystem will be used in this project to make a clear imagine about the project in order to implement it.

3-Drawing a general block diagram that describes and determines the project requirements.

Task [B] : Determine The Requirements .

Determining all the requirements of the project, and search for the alternatives.

1. Determine the hardware components (sensors, microcontroller, small tank, GSM) .
2. Determine the software components (java, android, NetBeans, C language).

Task [C] : Defining A Project Risk and Avoidance.

List all of the possible risks that may occur during the project life time, and prepare a correct plan for avoidance.

Task [D] : Requirements Analysis.

Analyzing all the requirements of the project, and collecting all information needed about usage and implementations.

3.1 Test the sensors to make sure they are working well.

3.2 Test the microcontroller to make sure that is working well.

3.3 Test the pumps to make sure that they are working well.

Task [E]: System Analysis and Design.

1- Analyze and design the system by drawing the block diagram and flow charts to clarify the system and its processes.

Task [F]: Project Iimplementation

1. Installation Of Sensors In Wells and Reservoirs.

1.1 Building the sensors from resistors and wires inside the reservoirs, or use ready sensors.

1.2 Put a Ultrasonic sensor inside the wells.

2-Put Pumps On Wells and Other Water Sources.

3-Connect The Sensors And Pumps With Microcontroller.

3.1Connect the sensors to input port on microcontroller.

3.2Connect the pumps to output port on microcontroller.

4- Programming The Microcontroller.

4.1 Identify input ports for sensors.

4.2 Identify output ports for pumps.

5 Connect the GSM With The Microcontroller.

5.1Identify input and output ports for GSM modem.

5.2 Programming the GSM modem to establish a communication with the microcontroller and the user mobile.

6-Design and Programming of the Application on the Computer (pc).

6.1 Use the NetBeans program to design the interface for the application.

6.2 Use the java language to program the application on pc.

7- Connect The System With Mobile.

7.1 Use AT commands to program GSM modem witch used to connect the microcontroller with mobile.

7.2Use android environment to build the application on the mobile.

Task [G]: Project Testing and Maintaining.

After design and implement the system, and connect the requirements, we will test the system and make sure it works will and with the desired goals.

3.2.2 Risks

That means any event will occur in the future and impact on the project plane, it always involves two characteristic:

1-Uncertainty: the risk may or may not happen; there are no 100% probable risks.

2-Loss: if the risk become reality unwanted consequence or losses will occur.

The types of risks faces the project are:

1- People Risk.

2-Components Risk.

3-Budget Risk.

1- People Risk:

This type of risk related to the kinds of people that deal with project at any time, as the following kinds:

Team:

1. Some members of the team ill.
2. Faces new information the team does not have experience on it.

Avoidance:

1. Make a correct plane, dividing the work between the members equally.
2. Learning and training about the new information during the first semester.

2- Components Risk

The hardware/software components may be causing risks as:

1. Some of the components not found in the local markets.
2. Some of the components not valid, and cost more than its importance.
3. Some of the components failed during the work.

Avoidance:

1- If the component not found in the local markets, the team search and demand it from the global markets.

2- If some of the components not valid or expensive, search for the alternatives or build it.

3-The team must dealing cautiously with the components, and making a save points at every time.

3- Budget Risk

This type of risk related to the project budget, the possible risk may happen in this side:

1. The project requirement cost more than expected.
2. The projects don’t meet financial support.

Avoidance:

1.Search well about the cheapest components that specify what project need.

2.Search for support and marketing the project.

Table 3.1 Risk Table Prior to Sorting.

Risk	***Probability***	***Impact***
1- Lack of training on tools.	40%	2
2- Some reduction in technical performance.	50%	2
3-The inability to deliver the project on time.	20%	1
4- Difficulty in dealing with the problems of code.	30%	1
5-Inability to provide the necessary pieces to build the project, such as sensors and other.	50%	2
6- The money will needed more than we budget.	40%	3
7- Inability to implement the project on an actual building.	30%	2

Impact values:

1- Catastrophic.
2- Critical.
3- Marginal
4- Negligible

3.2.3 Project Resource and Total Estimated Cost.

This section summarizes the costs of the hardware and software requirements for all suggested options.

1. Hardware resource:Arduino ADK, GSM, Pump, Pressure sensor, Resistance, Wire, mobile and personal computer.
2. Software resource: java language, android environment and C language.
3. Human resource: programmers.

1- Hardware Requirements Costs:

The hardware components that will be used in this project and their costs are shown in the Table3.2

Table3.2 Hardware Requirements Cost.

Resource	Number	Cost (NIS)
Arduino Mega	1	360
GSM	1	850
Pump	2	160
Flow sensor	2	65
Ultrasonic sensor	4	85
Pipes, cabling and misc	1	200
Valves	8	40
Solid State Relay	10	35
Mobile	1	2000
Personal computer	1	3000

3.2.4 Time Estimation.

1 -Task Set Table.

This table shows the tasks and their time, also shows the dependency between all tasks.

Table 3.3 Task Set Table.

	Task set	Time	Dependent Task
A	**General Project Analysis**.	**1 week**	
B	**Determined the Requirements**	**1 week**	**A**
C	**Defining a project risk and Avoidance**.	**1 week**	**B**
D	**Requirements Analysis**.	**2 week**	**C**
E	**System Analysis and Design.**	**1 week**	**D**
F	**Project implementation**	**8 weeks**	**E**
G	**Project testing and maintaining**.	**2 weeks**	**F**

2- Task Network:

A task network, also called activity network, is a graphic representation of the task flow for a project. Figure 3.1 show the task network.

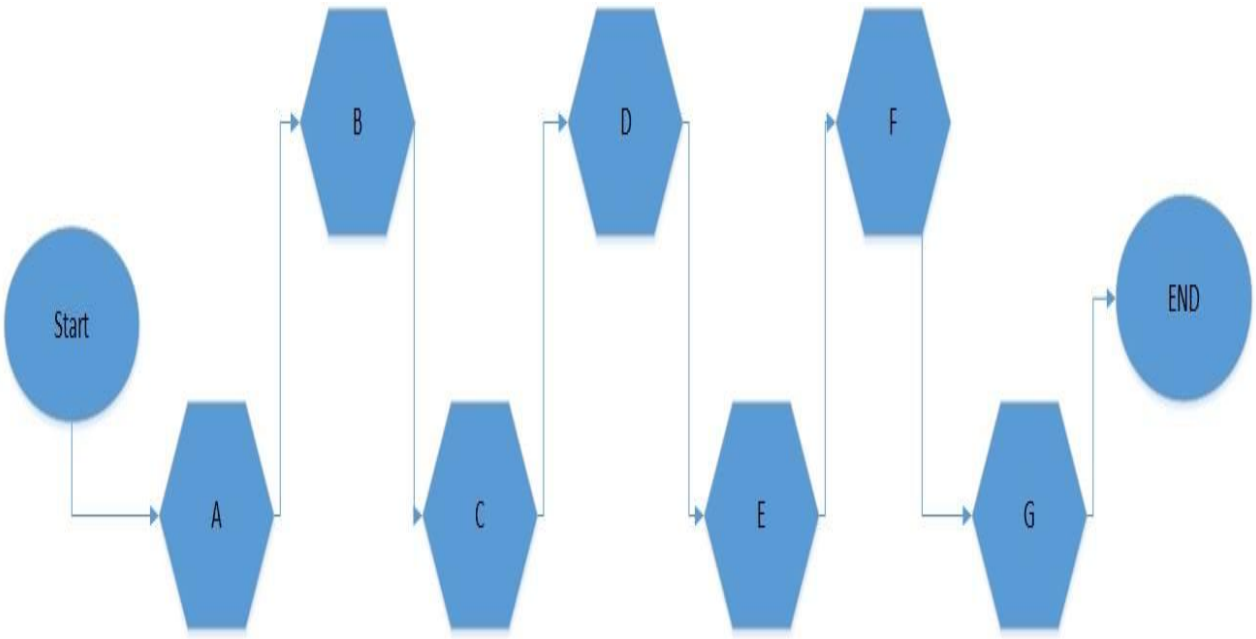

Figure (3. 1): Task Network.

3- Timeline Chart:

The figure 3.2 illustrates the format of timeline chare. All project tasks are listed in the left hand column. the horizontal bars indicate the duration of each task. When multiple bars occur at same time on the calendar, task concurrency is implied. The diamonds indicate milestones.

Figure 3.2

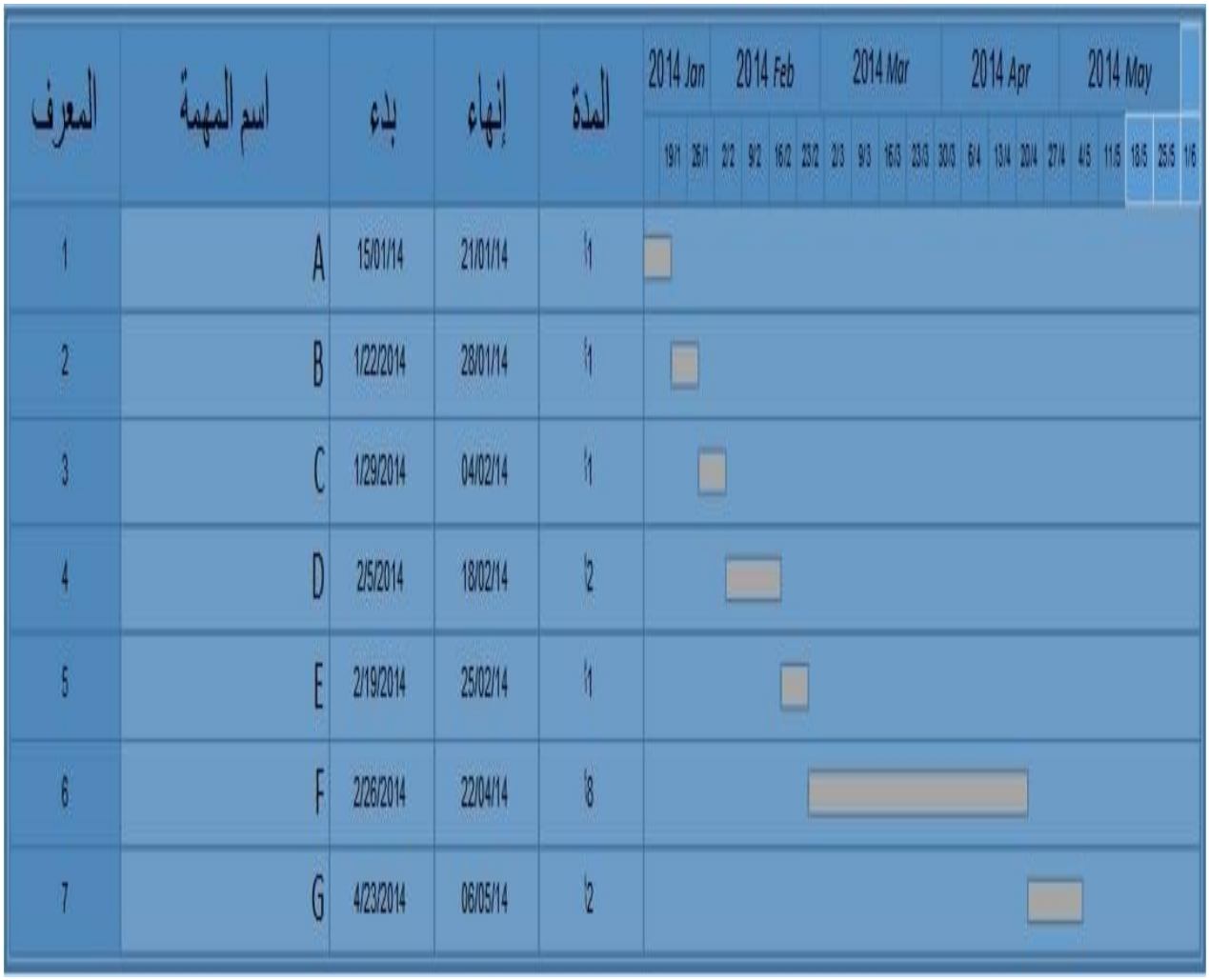

Figure (3. 2): Task Chart.

3.3 Project Methodology.

In this section we discuss the choices that can be used in the project.

3.3.1 Options.

1- Sensors Options.

In this section we will talk about the sensor option, that is water level sensors options, and water flow options.

A- For Water Level Sensors.

According to research the best two design options for water level sensor that will be used to sensing water:

1-Ultrasonic sensor.

2- Pressure sensor.

B- Water Flow Options.

According to research we have multi choice design options for water flow sensor that will be used to sensing water flow:

1- Pressure sensor.

2- Water flow sensor.

2- Microcontroller Options.

A- Arduino Mega.

B- Arduino UNO.

3.3.2 Analysis of Each Option.

We have many options for water level sensor, in this section we will analysis each one of them.

1- Analysis For Sensors Options.

In this section we will analysis ultrasonic and pressure sensor.

A- Ultrasonic Sensor:

When we use ultrasonic sensor we put it on the top of tanks or wells, the ultrasonic sensor send waves, this waves Collision with water and return to sensor, we use the time from send to return to calculate water level.

Advantages:

1. Contact-free detection.
2. Reliable even in critical ambient conditions with lots of dirt, dust, or mist.
3. Irrespective of the color, transparency, reflection properties, and surface texture of the object.
4. Accurate detection even of small objects.
5. Cuboid and cylinder designs for added constructional freedom.

Disadvantages:

1. High cost.

2. Not available frequently.

B- Pressure Sensor:

Second design option is pressure sensor, we will put this sensor in the bottom of tanks and wells and read pressure of water, then calculate water level by this reading and relationship between them.

Advantages:

1. Lower cost than ultrasonic sensor.

2. No need for a reference to calculate water level.

3. Avilable in many types commensurate with different depth of tanks and wells.

Disadvantages:

1. Lower reliability than ultrasonic sensor.

2. Need cables to connect with microcontroller.

C- Flow sensor:

For this option, we will put the sensor in water company line and read if water had arrived or not, also, we will put another sensor at the entrance of a tank to check whether the water is arrived or not. Then send the state of water flow as message to the applications.

Advantages:

1. Higher reliability.

2. Available.

Disadvantages:

1. Could we need more than one sensor.

2. More cost.

2 - Microcontroller Options Analysis.

A- Arduino Mega

The Arduino ADK is a microcontroller board based on the ATmega2560, It has a USB host interface to connect with Android based phones, based on the MAX3421e IC. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. [3]

B- Ardunio UNO.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

3.4 Project Components.

3.4.1 Hardware Components.

In this section we will talk about the hardware components, that we divide the system to multiple unit as control unit, sensor unit.

A- Control Unit.

In this section we will talk about the control unit, that is microcontroller and GSM.

Microcontroller.

Microcontroller is a computer on a chip that is programmed to perform almost any control, sequencing, monitoring and display the function. [1]

In this project we need microcontroller to process data that received as input from sensors and sent as output to pumps, also to communicate with the mobile's user through the GSM network.

The Arduino Mega is a microcontroller used to manage transport data between sensors and pumps.

GSM Modem(Global System for Mobile communication):

GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. [2]

We will use the GSM module in order to establish a communication between the microcontroller and the mobile through the GSM network. And so the user can make the management and controlling for the water level by using the mobile application through GSM network.

B- Sensing Unit.

Flow Water Sensor.

We will use flow sensor in water sources (company water line) to measure the availability there.

Ultrasonic.

We will use ultrasonic sensor in wells and reservoirs, to measure the water level there.

Pressure Sensor.

We will use pressure sensor in wells and reservoirs, to measure the water level there.

C- Pumping Unit.

Pump:

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. In our project we use it to fill tanks from different water sources.

Electrical Valves :

A valve is a device that allowed to water to passing from it or not, and allowed to water to pass in one way.

3.4.2 Software Components:

Now a day's computers are able to perform different tasks in different fields, but it can't do that by itself! It needs detailed procedures for each task. That what we call a computer program.

There is a lot of programming languages that is used to build out a computer program, choosing any language depends on the tasks of the program.

A- Languages Unit.

Android:

Android is a Linux-based operating system designed primarily for touch screen mobile devices such as smart phone's and tablet computers.

Android gives you a world-class platform for creating apps and games for Android users everywhere, as well as an open marketplace for distributing to them instantly.[3]

We will use the android language in our system, the android application will be programmed on the mobile in order to build a communication between the user and the controlling and management system (GSM module, Microcontroller, Sensors, ...) through the WIFI/GSM network.

C# language:

We use this language to make the platform of the application on the pc, and so, the user can access the system and perform the proper action, such as checking the states, run pumps, stop running….

3.5 Chapter Summary:

In this chapter we talked about management plan of project, methodology of working project and what component we could be choose and other option in software and hardware.

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4

CHAPTER FOUR

Software Requirement Specification (SRS)

4.1 Overview.

4.2 Requirement Description.

4.3 Class Responsibility Collaborator (CRC) Modeling.

4.4 Class Hierarchies and Relationship.

4.5 Chapter Summary.

Chapter Four : Software Requirement Specification (SRS)

4.1General Overview.

In this chapter we will talk about the specifications of software requirements, we describe the requirements and explain them as scenarios using use-case templates and diagrams, then we describe every requirement as a class, and the responsibility for each class, finally the relationship with other classes as CRC modeling and a hierarchy of classes.

At this part, we will explain the whole work of our project, how the management and controlling of the water level for multiple buildings from multiple water sources can be achieved by using the mobile on the GSM network and pc.

First, we will explain the work for building contains one floor only, and then we integrate the explanation for buildings with multiple floors.

Buildings with one floor:

Managing Unit:

1. All the information about the water level on the small tanks and the well, also the pressure on the water company line will be displayed on the mobile using programmed android application, as will as on the computer by using java programming language.

2. Through the GSM network, the mobile will be able to test the water level any time, and to give the proper order for the microcontroller, such as operating the pumps or stop those, for the pc, the same task will happen wirily.

3. Also, pc will receive messages about the small tanks states, and the mobile will be able to receive messages from the GSM module when any of the small tanks is empty and when it becomes full,

4. By using either the mobile or the pc, the user will decide which water sources will be used to fill the small tank, and this depends on the displayed information about the water level on the well and the water pressure on water company line.

5.When the user decides to fill or stop fill any tank, he/she will send this command by using the GSM network to the GSM module, or by using the pc, which inform the microcontroller to do the proper goal.

6. The system will have an additional feature when the user not be tensioned to his/her mobile or pc to stop the pumps after the water reached the desired level, the system will stop automatically after few minutes.

7. Also, the whole system will be integrated to work by itself, and so, all the previous tasks will be done automatically.

Sensing Unit:

1. First we put the sensors in the reservoirs and the available water sources, such as well and the water company line.

2. The sensors distributed between the cool small tank and the hot small tank, in order to sense the water level there. The sensor will be used for this purpose either the pressure sensor or the ultrasonic sensor.

3. For the water sources, the pressure or ultrasonic sensor well be used for the same purpose as the small tanks, in order to know the water level in it, but another pressure

sensor will be used in the water company line to test the pressure of the arrival water, and so to decide whether the water can go up to fill the small tanks directly or not.

Controlling Unit:

1. All the used sensors will be connected to a microcontroller wirily, this can be done through the multiple I/Os on the pic, and then the microcontroller will process the incoming information through different instruction codes written in C language.

2. Also the microcontroller will be connected to other two parts. The first one is the motor, which performs the proper operation, either operates the pump to fill the small tanks or stop filling them, and this depends on the o/p pin from the microcontroller to the motor.

3. The second part will be connected to the microcontroller is the GSM module, which establish a wireless communication between the microcontroller unit and the user's mobile through the GSM network.

4. The GSM module will be identified on the network by using a special sim card, and number of AT commands.

Water Pumping Unit:

1. The water will take its normal journey from the water sources to the small tanks depending on the user's commands.

2. For the water company line, after testing the pressure of the incoming water, the user decides to monitor the water direction, either to the well, or to fill any empty small tank if a message for this state had been sent.

3. For the well, the user can test the water level there, and use it to fill any empty small tank, and then stop the filling either for any level or when it is full, based on user's decision.

4. The motor which operates the pump, will be controlled by the whole management and controlling system, through the integrated work between the main units (sensing, controlling, managing,…).

4.2 Requirement Description

4.2.1 Use-Case Templates

Use-Case Template for Sensing the Water Level.

Use-case: sensing the waterlevel at wells and small tanks.

Primary actor: microcontroller.

Goal in context: To sensing level of a water at anytime in the well or tank.

Trigger: the building owner decides to show the level of water at wells or small tanks.

Scenario:

1. The sensor senses the water level at tanks and wells.
2. The sensor sends a signal to microcontroller.
3. The microcontroller processing signal and keep it to sent to application.

Use-Case Template for Sending A Message.

Use-case: send a message to the application (pc/mobile).

Primary actor: GSM and microcontroller.

Goal in context: to inform about the state of the small tank that is full or empty.

Scenario:

1- Sensing the water level on small tank and well.

2- Send a signal to the microcontroller to detect the state of the small tank and well.

3- If there are full or empty, send a message to the application, and there are use GSM to send a message to the mobile application.

Actor 1 : Microcontroller.

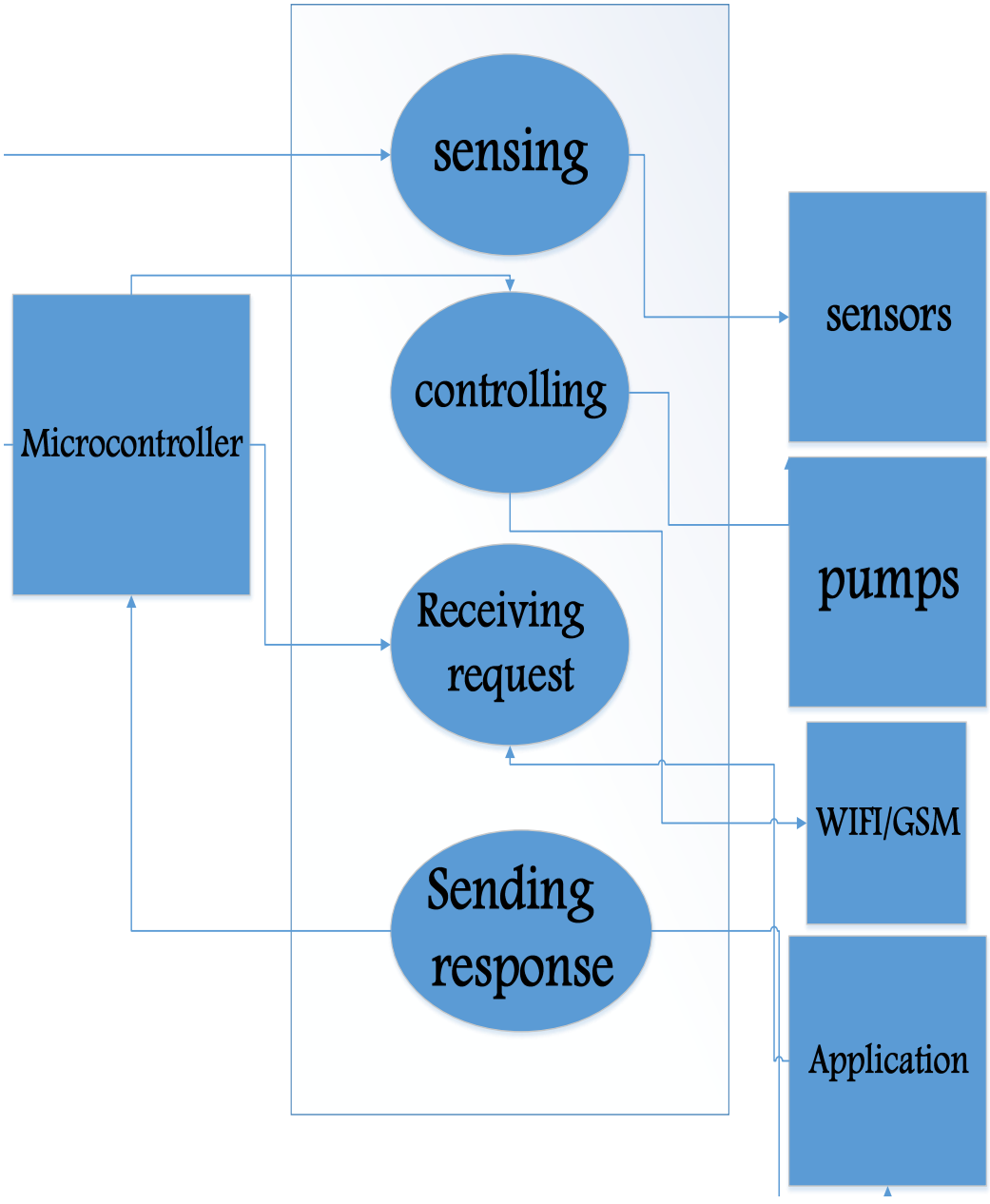


Figure (4.1): Use Case Diagram Microcontroller.

Use-Case Template for Water Pumping.

Use-case: water pumping.

Primary actor:building owner.

Goal in context: to fill the small tank from different water source.

Scenario:

1. The water will take its normal journey from the water sources to the small tanks depending on the user's commands.

2. For the water company line, after testing the pressure of the incoming water, the user decides to monitor the water direction, either to the well, or to fill any empty small tank if a message for this state had been sent.

3. For the well, the user can test the water level there, and use it to fill any empty small tank, and then stop the filling either for any level or when it is full, based on user's decision.

4. The motor which operates the pump, will be controlled by the whole management and controlling system, through the integrated work between the main units (sensing, controlling, managing,…).

Use-Case Template For State Monitoring.

Use-case: monitoring state of water.

Primary actor: building owner.

Goal in context: to check state of water.

Scenario:

1- Building owner send a request to check state of water in tanks or wells by application.

2- Building owner send a request to check state of water in water company line by application.

3- The microcontroller received a message, processes it and replays for the application

Actor 1: Home Owner.

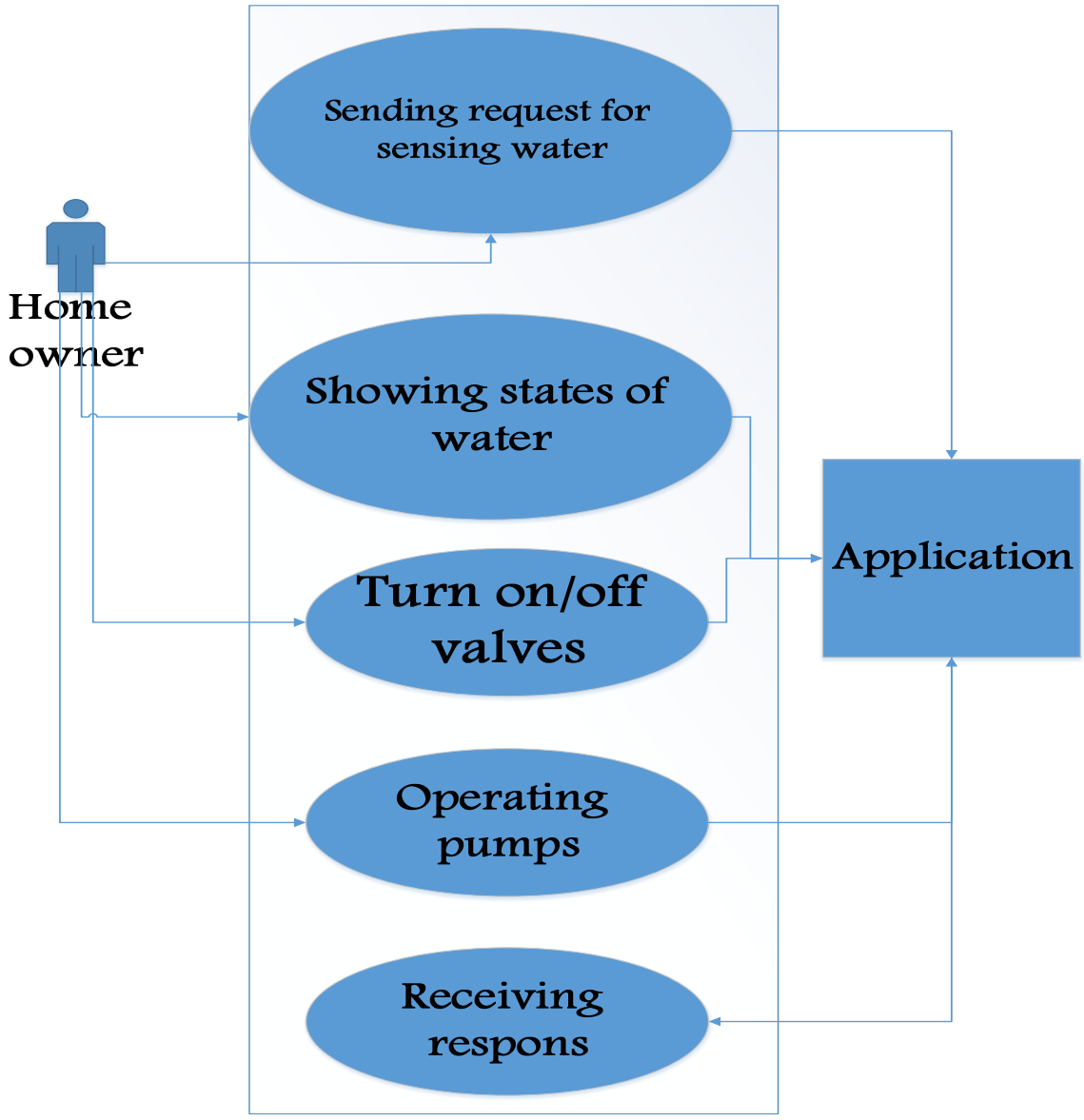


Figure (4.2): Use Case Diagram For Home Owner.

Use-Case Template For Monitoring and Maintaining the System.

Use-case: monitoring and maintaining the system.

Primary actor: developer.

Goal in context: to maintain and fixing any error could done, and monitor the system every period of time.

Scenario:

1- Checking state of sensor after period of time.

2- Checking state of microcontroller after period of time.

3- Checking state of pumps after period of time.

4- Checking state of application after period of time.

5- Fixed any error could be done

Use-Case Template For Controlling and Managing The System.

Use-case: controlling and managing the whole the water system.

Primary actor: user mobile.

Scenario :

1- Through the mobile, the user can test the water level and the water availability in both the water sources and the small tanks any time.
2- The user will receive a message when the small tanks either full or empty.
3- Through the mobile application the user will decide which water source will be used in the filling process and to which small tanks.
4- The application will send a message command to the microcontroller in order to run the pumps or to stop working them.

Actor 3 : Developer.

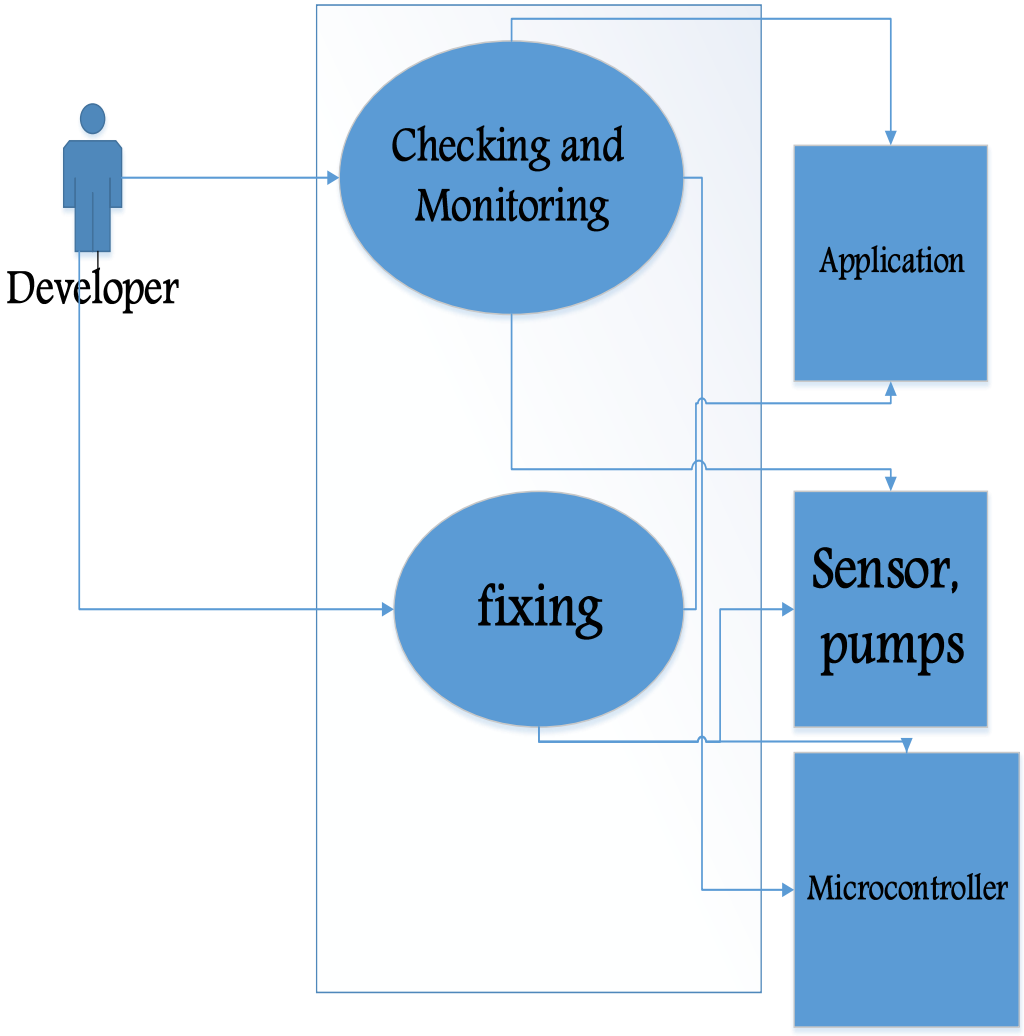


Figure (4.3): Use Case Diagram Developer.

Actor 4 : Mobile User.

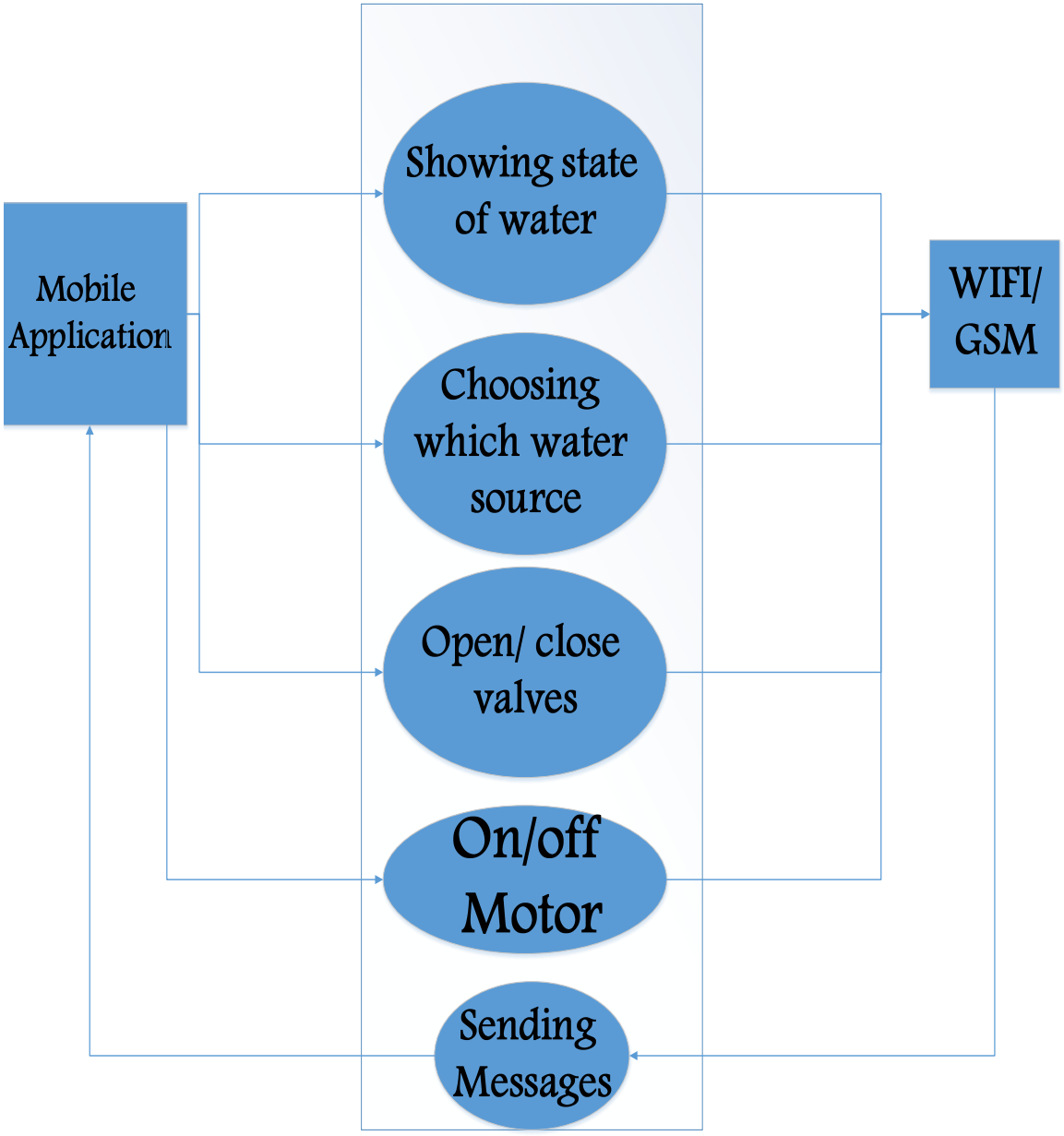


Figure (4.5): Use Case Diagram Mobile User .

4.3 Class Responsibility Collaborator (CRC) Modeling.

Class responsibility collaborator (CRC) modeling provides a simple means for identifying and organizing the class that are relevant to system or product requirements.

In this section we will divide the system to class, and then identify the responsibility for each class, so we will identify the attribute for each class, and so collaborator with the other class.

Table (4.1): Sensors Class.

Class : Sensors	
Description : This sensor will put in a small tanks or in the wells to sense the levels of water on it, so the user canSurveillancethe water levelin eachof the reservoirsandwellsallthetime.	
Responsibility:	**Collaborator :**
Sensor ID.	
Sensor location.(small tanks, wells,)	**Water sources.**
Sensor type.	
The number of sensor needs.	
Sense the level of water in the small tank.	**Small tanks.**
Measure the pressure of water in water line company	**Water sources.**
Send the signal to the microcontroller.	**Microcontroller**.

Table (4.2): Small Tanks Class.

Class : Small Tanks	
Description : The small tanks are used for water level conservation, for which the system will control and monitor the water there, and the user can either detect the water level through the application, fill the tanks from different water sources, receive a massage through the GSM network about the state of tank (full, empty).	
Responsibility:	**Collaborator :**
Tank ID.	
Tank state (full, empty).	
Water level.	
The water source.	**Water source.**
The number of small tanks.	

Table (4.3): Pumps Class.

Class : Pumps	
Description : This device will used to pump the water from different water sourceto the small tank.	
Responsibility:	**Collaborator :**
Pumps type.	
Water source.	**Water source.**
Take the comment from micro.	**Microcontroller**
The state of the motor (on/off).	
The number of pumps need.	

Table (4.4): Microcontroller Class.

Class : Microcontroller	
Description : All the used sensors, motors, and GSM module will be connected to a microcontroller wirily, this can be done through the multiple i/p on the pic, and then the microcontroller will process the incoming information through different instruction codes written in C language.	
Responsibility:	**Collaborator :**
Microcontroller pins (input, output).	
Received signal from pressure sensors.	**Sensors.**
Received signal from ultrasonic sensors.	**Sensors.**
Process the signal.	
Give the commands to the motors (on/off).	**Pumps.**
Send a message to the application through the GSM.	**GSM**

Table (4.6): Application Class.

Class : Application	
Description : Throw the interfaces of the application on pc or mobile, the user have can send and resave comment to control and manage the system.	
Responsibility:	**Collaborator :**
Mobile application.	**GSM.**
PC application.	
Send command to control and management the water level system.	**Microcontroller**
Reserve massage about the stat of tanks and wells.	
Show the level of water in the small tanks and wells.	

Table (4.7): Water Sources Class

Class : Water Source	
Description : There are many different water sources such as wells or water company line…. etc.	
Responsibility:	**Collaborator :**
Water sours type.	
The pressure of water in water company line.	**Sensors**.
The state (full, empty).	

The water level senor.	**Sensors.**
The water level in the well.	
The number of wells.	
The number of other water source.	
The pumps that connect on the water source.	**Pumps.**

Table (4.8): Mobile Application.

Class: Mobile Application.	
Description : The application will be programmed and installed on the users mobiles, to communicate with the microcontroller through GSM network.	
Responsibility:	**Collaborator :**
Mobile number	
GSM/GPRS number	
Test the water level and wells.	GSM/GPRS modem
Test the water availability in the water company line	GSM/GPRS modem
Decide which water source will be used and to which small tanks.	GSM/GPRS modem
Receive messages about the water state.	GSM/GPRS modem
Send a command to the microcontroller to run or stop the pumps.	

4.4 Class Hierarchies and Relationship.

In this section we will show a hierarchy of classes and what attribute in each classes, and we will show the relationship between them.

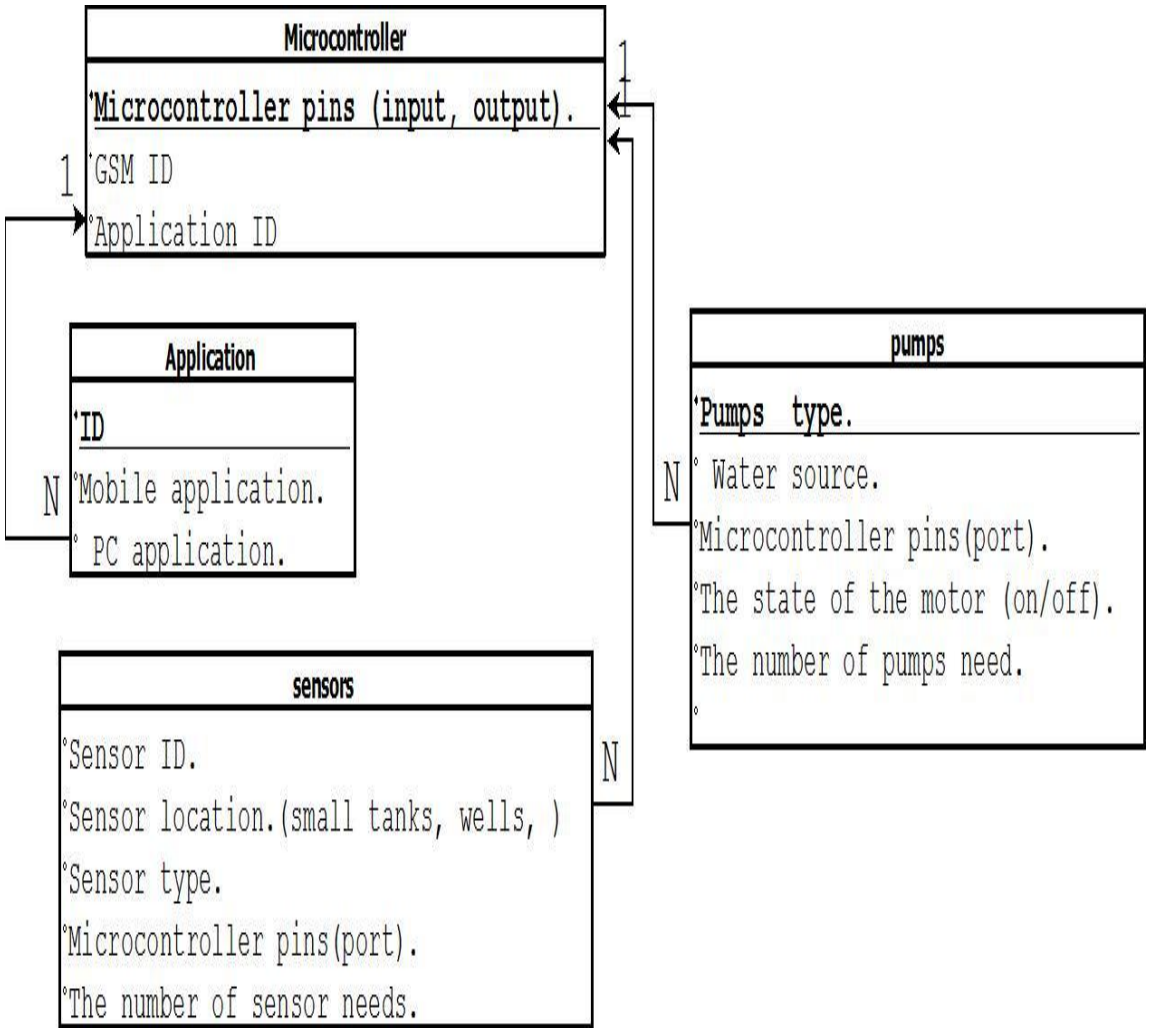


Figure (4.6): Class Hierarchies and Relationship For Microcontroller class.

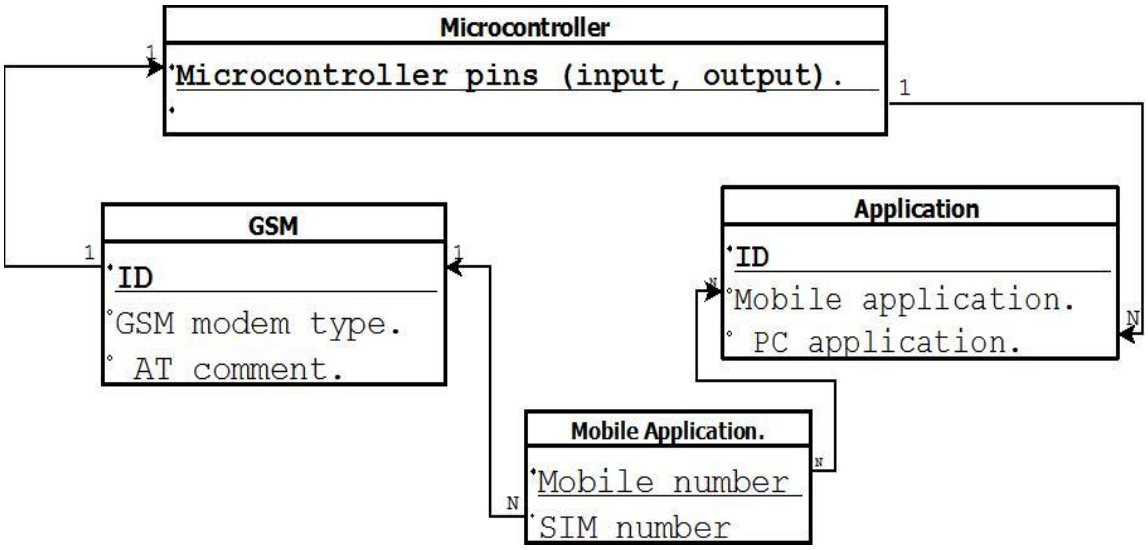


Figure (4.7): Class Hierarchies and Relationship for Application class.

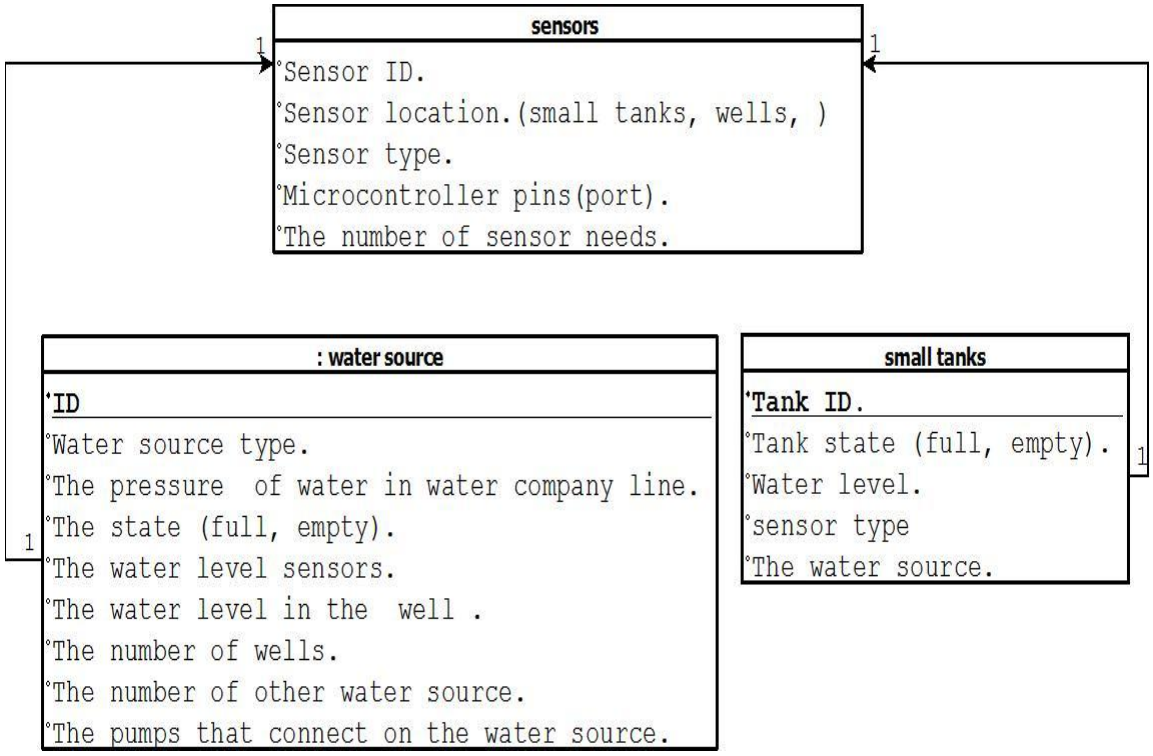


Figure (4.8): Class Hierarchies and Relationship For sensor class.

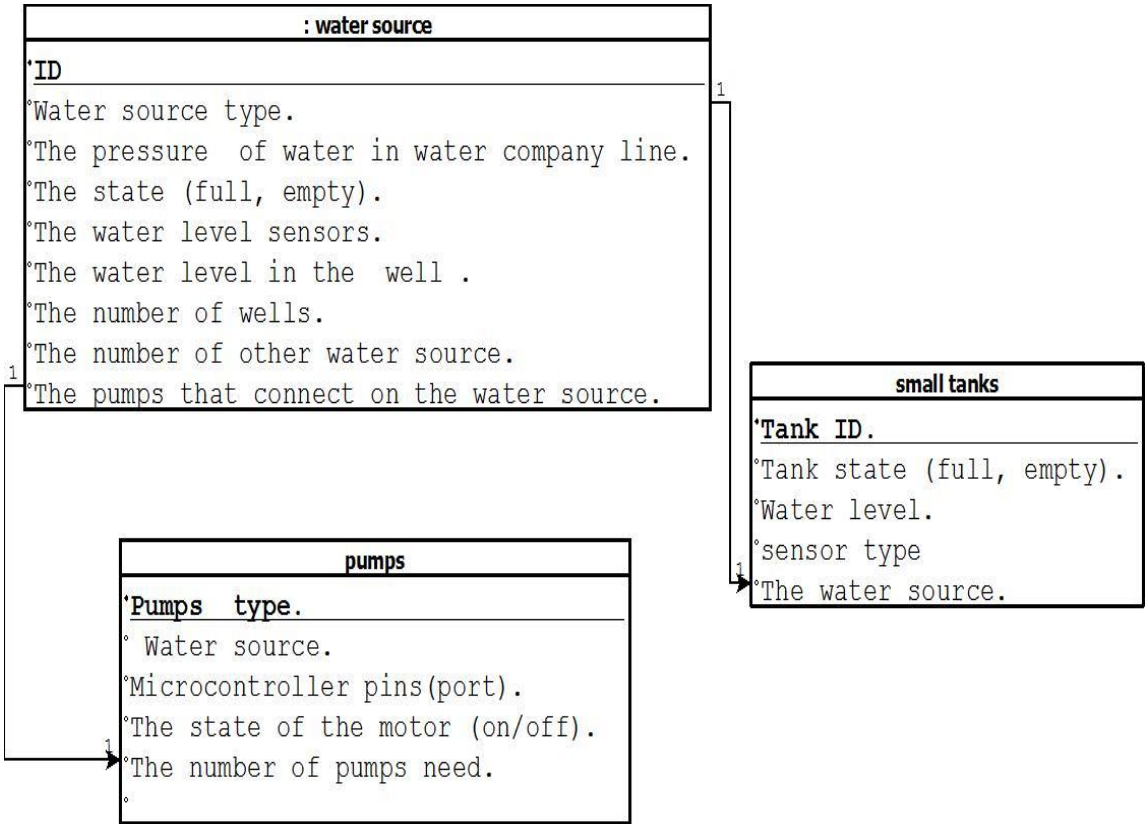


Figure (4.9): Class Hierarchies and Relationship For Water Source Class.

4.5-Chapter Summary

In this chapter we explained and described the requirements by different modeling, first we described them by use-case scenarios and the classification the requirements as classes, then describe the relationship between them.

5

CHAPTER FIVE

System Design

5.1 Chapter Overview

5.2 Objects-Relational Model (Software Components).

5.3 State Behavioral Modeling

5.4 Subsystem Design.

5.5 Class and Object Design.

5.6 Software Interface Design.

5.7 Hardware Interface Design.

Chapter Five : System Design :

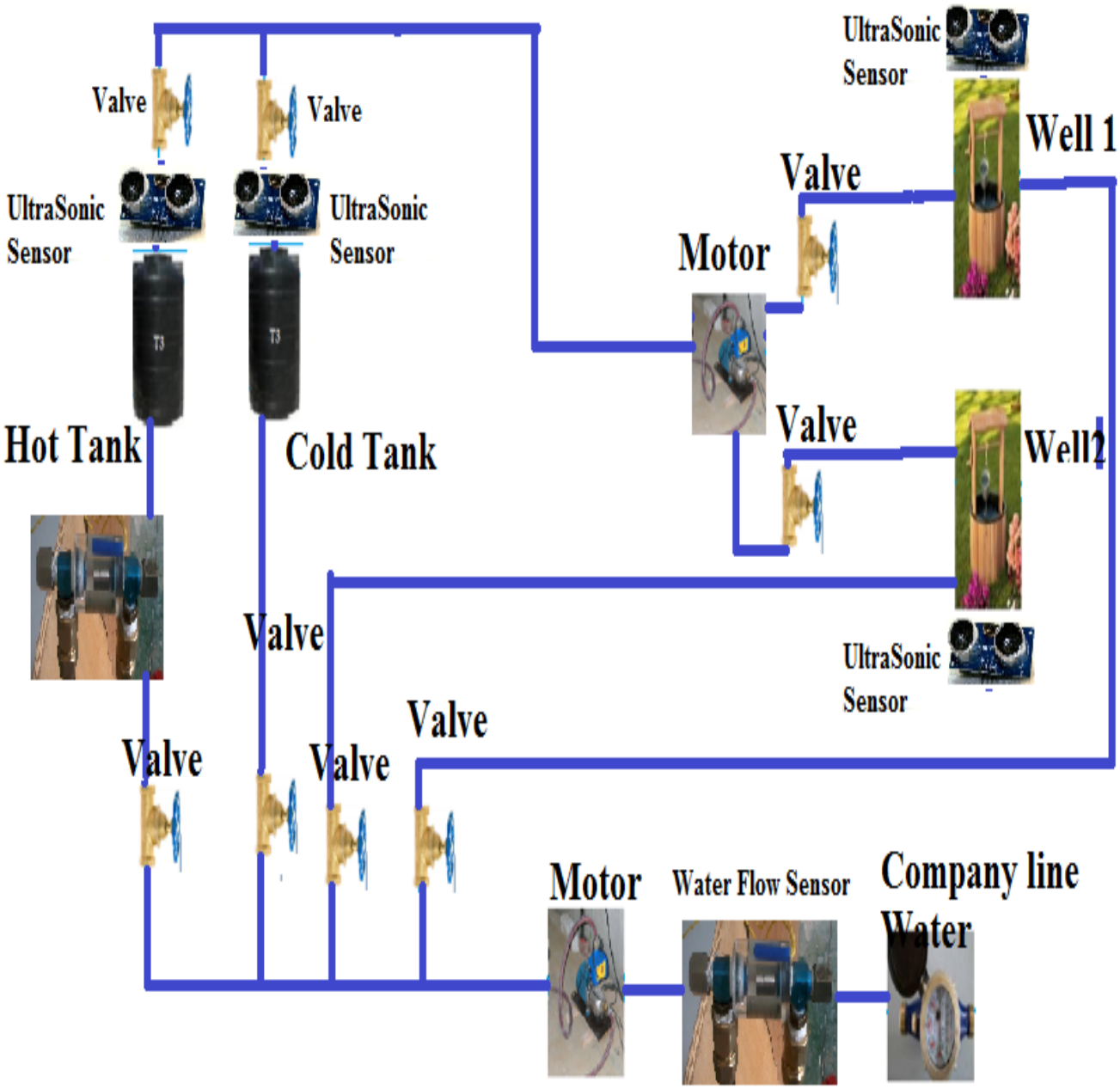
5.1 Chapter Overview:

At this chapter, we will talk about the system block diagram in both hardware and software, the objects relational model in software component and the state behavioral method.

Then we will explain the subsystem design and describe each tasks and components (software and hardware), and class and object design which gives more implementation details about each class attribute and operation.

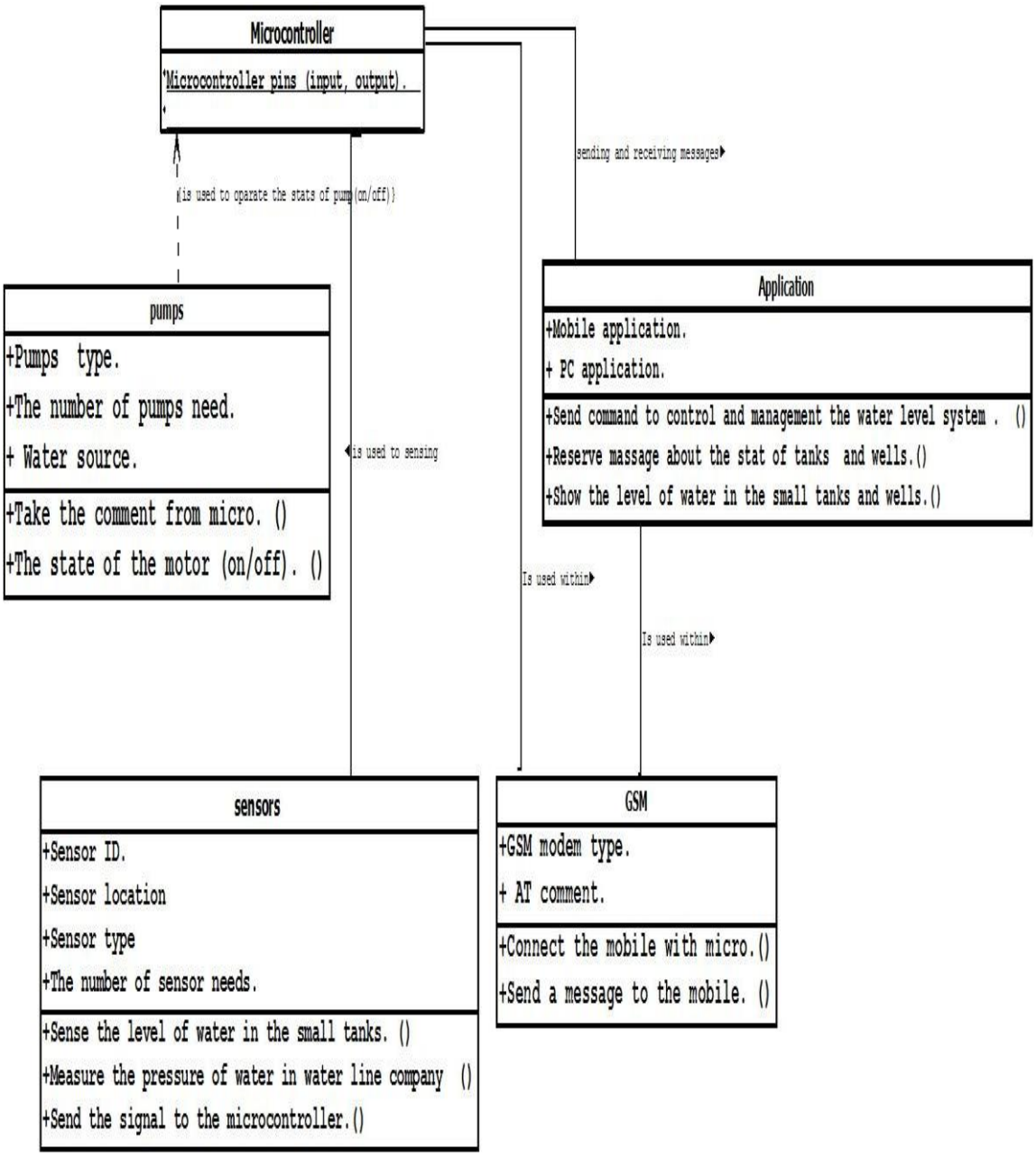
Then we will explain the whole system interfacing, software and hardware, including the object interfacing, and user interfaces,.. .

System block diagram (detailed) : both software and hardware components as shown in fig(5.1).

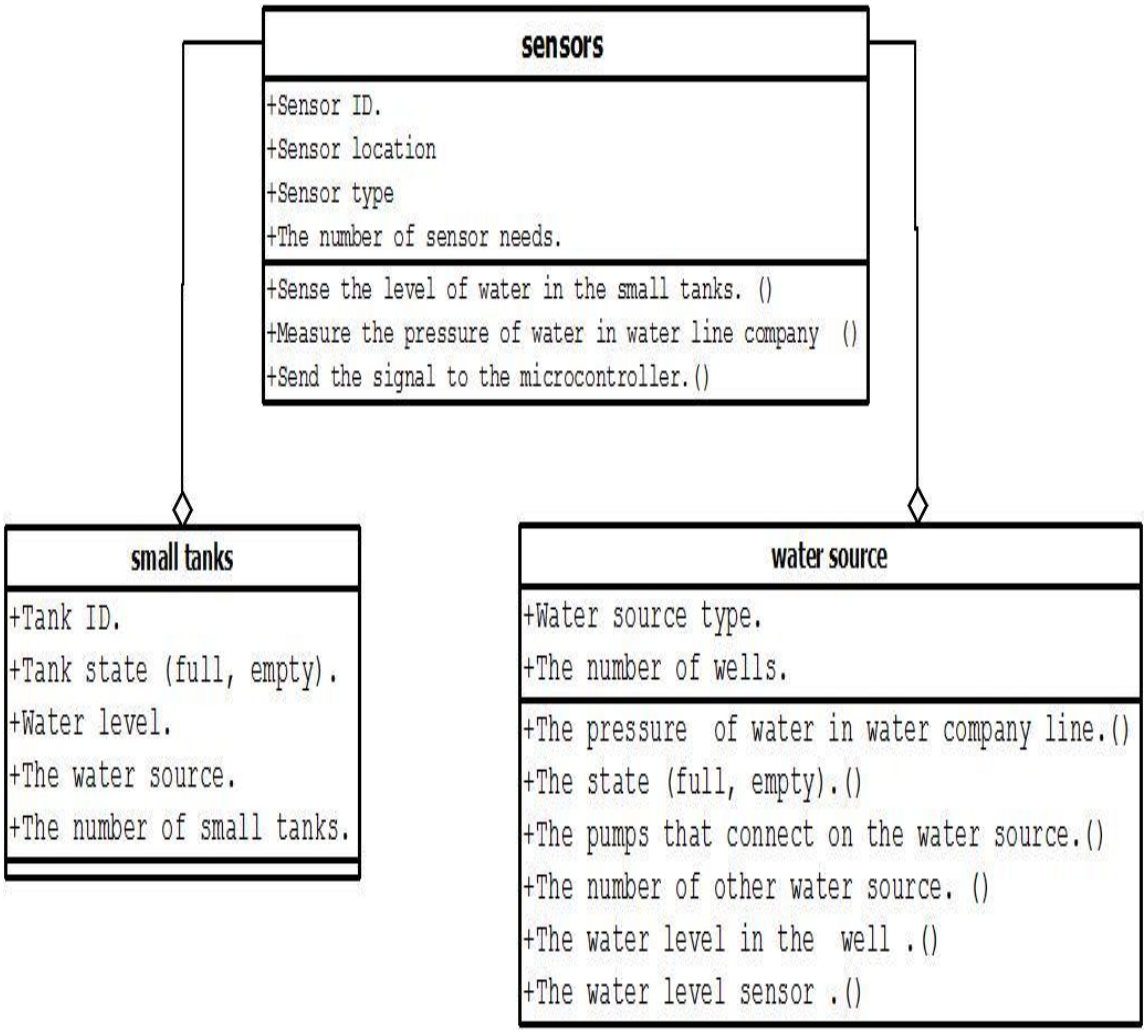


Figure(5.1):System Conceptual Diagram.

5.2 Objects-Relational Model (software components).



Figure(5.2 A):Objects-Relational Model.



Figure(5.3 B):Objects-Relational Model.

5.3 State Behavior Modeling:

In this section we maintained flowing control signals, states and data between software components, hardware components from input components to output components.

5.3.1 Control Flow.

In this subsection we maintained flowing control signals between software components, hardware components from input components to output components.

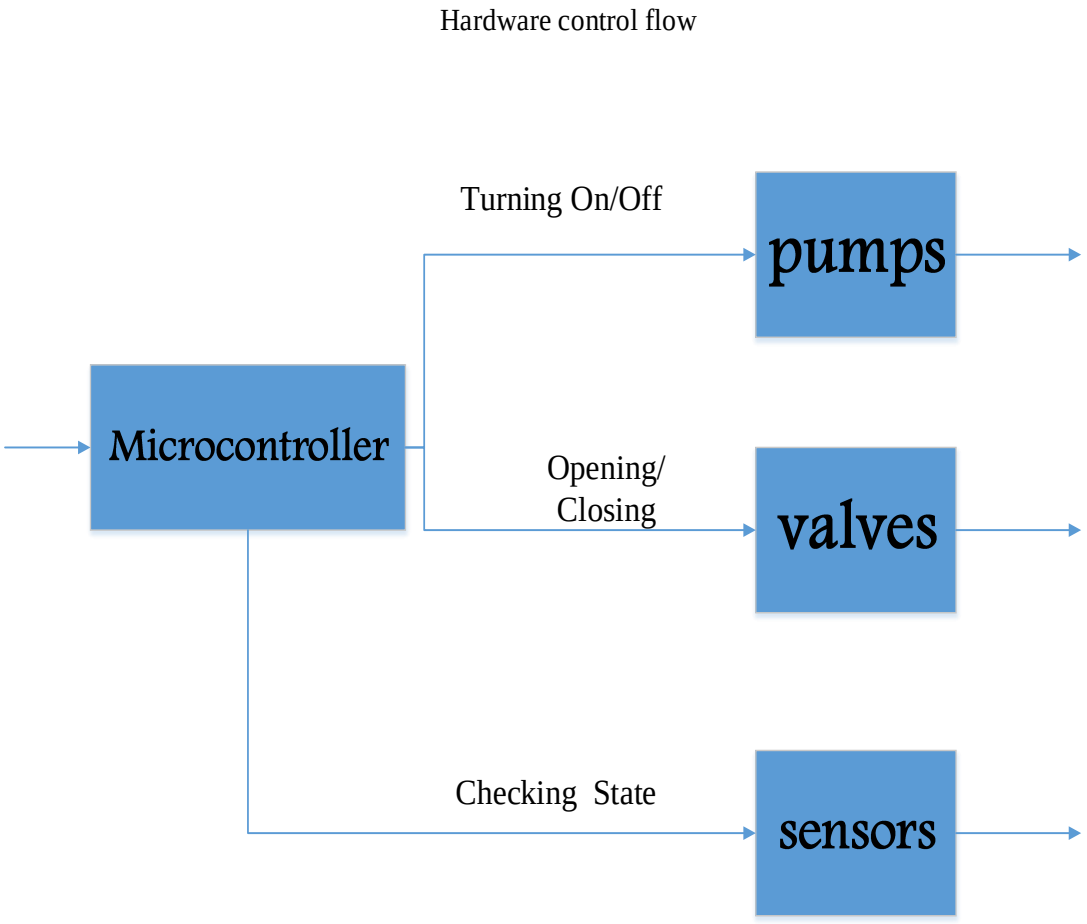
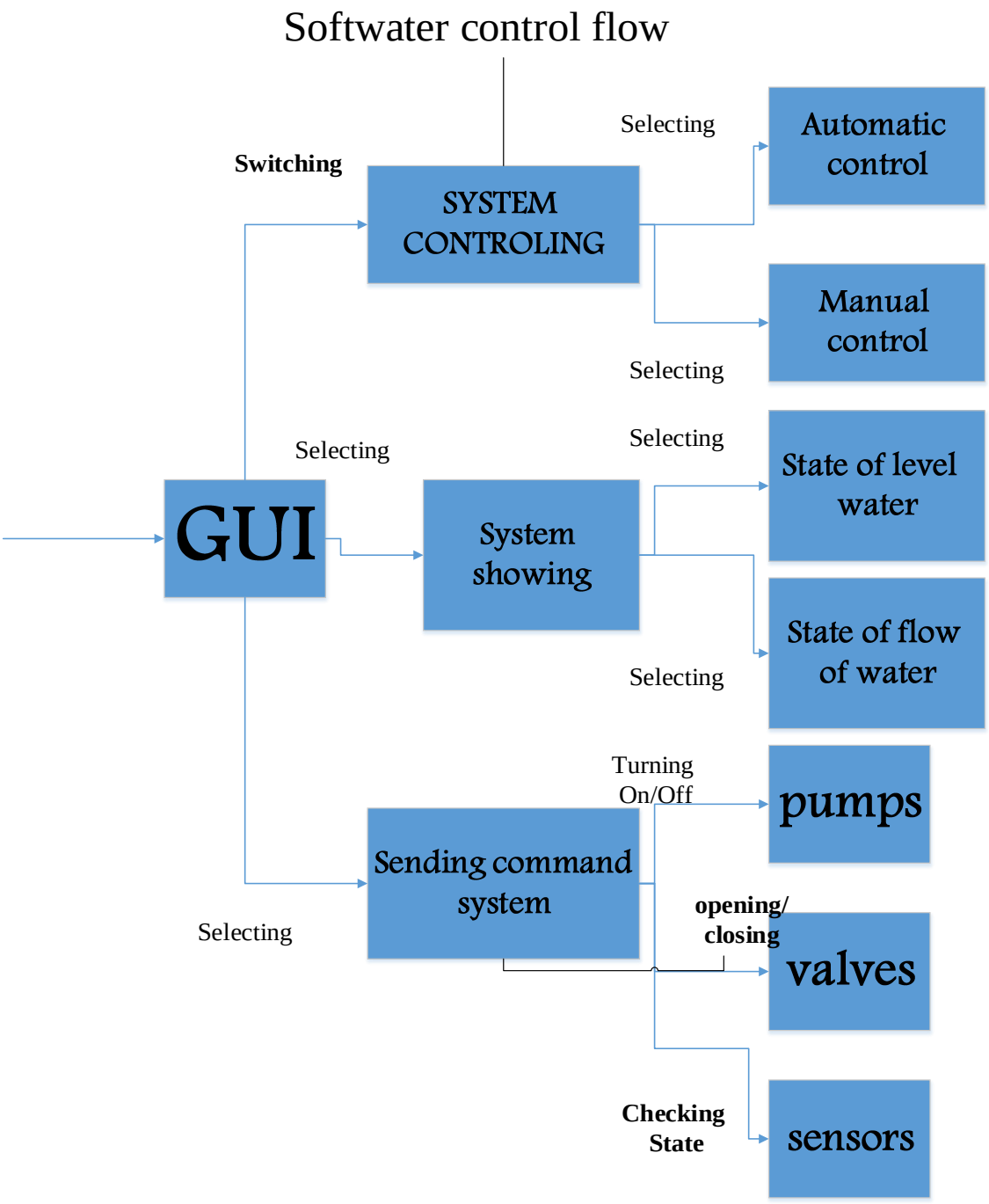


Figure (5.3): Hardware Control Flow.



Figure(5.4):Software Control Flow.

5.3.2 Data Flow:

In this subsection we maintained flowing data between software components, hardware components from input components to output components.

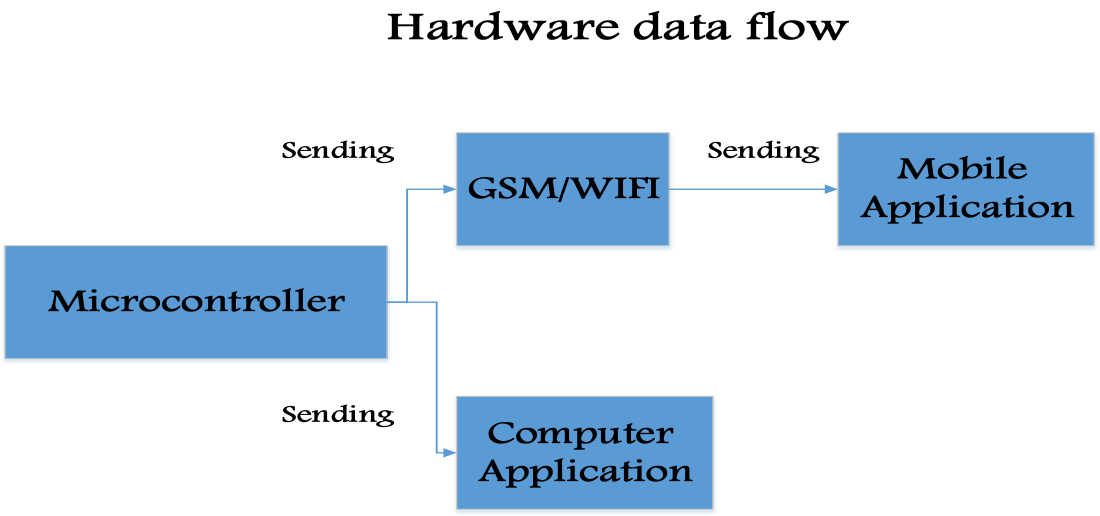


Figure (5.5):Hardware Data Flow.

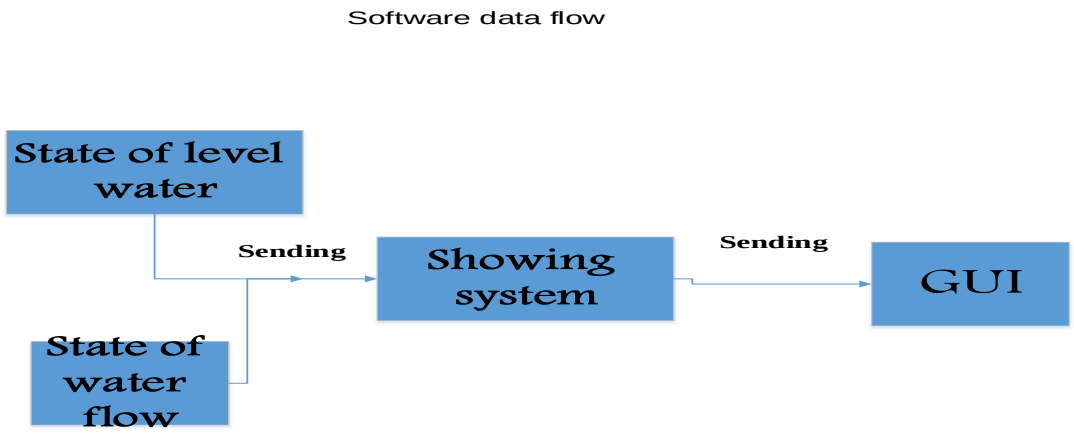


Figure (5.6): Software Data Flow.

5.3.3 State Flow:

In this subsection we maintained flowing states between software components, hardware components from input components to output components.

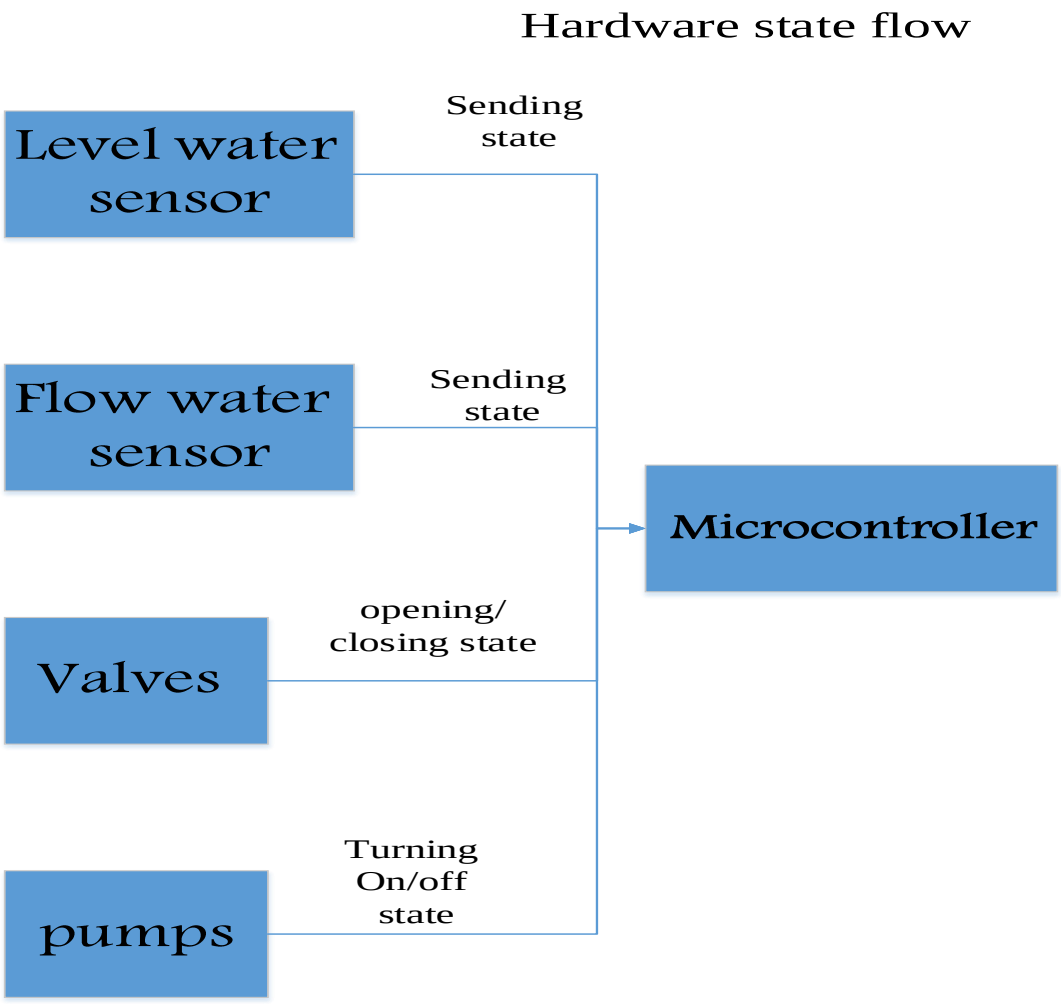


Figure (5.7):Hardware State Flow.

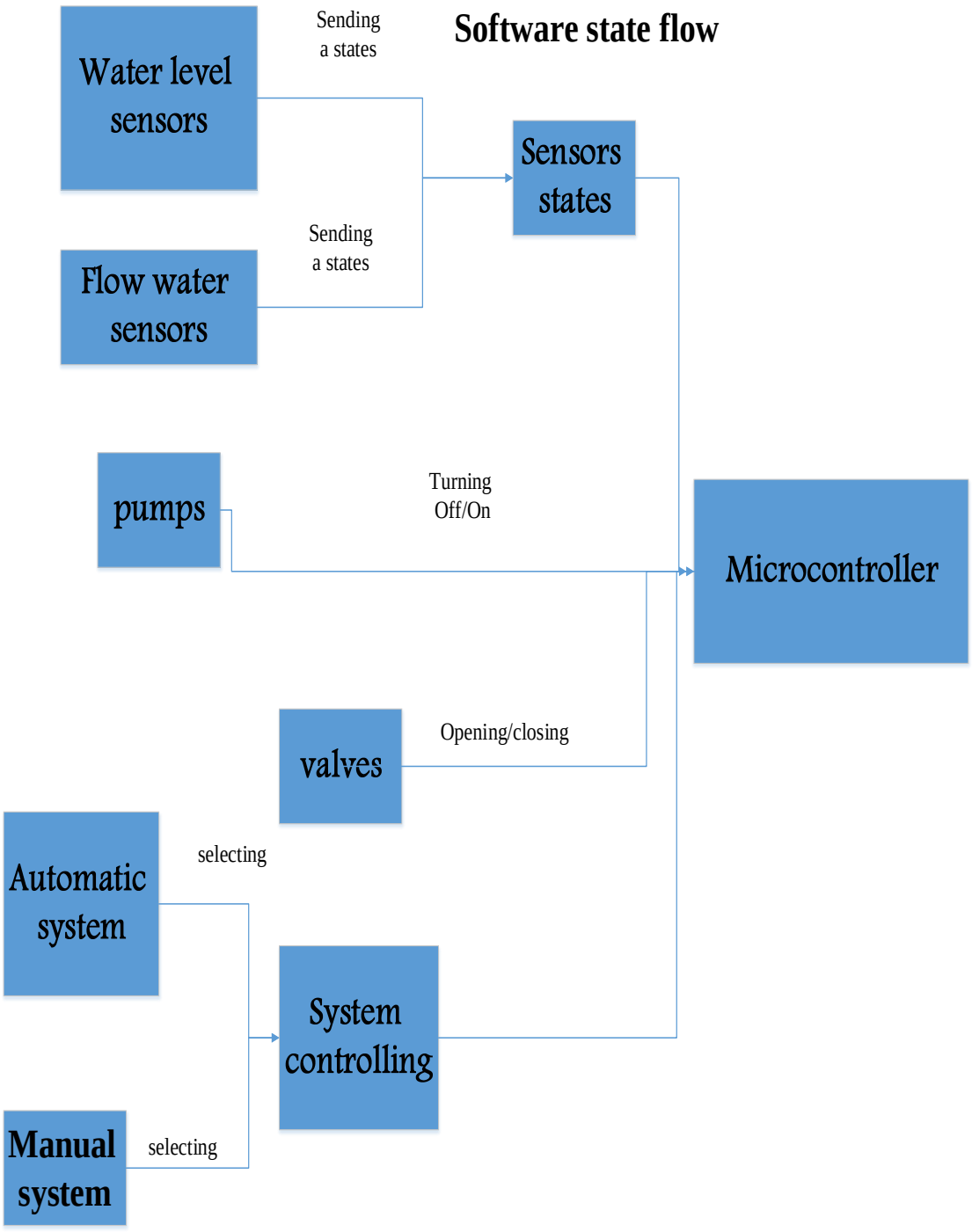


Figure (5.8):Software Stat Flow.

5.4 Subsystem Design:

In this section, we will describe each subsystem tasks, and the components, hardware and software.

5.4.1 Hardware Subsystem Design.

Here, we will explain the hardware components, their features, pins, and the inter connection between them the rest of the system in block design.

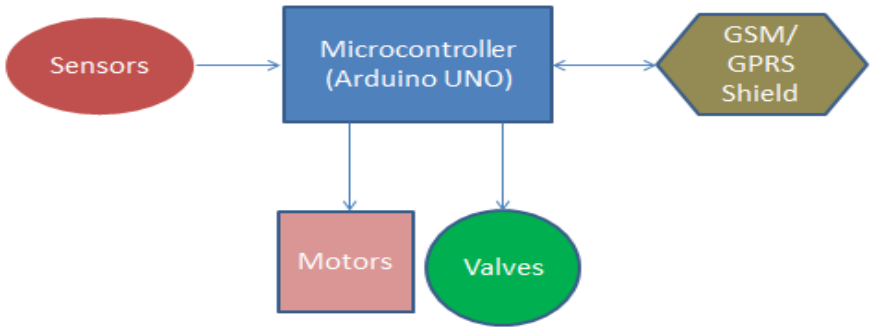


Figure (5.9): Block Diagram For Hardware Design.

1.Arduino Mega :

The main component that will be used in our design is the Arduino UNO, which will take the input signals from the sensors, and then give the proper output signal to the desired connected device (GSM/GPRS modem, motors, valves, …) after processing.

Arduino Mega:

Figure (5.10) : Arduino Mega [1]

Overview

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. [1]

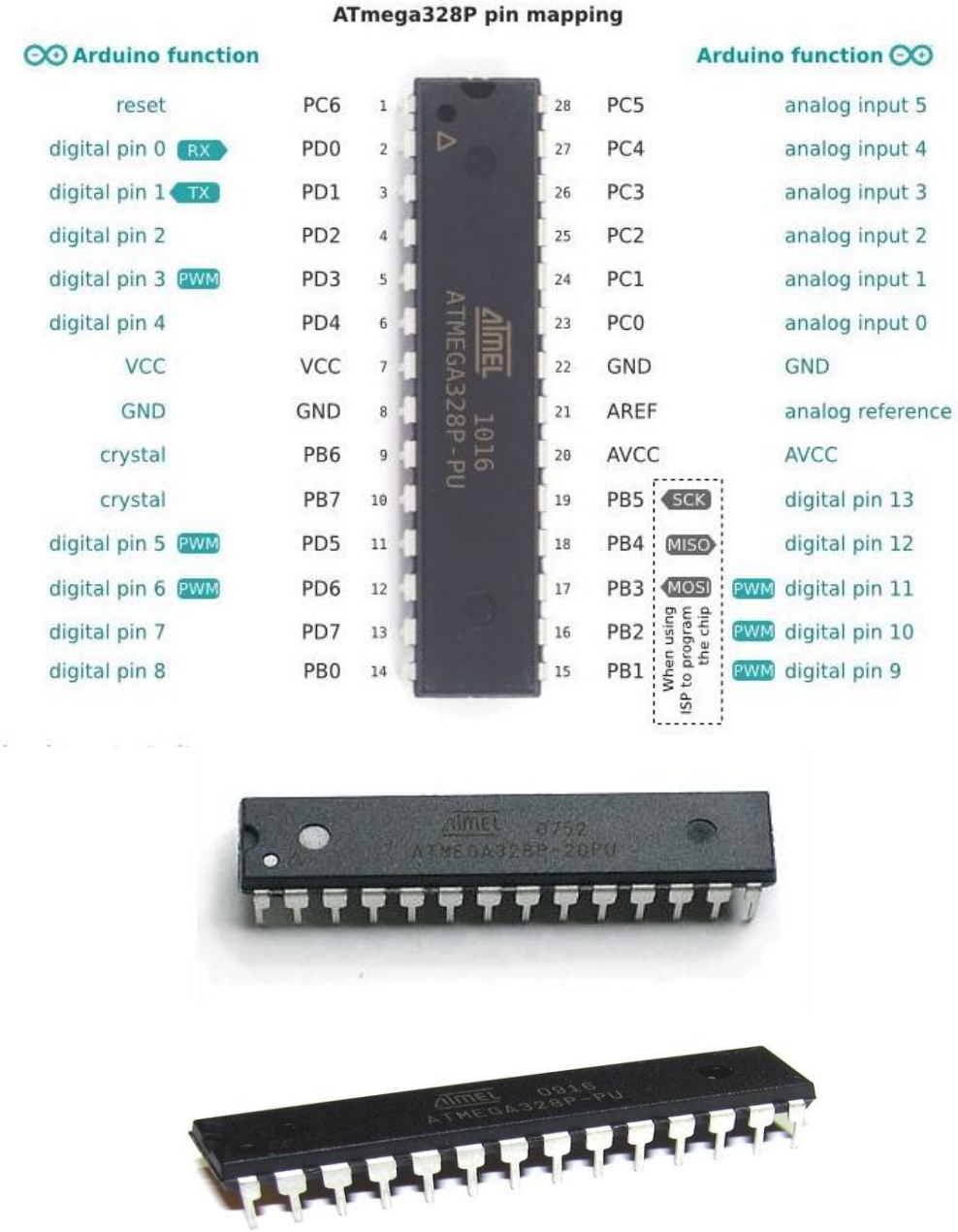


Figure (5.11): Arduino Pin Mapping [2]

2. Ultrasonic Sensor:

Ultrasonic distance sensor provides precise, non-contact distance measurements from about 2 cm (0.8 inches) to 3 meters (3.3 yards). It is very easy to connect to microcontrollers, requiring only one I/O pin.

This sensor works by transmitting an ultrasonic (well above human hearing range) burst and providing an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring the echo pulse width the distance to target can easily be calculated. [9]

Features

• Supply Voltage – 5 VDC

• Supply Current – 30 mA typ; 35 mA max

• Range – 2 cm to 3 m.

• Echo Pulse – positive TTL pulse, 115 uS to 18.5 ms

• Burst Frequency – 40 kHz for 200 µs

• Delay before next measurement – 200 µs

3. Valve:

We will use this device as a switch, to enable the water to go through the pipe or not, it will be controlled from the Arduino, and it will be put after the AC pump.

Figure (5.12): Solenoid Valve.

4. GSM/GPRS Shield:

The Arduino GSM/GPRS shield allows an Arduino board to connect to the internet using the GPRS wireless network, sends and receive SMS, and make voice calls using the GSM library.

The shield will work with the Arduino Uno out of the box. The shield will work with the Mega, Mega ADK, and Leonardo boards with a minor modification. [5]

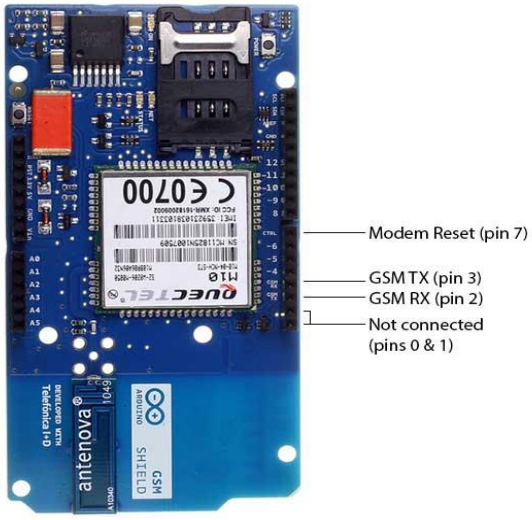


Figure (5.13): GSM/GPRS Shield [5]

Network operator requirements:

To access a network, we must have a subscription with a mobile phone operator (either prepaid or contract), a GSM compliant device like the GSM shield or mobile phone, and a Subscriber Identity Module (SIM) card. The network operator provides the SIM card, which contains information like the mobile number, and can store limited amounts of contacts and SMS messages. [5]

SIM cards:

In addition to the GSM/GPRS shield and an Arduino, we need a SIM card. The SIM represents a contract with a communications provider. The communications provider selling the SIM has to either provide GSM/GPRS coverage where we are.

The SIM must be inserted into a powered GSM/GPRS shield that is mounted on an Arduino for activation, this SIM card come without a PIN, but it is possible to set one using the GSM library's GSMPIN class. [4]

Power requirements:

It is recommended that the board be powered with an external power supply that can provide between 700mA and 1000mA. Powering an Arduino and the GSM shield from a USB connection is not recommended, as USB cannot provide the required current for when the modem is in heavy use.

The modem can pull up to 2A of current at peak usage, which can occur during data transmission. This current is provided through the large orange capacitor on the board's surface. [5]

5. Solid State Relay:

A solid-state relay is an ON-OFF control device in which the load current is conducted by one or more semiconductors - e.g., a power transistor, an SCR, or a TRIAC.

Like all relays, the SSR requires relatively low control circuit energy to switch the output state from OFF to ON, or vice versa. Since this control energy is very much lower than the output power controllable by the relay at full load,"power gain" in an SSR is substantial--frequently much higher than in an electromagnetic relay of comparable output rating. To put it another way, the sensitivity of an SSR is often significantly higher than that of an EMR of comparable output rating. [11]

Figure (5.14): Solid State Relay [12]

Specifications:

- Load Current: 40A
- Load Voltage: 5-220V AC Actual (24-220V AC Marked)
- Control Voltage: 3-32V DC
- Control Current: 5-25mA DC
- On Voltage: ≤2.3VDC
- On-off Time: ≤10mS
- Insulation Resistance : 500M ohm/500VDC
- Ambient Temperature.: -30℃～75℃
- Working indicators: LED

Main Applications:

1. Welding machines/DC
2. Motor control,AC motor

6. Centrifugal pump AC:

This device is an AC motor operates on 220v, and will be used to pump the water from the desired water source to the desired small tanks.

Figure (5.15): Centrifugal Pump [10]

Quick Details

1. Structure: Single-stage Pump
2. Usage: Water
3. Power: Electric
4. Fuel: Electric
5. Horse Power: 0.5-2.0 HP
6. Voltage: 110V/ 220V/230V/240V/380V
7. Frequency: 50HZ/60HZ

5.5 Class and Object Design:

This section gives more implementation details about each class attribute and operation. (Software components).

Sensors Class.

The sensor class shows the attribute and the operation for the sensor, that we have in our system more than one type of sensor, such as ultrasound sensor and pressure sensor.

The sensor class is as follows

Table (5.1): Sensors Class.

Class: sensors.
-Sensor ID.
-Sensor location.(small tanks, wells,)
-Sensor type.
-The number of sensor.
+Sense the level of water in the small tank ( ).
+Measure the pressure of water in water line company ( ).
+ Send the signal to the microcontroller. ( )

Class Name: Sensors.

Attributes:

a) Sensor ID. : int

Sensor ID is a sensor identification number of type positive integer. It is a public attribute. It is used in order to authenticate the sensor with the system.

That we have more than one sensor in our system, each sensor have unique ID or number.

b) -Sensor location: int

Sensor location is a positive integer. It is a public attribute. It is used in order to authenticate the sensor location that is in small tank or water source (well).

It is represented as foreign key from small tanks class or water source.

c) -Sensor type: string.

Sensor type is string variable. It is a public attribute. It is used in order to identify the type of sensor.

d) -The number of sensor: int.

The number of sensor is a positive integer. It is a public attribute. It holds the number of sensors that will be used in our system.

Operations:

a) +Sense the level of water in the small tank ( ).

+Sense the level of water in the small tank () is a public function which does not return any value. When this function is called, the sensor senses the level of water.

b) +Measure the pressure of water in water company line ( ).

+Measure the pressure of water in water company line ( ) is a public function which does not return any value. When this function is called, the sensor senses the pressure of water in Water Company Line.

c) + Send the signal to the microcontroller. ( )

+ Send the signal to the microcontroller. ( ) is a public function. When this function is called, the reading of sensor is sent to the microcontroller.

Small Tanks Class.

The small tanks class shows the attribute and the operation for the small tan, that in our system we have many small tanks; each can fill from multiple water sources.

Table (5.2): Small Tanks Class.

Class: Small Tanks.
- Tank ID.
- Tank state (full, empty).
- Water level.
- The water source.
- The number of small tanks.

Class Name: Small Tanks.

Attributes:

a) -Tank ID: Int

Tank ID is a tank identification number of type positive integer. It is a public attribute. It is used in order to authenticate the tank with the system.

That we have more than one tank in our system, each tank has a unique ID or number.

b) Tank state: Boolean

Tank state is Boolean identifier. It is used in order to identify the state of the tank that is full or empty, zero (0) represents empty, one (1) represents full.

c) Water level: double.

Water level is a value of type double. It is a public attribute. It is used to show the level of water when the user requests for it.

d) The water source: int

The water source is a value of type int. it is a public attribute. That it is used to identify the water of source that we will used to fill that small tank (depend on the ID of tank). It is represented as foreign key from water source class.

e) The number of small tanks: int

The number of small tanks is a positive integer. It is a public attribute. It holds the number of small tanks that will be used in our system.

Pumps Class.

The pumps class shows the attribute and the operation for the pump, that in our system we have many pumps, used to pump the water from multiple sources to different tanks.

Table (5.3): Pumps Class.

Class : pumps.
- ID
- Pumps type.
- Water source.
+ Take the command from micr( )
+ The state of the motor (on/off ( )
+ The number of pumps needed( )

Attributes:

a) ID: int

Pump ID is a pump identification number of type positive integer. It is a public attribute. It is used in order to authenticate the pump with the system.

That we have more than one pump in our system, each pump has a unique ID or number.

b) Pumps type.

Pump type is string variable. It is a public attribute. It is used in order to identify the type of pump.

- C) Water source: int

  The water source is a value of type int. it is a public attribute. That it is used to identify the water source that will be used to fill the small tanks by using the pump (depends on the ID of the pump). It is representing as foreign key from water source class.

Operations:

a) + Take the command from micr(boole)

Take the command from micr ( ) is a public function which does not return any value. When the function is called, it takes Boolean variable from the micro, if it is zero turn off, if it is one (1) turn on.

b) + The state of the motor (on/off (): Boolean.

The state of the motor () is Boolean function that doesn't take any value and returns 0 if the pump is off, or returns 1 if the pump is on.

c) + The number of pumps needed( )

The number of pumps needed ( ) is integer function, doesn't take any value and returns the number of pumps in the system.

Microcontroller Class.

The microcontroller class shows the attribute and the operation of the microcontroller, that in our system the microcontroller is the primary component, the microcontroller used for controlling components in our system.

Table (5.4): Microcontroller Class.

Class : Microcontroller.
- Microcontroller pins (input, output).
+ Receives signal from pressure sensors ( )
+ Receives signal from ultrasonic sensors. ( )
+ Processes the signals. ( )
+ Sends commands to the motors (on/off). ( )
+ Send the data to the GSM modem. ( )
+ Receive the data from the GSM modem. ( )

Operations:

a) - Microcontroller pin (input, output).

Microcontroller pin (input, output) is a private variable that takes two values input and output for the pins connected with different components.

b) + Receive signals from the pressure sensors ( )

Receive signals from the pressure sensors ( ), this public function takes values from pressure sensors.

c) + Receive signals from ultrasonic sensors ( )

Receive signals from ultrasonic sensors ( ), this public function takes values from ultrasonic sensors.

d) + Process the signal( )

Process the signal ( ), this public function doesn't take value, when signal is received from different sensors; this function processes them and returns a value.

e) + Send commands to the motors (on/off). ( )

Send commands to the motors (on/off). ( ), is a public function used to send one for turning on a motor, or zero for turning off a motor (Controlling the motor).

f) + Send the data to the GSM modem ( ).

Send the data after processing the incoming signals from the different components in the system, such as motors state, water level, water availability, valve state,... to the connected GSM and then, the GSM will send this data as a message to the user mobile.

g) + Receive the data from the GSM modem ( ).

Receive the data from the GSM modem after the user sent a message to the system, to achieve any goal, such as knowing the motors state , water level, water availability, valve state, or controlling the state of any component (on/off, open/close). And all these cases depend on the user commands nature sent from the mobile application to the GSM modem.

GSM Class.

The GSM class show the attribute and the operation of the WIFI/GSM, that in our system the WIFI/GSM used to send and receive message between mobile application and microcontroller.

Table (5.5): GSM Class.

Class : GSM
GSM modem type.
AT command.
+ Connect the mobile with micro. ( )
+ Send a message to the mobile ().
+ Receive a message from the mobile ().
+ Send the data to Microcontroller. ( )
+ Receive the data from the Microcontroller. ( )

Attributes:

a) GSM modem type: string

The GSM modem type is a value that type of a string, it is a public attribute. That identify the GSM and it helps its configuration with the microcontroller.

b) AT command: string

AT command is a command used to program a GSM modem.

Operations:

a) + Connect the mobile with micro. ( )

Connect the mobile with micro. ( ), this function used to initialize a connection between microcontroller and GSM modem.

b) + Send a message to the mobile ().

Send a message to the mobile ( ) , this function is used to send text message to user mobile to tell the owner what is going on in the system.

c) + Receive a message from the mobile ().

Receive a message from the mobile ( ), this function is used to receive a message from the mobile to tell the system what to do.

d) + Send the data to microcontroller. ( )

Send the data to the connected Microcontroller after receiving a message from the user mobile, to achieve any goal, such as knowing the motors state , water level, water availability, valve state, or controlling the state of any component (on/off, open/close). And all these cases depend on the nature user commands sent from the mobile application to the GSM modem.

e) + Receive the data from the microcontroller. ( )

Receive the data after processing the incoming signals from the different components in the system, such as motors state, water level, water availability, valve state,... from the connected Microcontroller. And then, the GSM will send this data as a message to the user mobile.

Application Class.

The application class shows the attribute and the operation of the application, that in our system the application is used to control and manage the water level.

Table (5.6): Application Class.

Class : Application
- Mobile application.
- PC application.
+ Send command to control and manage the water level system. ( )
+ Receive massages about the state of tanks and wells. ( )
+ Show the level of water in the small tanks and wells. ( )

Attributes:

a) Mobile application.
   Is a Boolean attribute, when it is 1 the controlling and management is from mobile.

b) PC application.
   Is a Boolean attribute, when it is 1 the controlling and management is from computer.

Operations:

a) + Send command to control and manage the water level system. ( )
   This function is used to send SMS change the state of any component in the system, such as running the pumps or stop them, open the required valve or close any one, choose the required water source and the proper small tanks in the process, etc.

b) + Receive massage about the state of tanks and wells. ( )

This function receives messages from GSM modem if it is mobile application, and so the user can know the current state any time. Or it can receive data if it is a computer application when asking for any state.

c) + Show the level of water in the small tanks and wells.( )

This function is used for showing the states of different water sources as will as the small tanks through SMSs in the case of mobile, or data sending in the case of computer. Also, in the case of empty/full small tanks or wells, the system will send a message to the user mobile to till him the new state over the GSM network, whatever the application used is.

Water Source Class.

The water source class shows the attribute and the operation of water source in our system.

Table (5.7): Water Source Class.

Class :Water Source
- Water source ID
- Water source type.
- The pressure of water in water company line.
- The state (full, empty).
- The water level sensor.
- The water level in the well.
- The number of wells.
- The number of other water source.
- The pumps that connect on the water source.

Attributes:

1) Water source ID: int.

   Water source ID it attribute used to give every water source number to distinguish between them.

2) Water source type: string

   Water source type is an attribute used to give every water source different type to distinguish between tanks and wells.

3) The pressure of water in water company line: int

   The pressure of water in water company line is an attribute used to give pressure of water available at the line.

4) The state (full, empty).:boole

   The state (full, empty) is an attribute used to give the state zero if the reservoir is empty or one if it is full.

5) The water level sensor: int

   The water level sensor is an attribute used to give the sensor a number.

6) The water level in the well : int

   The water level in the well is an attribute used to give the water level presents in wells.

7) The number of wells: int

   The number of wells is an attribute used to give the well a number.

The Dependencies Between All Classes:

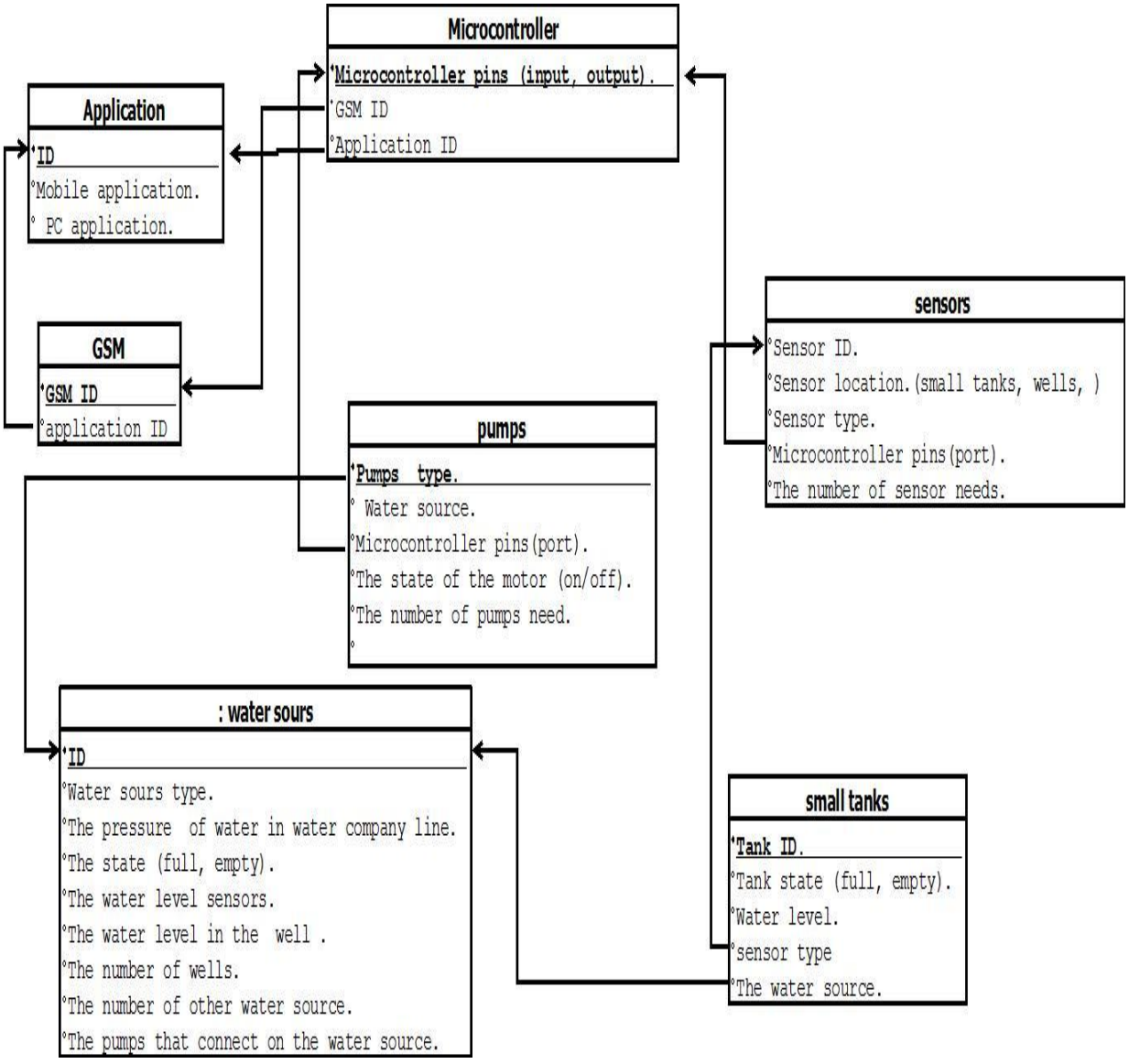


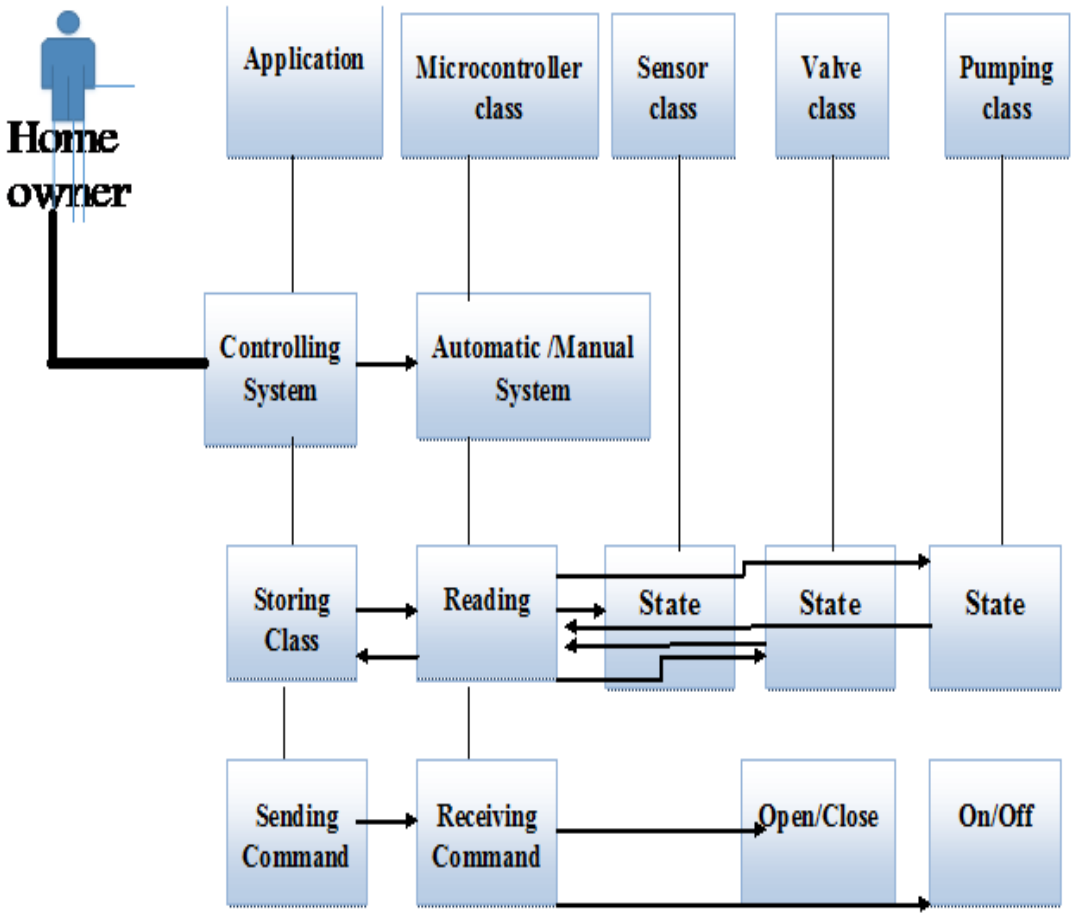
Figure (5.16): The Dependence Between All Classes Diagram.

5.6 Software Interface Design:

In this section we explain the dependencies between classes by using sequence diagram, and then we explain boundaries of classes by graphical user interface designing

5.6.1 Object Interfacing

In this subsection we explain the dependencies between classes by using sequence diagram.



5.6.2 User Interface Design.

In this subsection we explain the boundary interfaces, external interfaces.

A- For PC :

The following platforms will be displayed to the user on the pc in order to interact with the management and controlling system.

Figure (5.17): PC Platform For Main Page.

For figure (5.17) the user choose controlling method (Manual, Automatic).

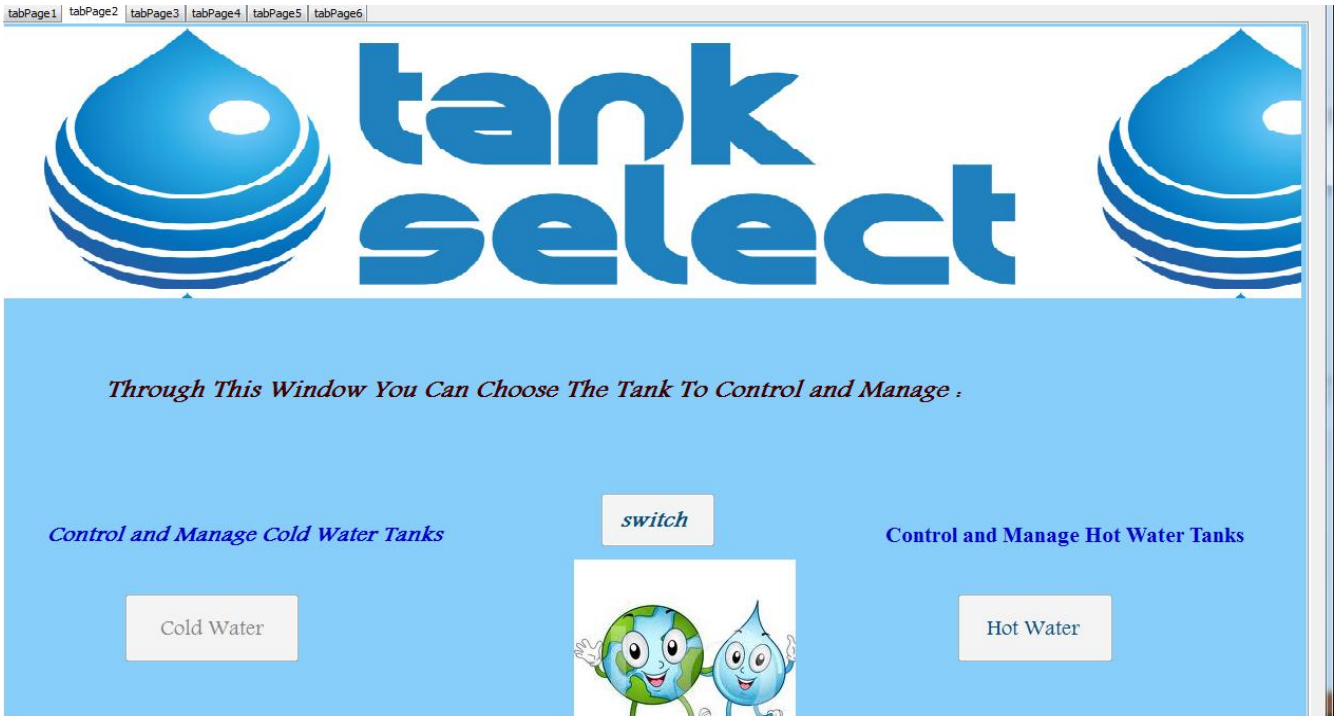


Figure (5.18) : PC Platform To Select The Water Tanks.

If the user selects the manual method ,then the system enable the user to select the tank to be managed and controlled as shown in the figure (5.18).

Either the user selects the hot water or the cold one , the system enables him to check the water level in the tanks , check water availability for wells suitable for pumping, and stop pumping, as shown in figure(5.19) and figure(5.20).

Figure (5.19) : PC Platform To Control and Manage Cold Water Tanks.

Figure (5.20) : PC Platform To Control and Manage Hot Water Tanks.

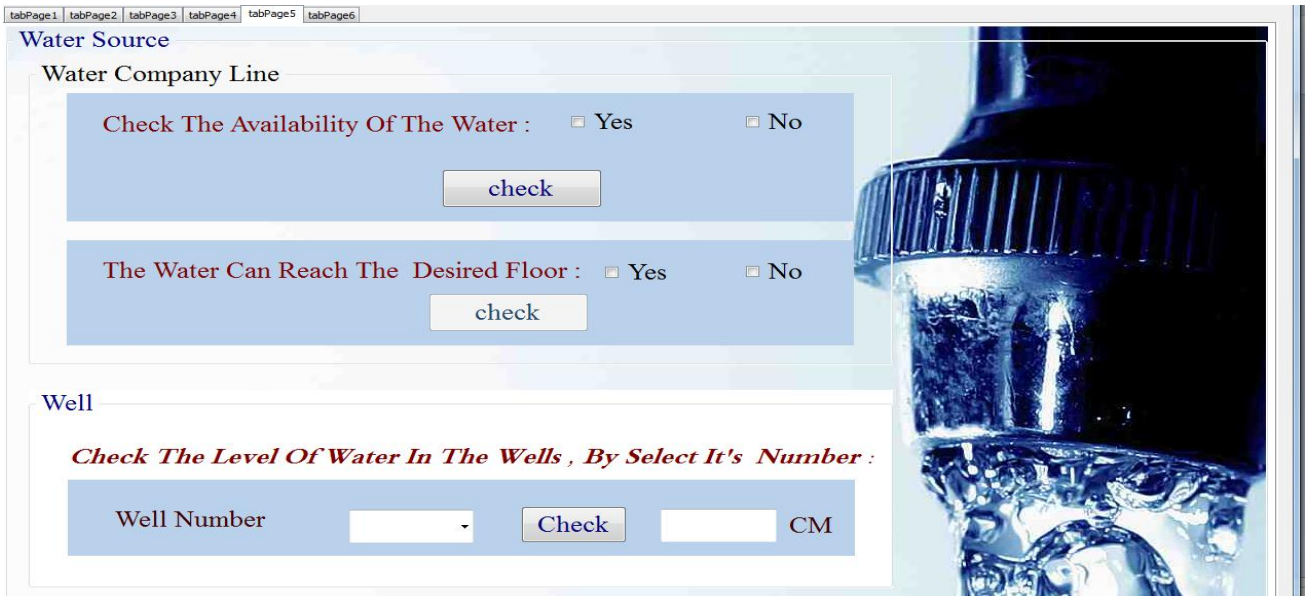


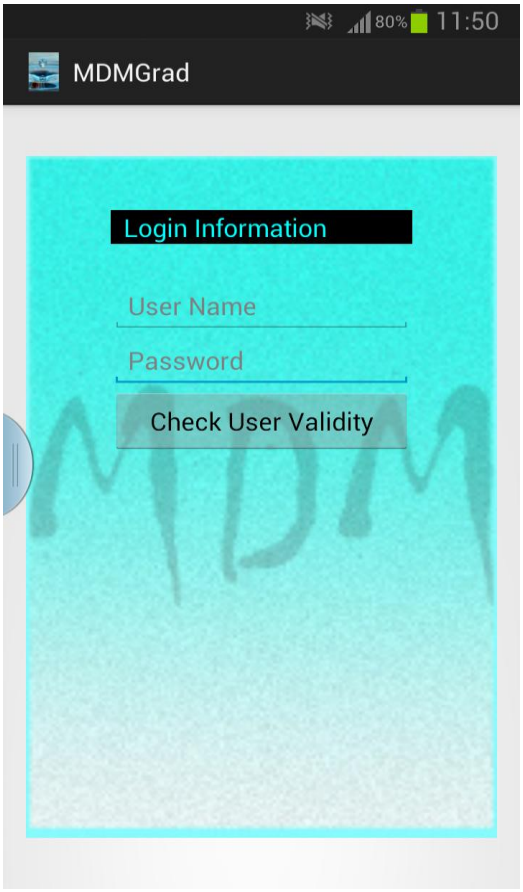
Figure (5.21) : PC Platforms To Check Water Source.

For figure(5.21)the user can check the water availability for the company line, then select the destination for this water if any, also the user can heck the water level for well.

B-For Mobile:

The application is made on the mobile to access the system for controlling and management is as follows:

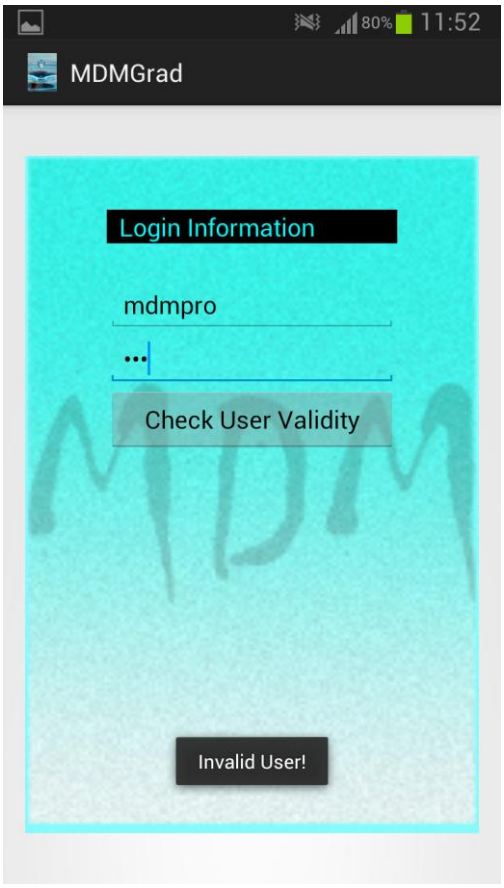
Fig(5.22): Mobile Application Icon



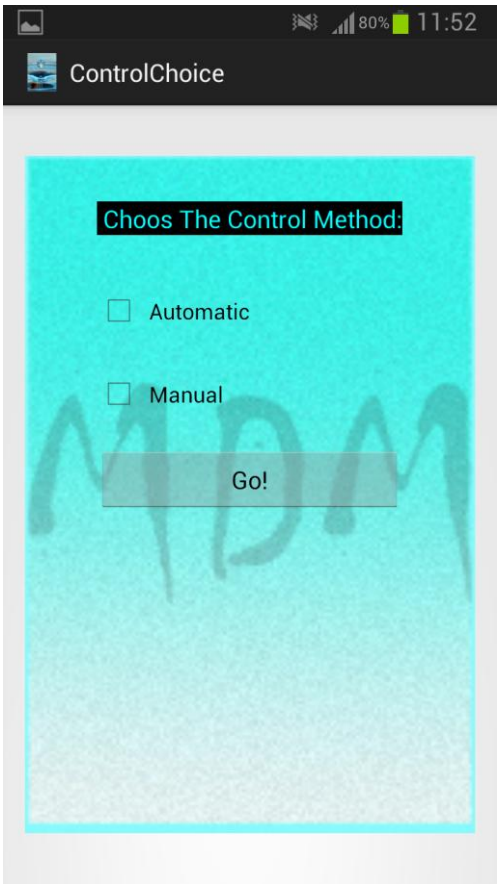
Fig(5.23): Mobile App Main Page

When you access the application, first you will hear the name of the project "Welcome To Mobile Based Water Level Management & Controlling System".

Then, you asked to enter your username and password, if at least one of them is wrong , then you will not be able to continue, enter the correct information to complete your access.

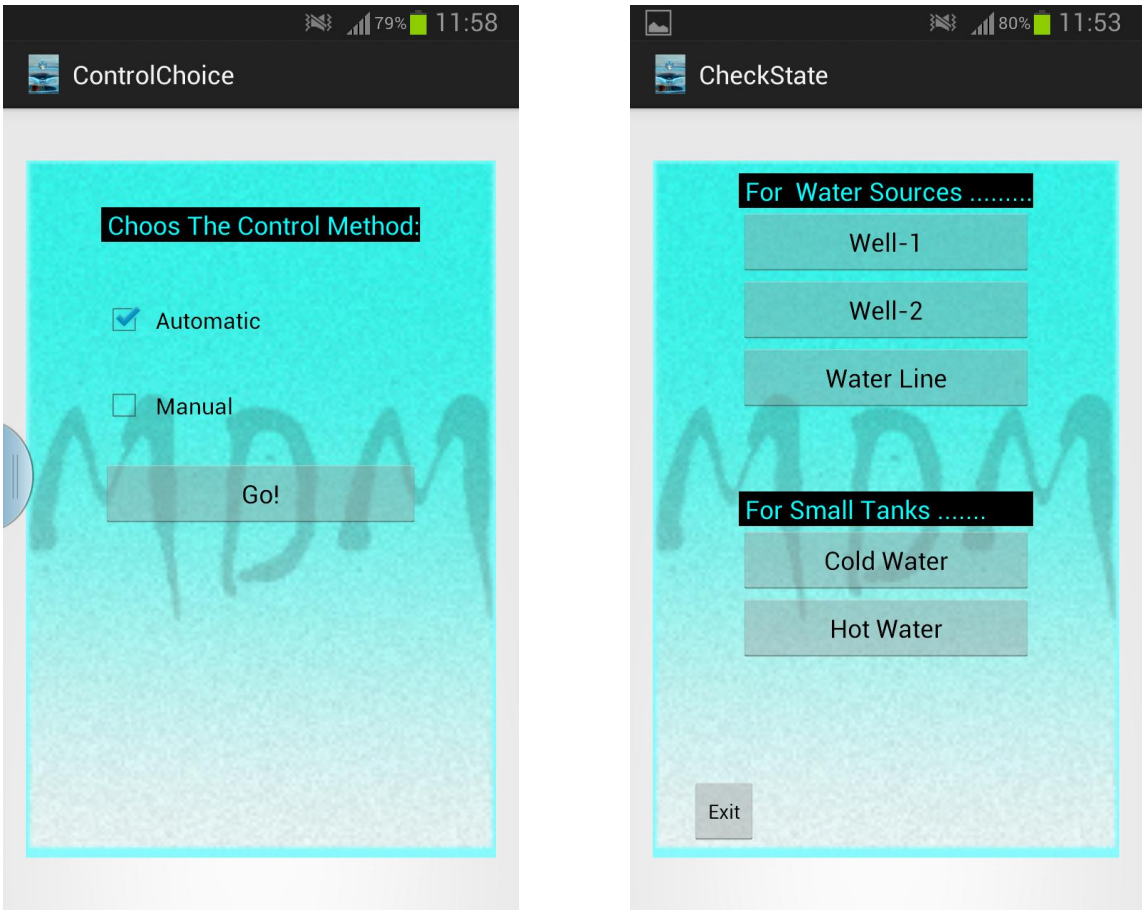


Fig(5.24):Wrong Access For Mobile App



Fig(5.25):Control Choices In Mobile App

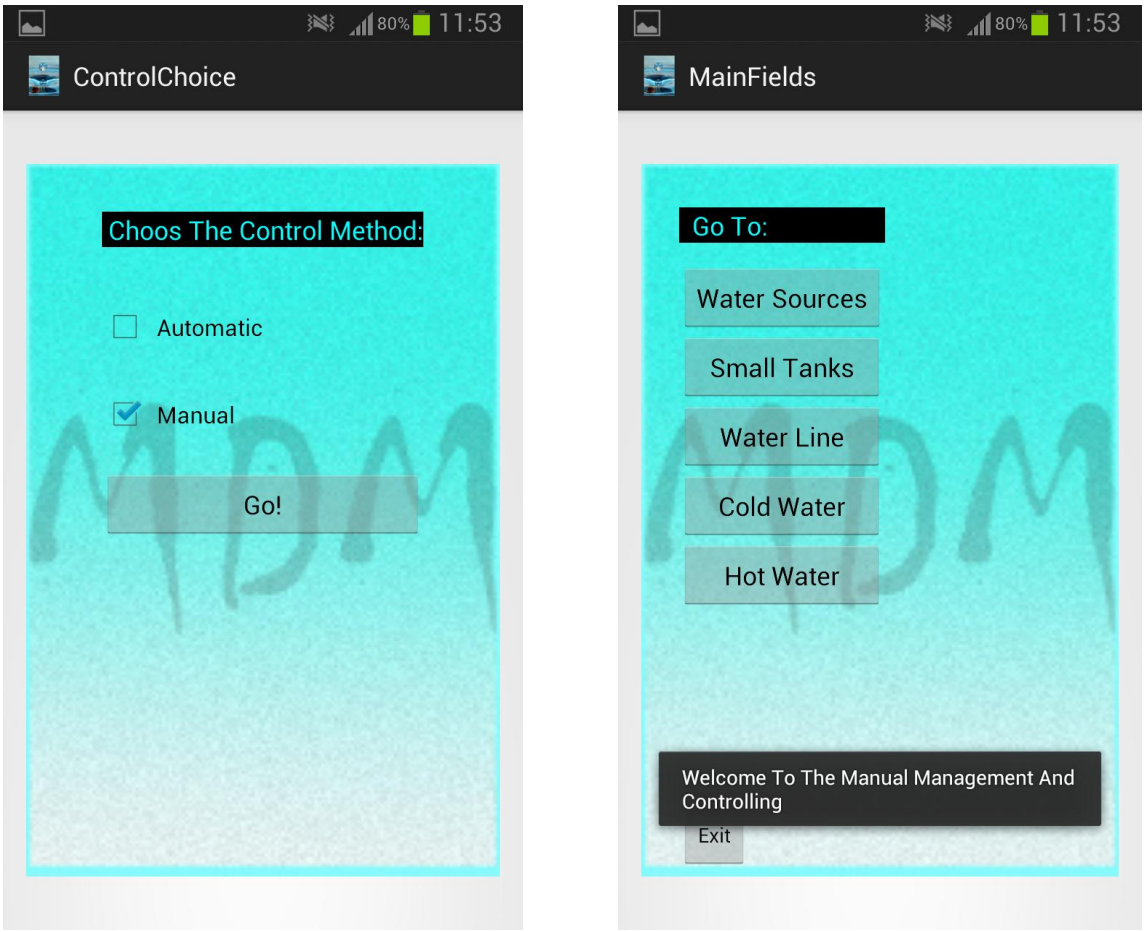
Then, you can choose your control method , either manually ore automatically. If you choose the first one, you can do many thing, such as pumping, stop pumping, checking the states. But if you choose the second one, then you can only check the states for water sources and small tanks.



Fig(5.26):Automatic Controlling Via Mobile App & Its Allowed List For Checking States Only.

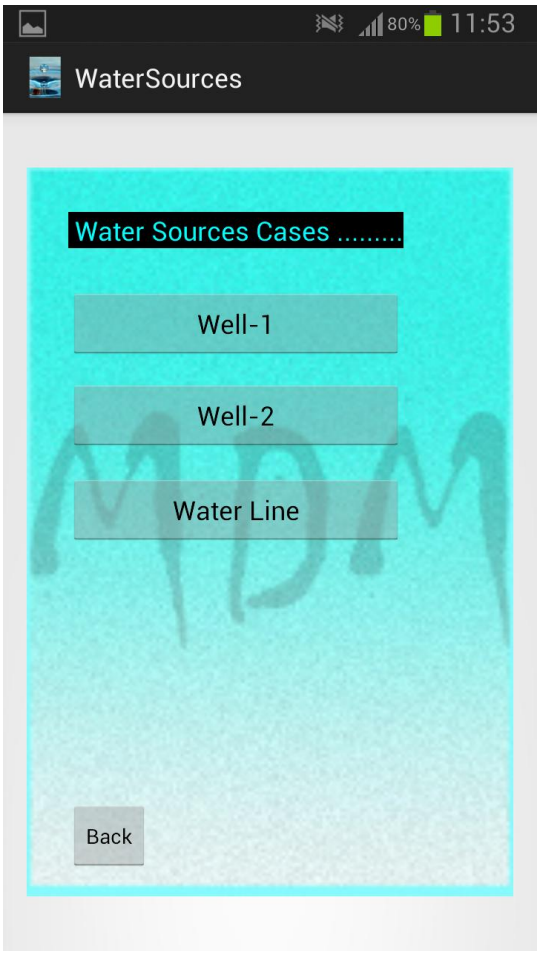
In Automatic controlling, the system chooses the water source (depending on the written algorithm) to fill the empty well or the empty tank, and stop the filling automatically when it is full.

The user will know what happened in the system, he/she will receive sms to till about empty or full state.

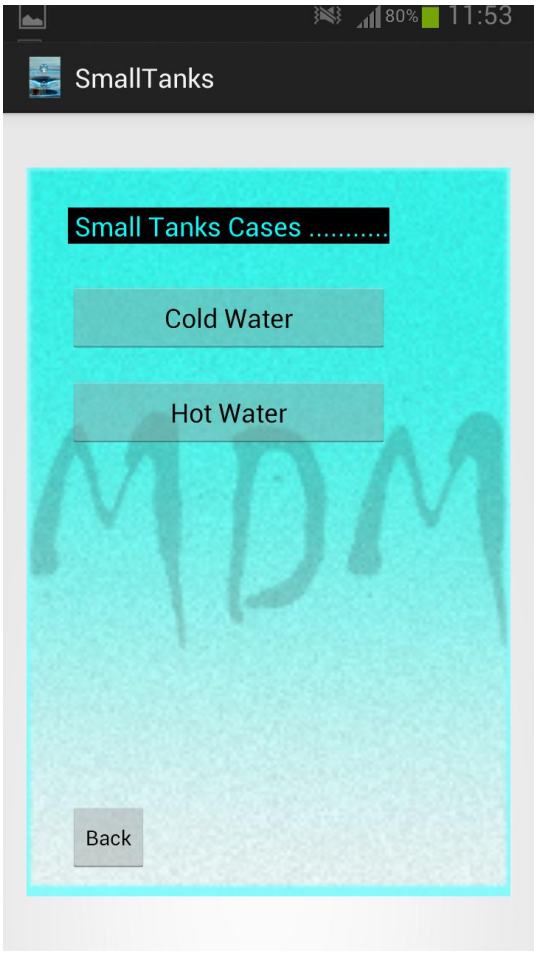


Fig(5.27): Manual Controlling Via Mobile App & Its Main Fields.

When you open the manual list, you can go through many fields, to know the water level in each water source as will as the small tanks, run or stop pumping from any water source to any well or tank.

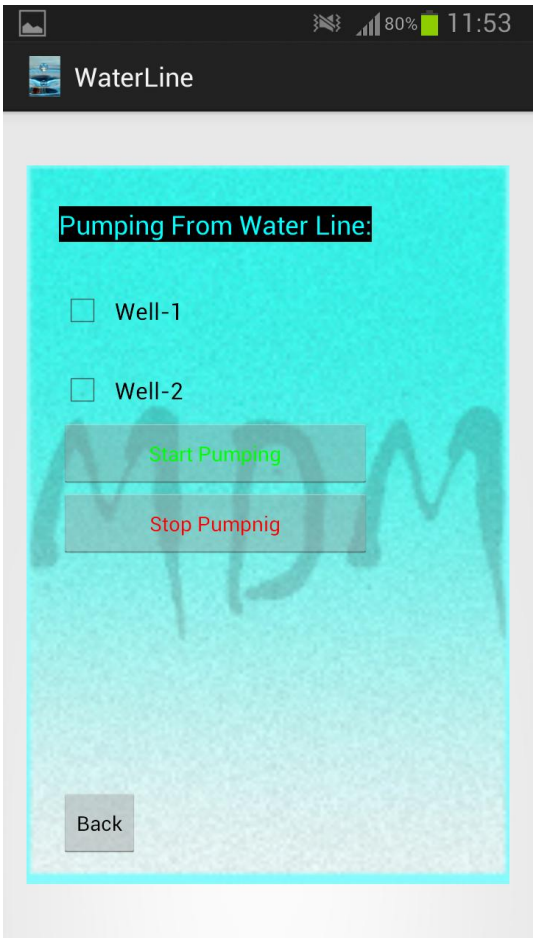


Fig(5.28):Check State For Water Sources Via Mobile App.



Fig(5.29):Check State For Small Tanks Via Mobile App.

For pumping, this application allows pumping from one source to multiple destinations, and so, the tank for example will be filled from one source at a time.

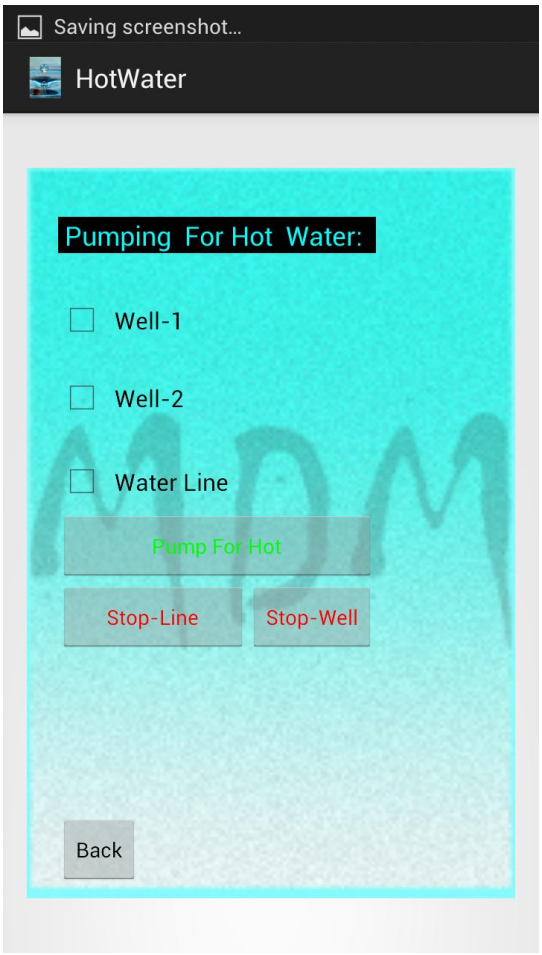


Fig(5.30):Water Line Pumping Via Mobile App

Fig(5.31):Cold Water Pumping Via Mobile App

From any field, the user can return to the main fields list to go to another one if he/she want.

Finally, to exit from the application, the user can press the "Exit" button to go back to the control choice page.



Fig(5.32): Hot Water Pumping Via Mobile App.

5.7 Hardware Interface Design:

At this section, we will talk about the interfaces between the hardware components, how they should connect to have the desired system design, and finally, the interaction between the hardware and software to achieve our designed system's goal.

5.7.1Component Interfacing:

Now, we want to explain how the hardware components will be connected with each other, and the additional devices maybe used to make the design correct.

1. Sensor and Arduino Mega interface:

As we mentioned before, the sensors will be used(ultrasonic, pressure) to test the water level in the wells and in the small tanks, also the water availability on the water company line, and then send the signal to the Arduino to be processed.

We will explain the interface between the suggested sensors and the Arduino kit, the pins will be used, the required current or voltage level… .

1. **Ultrasonic sensor**:

An ultrasonic range finder detects the distance of the closest object in front of the sensor (from 2 cm up to 3m). It works by sending out a burst of ultrasound and listening for the echo when it bounces off of an object. The Arduino board sends a short pulse to trigger the detection, then listens for a pulse on the same pin using the **pulse In()** function. The duration of this second pulse is equal to the time taken by the ultrasound to travel to the object and back to the sensor. Using the speed of sound, this time can be converted to distance. [3]

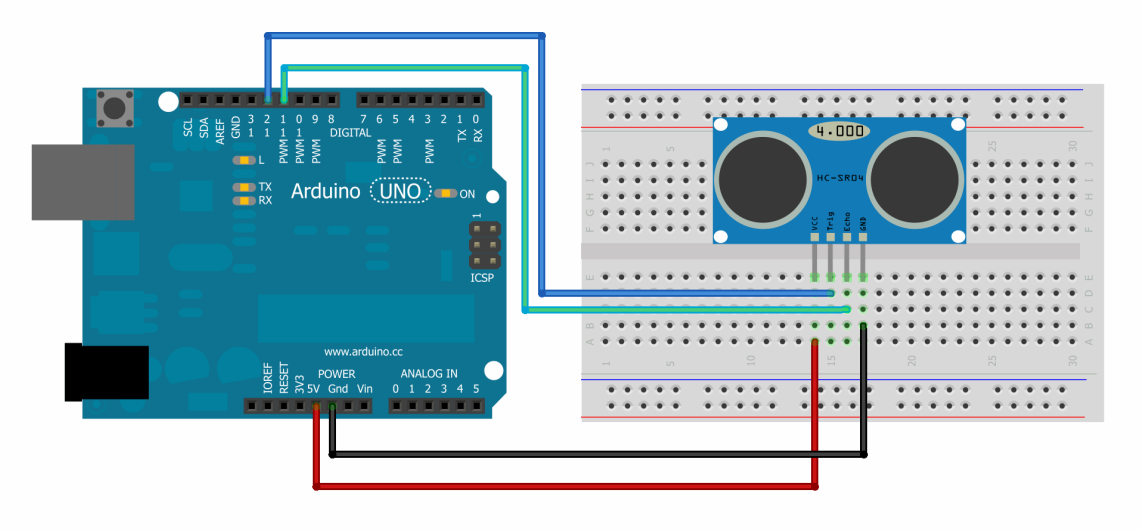


Figure (5.33): Arduino With Ultrasonic Sensors Schematic [3]

2.GSM/GPRS shield with Arduino Mega:

We will use the GSM/GPRS shield together with Arduino kit to have a wireless communication between the mobile and the system through the GSM network.

Based on this communication, the user can take multiple decisions, starting from testing the water level, choose the proper water source and the proper tanks, turn on the pumps, or stop working them, receive messages about the current state.

When the Arduino kit processed the incoming data from the sensors, a communication between the mobile and the kit maybe established according to the incoming results.
If the sensor senses no water or the water is full, the GSM/GPRS modem will send a message to the mobile to till him the current situation.

When the Arduino kit processed the incoming data from the sensors, a communication between the mobile and the kit maybe established according to the incoming results.
If the sensor senses no water or the water is full, the GSM/GPRS modem will send a message to the mobile to till him the current situation.
Also, the user can send a message to GSM/GPRS modem to ask for the water level or availability any time.

Finally, the user can send a command message, to inform the kit to run the pumps or stop running them.

Now, we want to talk about the connection between the GSM/GPRS shield and the Arduino kit.

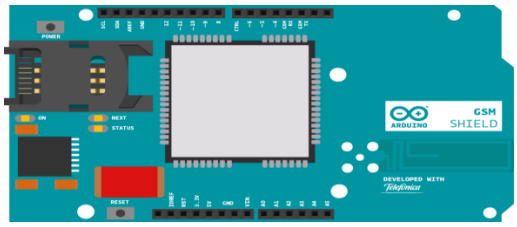


Figure (5. 34): Image Of The Arduino GSM Shield On Top Of an Arduino Uno [6]

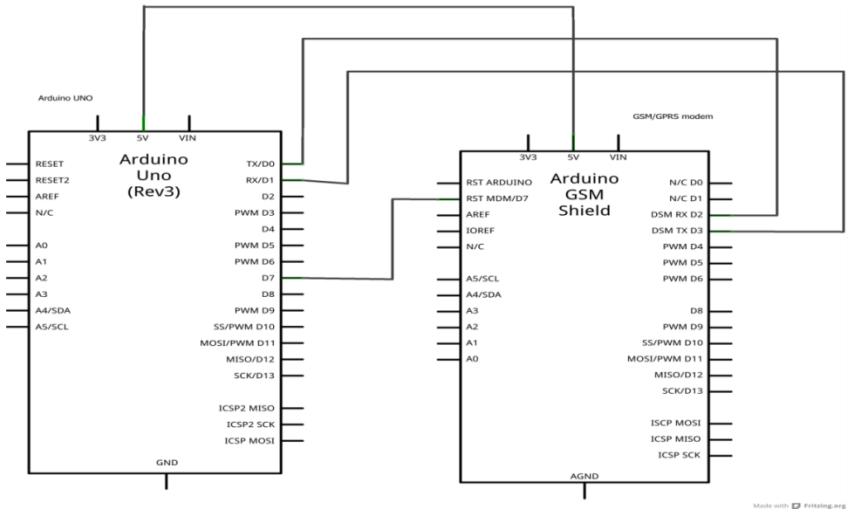


Figure (5.35): Arduino With GSM/GPRS Shield Connection.

Hardware Required:

1. Requires and Arduino board

2. Operating voltage 5V (supplied from the Arduino Board)

3. Connection with Arduino Uno on pins 2, 3 (Software Serial) and 7 (reset).

The shield uses digital pins 2 and 3 for software serial communication with the M10. Pin 2 is connected to the M10's TX pin and pin 3 to its RX pin. The modem's PWRKEY pin is connected to Arduino pin 7.

The M10 is a Quad-band GSM/GPRS modem that works frequencies at GSM850MHz, GSM900MHz, DCS1800MHz andPCS1900MHz. It supports TCP/UDP and HTTP

protocols through a GPRS connection. GPRS data downlink and uplink transfer speed maximum is 85.6 kbps.

Once you insert the SIM in the shield, mount it on top of an Arduino board.

Figure (5.36): Arduino With GSM/GPRS Shield [4]

You can upload sketches to the board by connecting it to your computer with a USB cable and upload your sketch with the Arduino IDE. Once the sketch has been uploaded, then we can disconnect the board from our computer and power it with an external power supply.

When the yellow status LED turns on, it means the modem is powered, and we can try connecting to the network.

For connecting the pc with the Arduino kit, we use the USB port as the following figure shows.

Figure (5.37): USB Port Connecting PC With Arduino [13]

3. Relay and Arduino Mega interface:

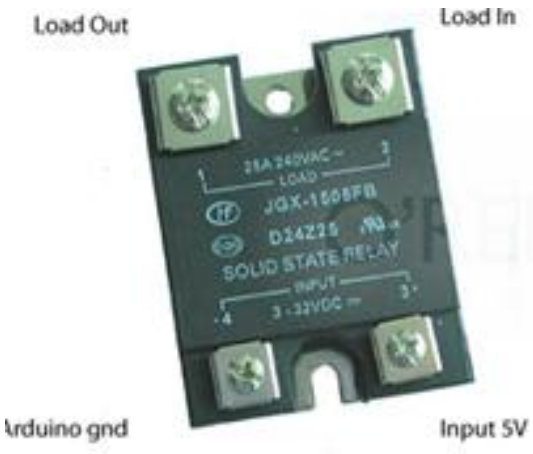


Figure (5.38): SSR

At this part, we will talk about the connection between the Arduino kit and the ac motors. As we know, the centrifugal pump is an AC 220v pump, and the Arduino only gives an output voltage of 5v, and so to make this kind of connection possible we will use a solid state relay, which takes the small voltage from the Arduino, and supply the pump with high ac voltage reaches up to 220v or more.

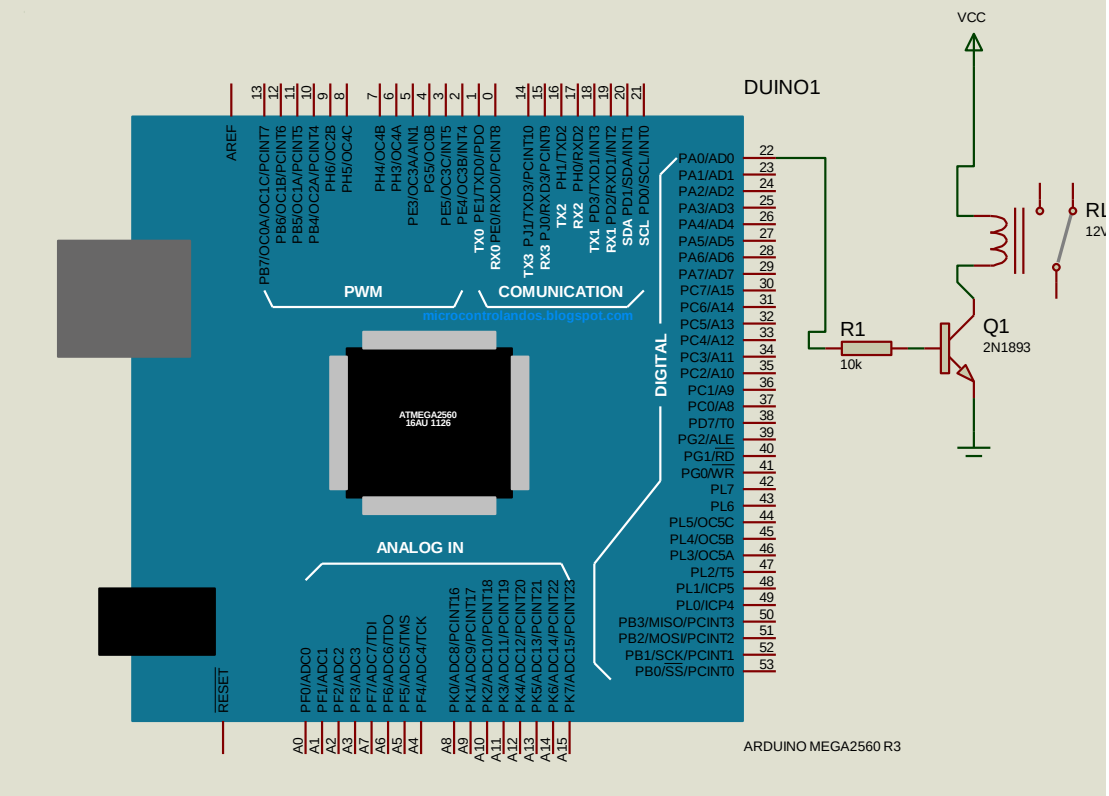


Figure (5.39): Arduino With SSR Circuit.

5.7.2User Interface Design:

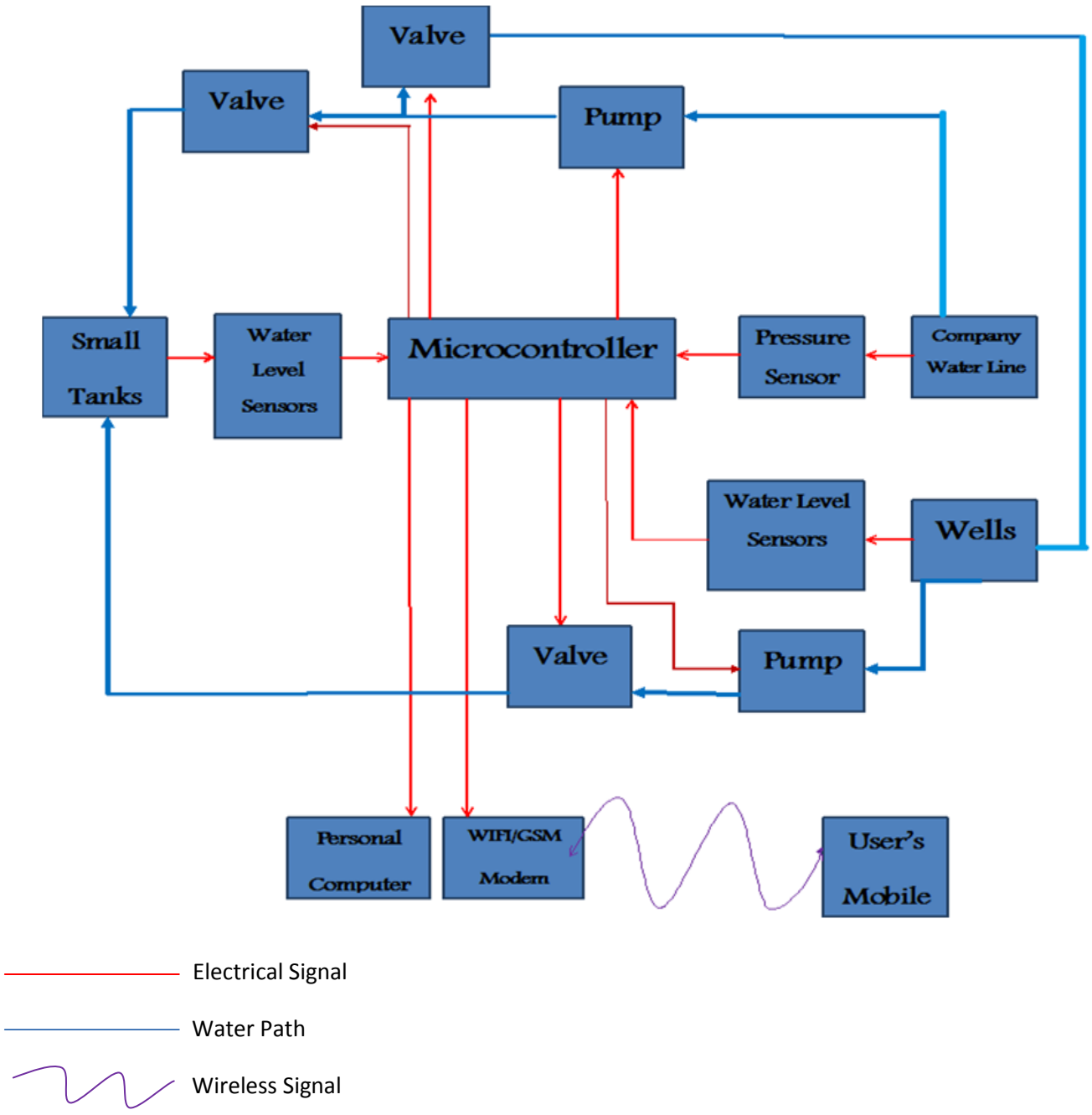


Figure (5.40): System Block Diagram.

5.8 Chapter Summary .

In this chapter we defined the components, modules, interfaces, and data for the system to satisfy specified requirements. We also have drawn control, data, state diagrams and block diagram. In addition to that we have drawn the design of the access control system in order to use it to implement the system.

5.9 References :

1. Arduino Uno ,http://arduino.cc/en/Main/arduinoBoardUno
2. 2- ATMega328P ATMega328 28 PIN DIP IC with Arduino UNO optibootbootloader install, http://www.ebay.in/itm/ATMega328P-ATMega328-28-PIN-DIP-IC-Arduino-UNO-optiboot-bootloader-install-/281105736155#ht_841wt_1037
3. Ping Ultrasonic Range Finder,http://arduino.cc/en/Tutorial/Ping?from=Tutorial.UltrasoundSensor
4. Arduino GSM Shield,**http://arduino.cc/en/Guide/ArduinoGSMShield**
5. Arduino GSM Shield, http://arduino.cc/en/Main/ArduinoGSMShield
6. GSM Test GPRS ,**http://arduino.cc/en/Tutorial/GSMToolsTestGPRS**
7. BROADBAND AND INTERNET ACCESS, http://www.wtec.org/loyola/wireless/03_03.htm
8. Advanced Packet Data Testing with Linux, http://www.linuxjournal.com/article/3724

9. Ultrasonic Distance Sensor, http://www.cs.unca.edu/~bruce/Spring06/180/PING.pdf

10. TOPS QB 0.5hp ac portable small electric vortex peripheral centrifugal impeller clean water pump with motor, **http://www.alibaba.com/product-gs/871775424/TOPS_QB_0_5hp_ac_portable.html**

11. Solid State ReIays, http://www.omega.com/temperature/z/pdf/z124-127.pdf

12. Mager solid state relay ac SSR relay MGR-1 D4840, **http://hence.en.alibaba.com/product/541601567-209436391/Mager_solid_state_relay_ac_SSR_relay_MGR_1_D4840.html**.

13. http://m2msupport.net/m2msupport/communication-tool-for-arduino-gprs-sheilds/

6

CHAPTER SIX

Testing

6.1 Introduction.

6.2 Hardware Testing.

6.3 Software Testing .

6.4 Chapter Summary

6.1 Introduction

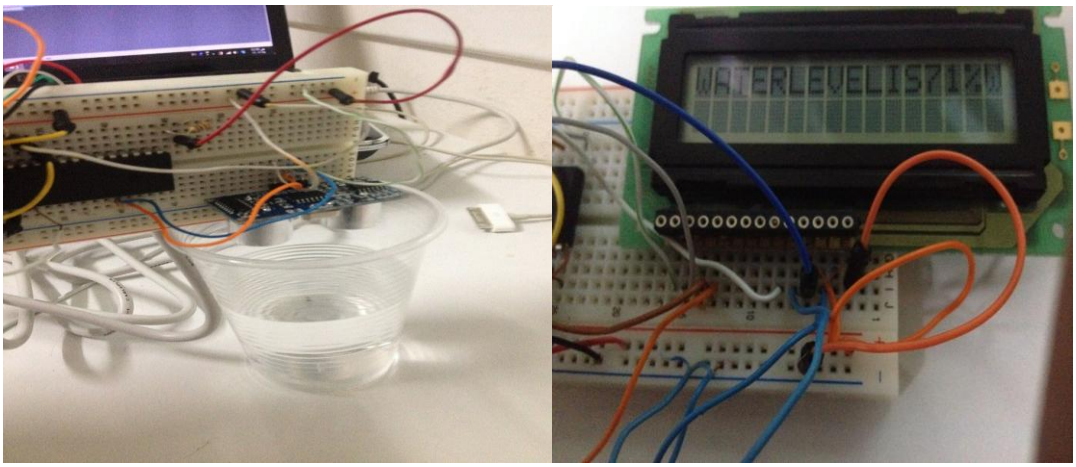
Measuring and testing the performance of the system is the final stage to complete the project. And this chapter gives a detailed description of the project testing performance.

6.2 Hardware Testing

Checking of and testing the results of the project sensors, microcontrollers, modems, valves as follows:

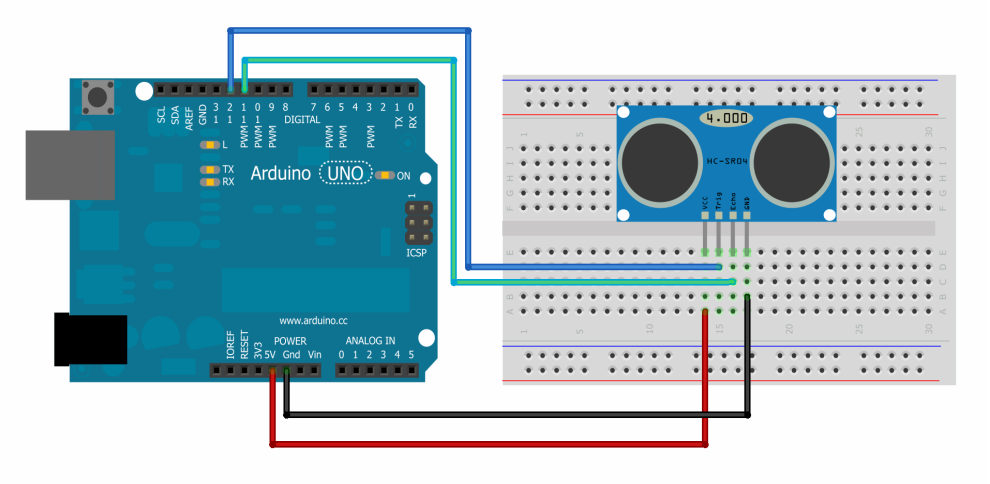
1.**Ultrasonic Sensor Testing :**

Firstly we tested the sensor via pic (18F0455) and used LCD to show the result, here we used C language for programming, as shown in the next figure:



Figure(6.1):Ultrasonic Sensor Test Via PIC

Secondly, we connected the sensor with the arduino mega via four ports (Vcc, GND , trig , echo) as shown below :



Figure(6.2): Ultrasonic Sensor Connection

The result is shown at the serial monitor as shown below:

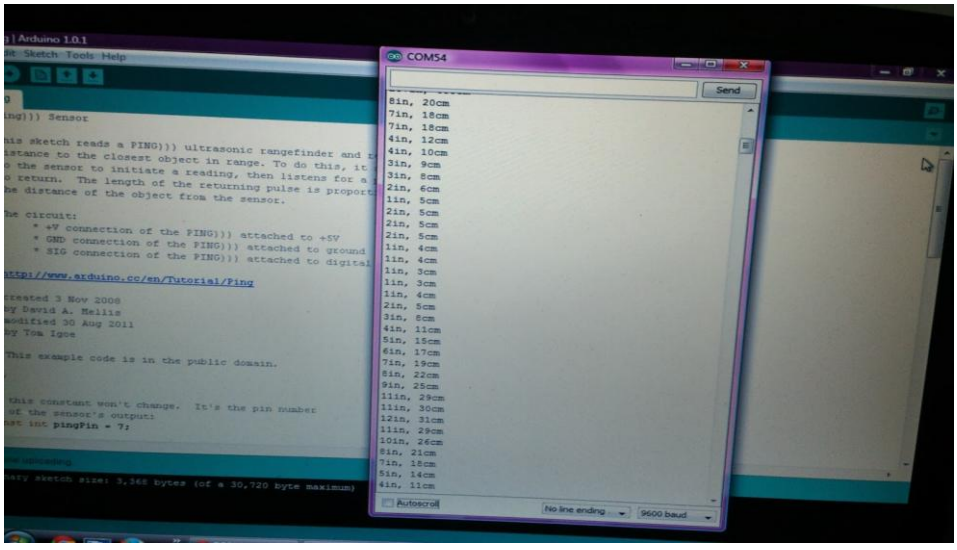


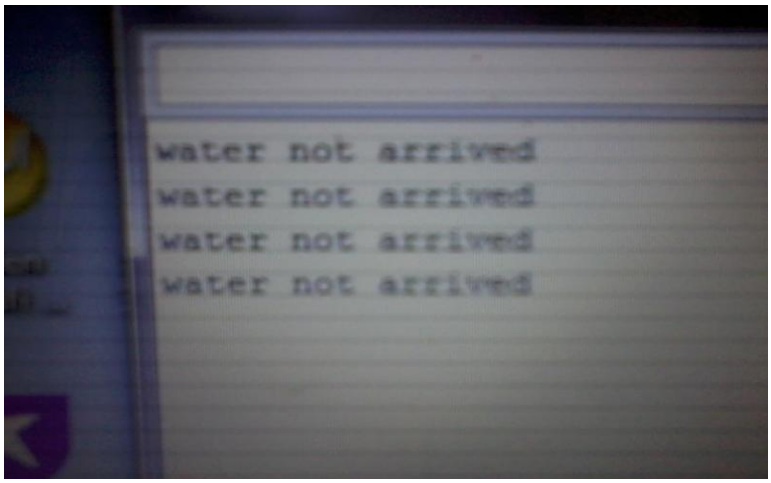
Figure (6.3): Ultrasonic Output At The Serial Monitor

2.Flow Sensor Testing :

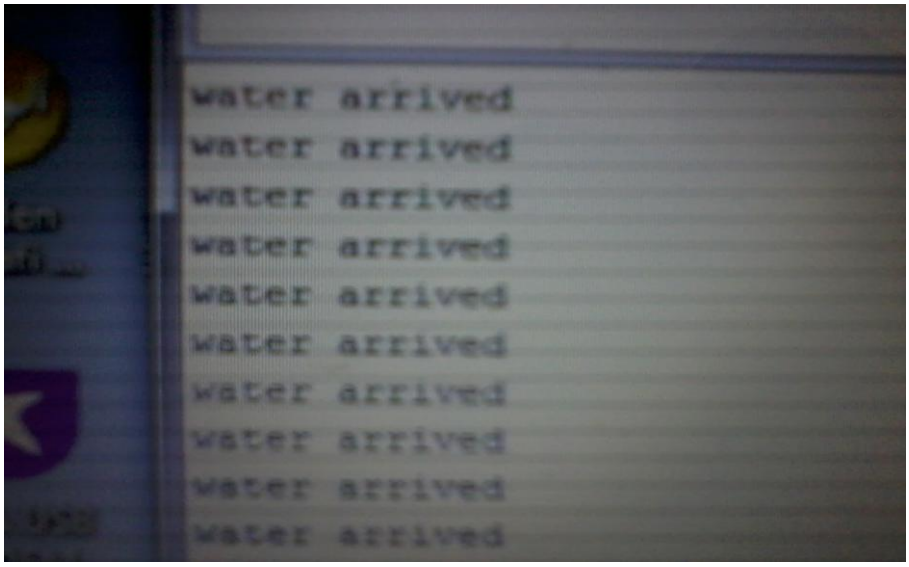
We have connected the flow sensor with the arduino via two ports (Gnd , input pin)

Figure(6.4) : Flow Sensor Connection

And the result we saw at the serial monitor is as follow :



Figure(6.5): The Flow Sensor Output 1 .

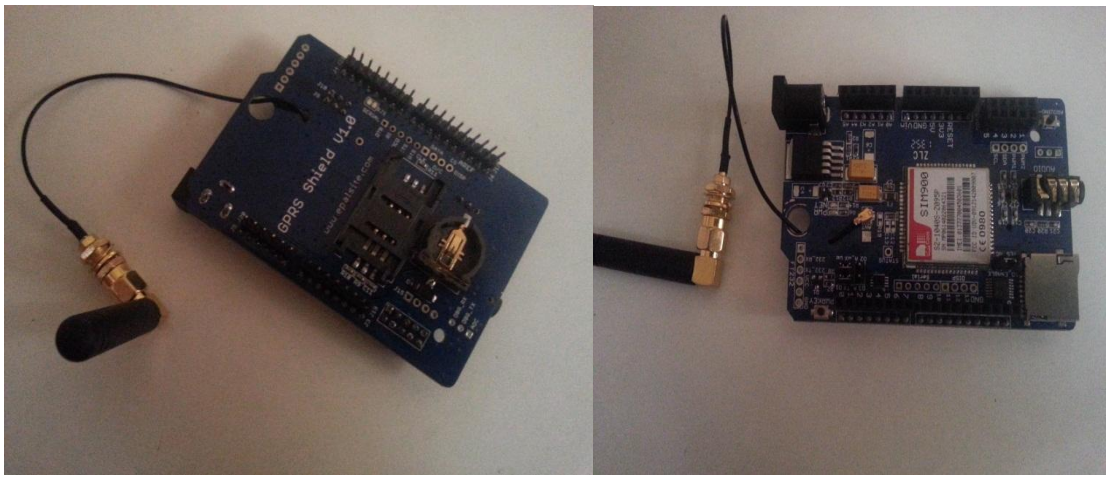


Figure(6.6): The Flow Sensor Output 2.

3.GSM Shield Testing :

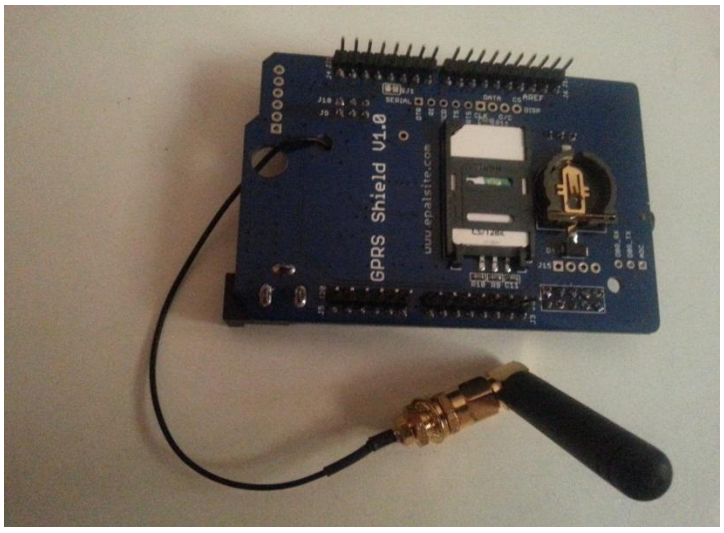
In our project we have used the GSM/GPRS shield to make a connection between the user and the system over the GSM network.

We have chosen the SIM900 shield, it is compatible with arduino, we used the AT command list especially for this shield, and mad some tests to make sure the part is working successfully and everything is ok.



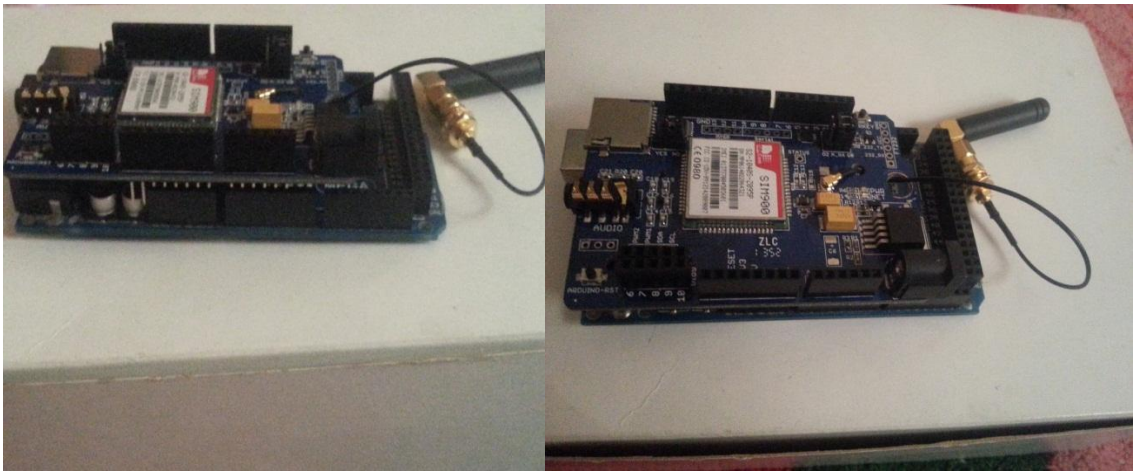
Figure(6.7) : SIM900 GSM shield

First to make the shield working on the network, we must insert the sim card in it, and be sure that it doesn't require the bin code, we can control this issue through inserting it on the mobile.



Figure(6.8) : GSM With SIM

Then, we connect the shield with the Arduino mega so that the compatible bins are with each other. The connection between the shield and the Arduino can done either via hardware or software serial, we can choose one of them through the jumper on the top.



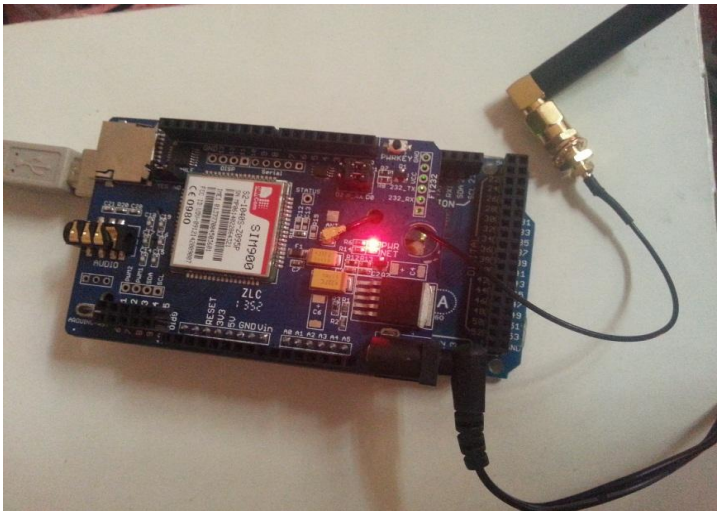
Figure(6.9) :GSM Shield With Arduino Mega.

The second issue we concerned on in order to make the connection effective is the power. Arduino gives current less than 0.5Am, and the shield needs current reaches to 2Am, for this reason, we have used external power supply (8V) to give the proper current level.

Figure(6.10) : GSM External Power Supply .

Then we connect all the requirements together(Arduino, GSM shield with sim card, power …).

The red light indicates that the shield is on, and the green one behind it is used for network state, when the off is longer than the on, the sim is "on" on the network.



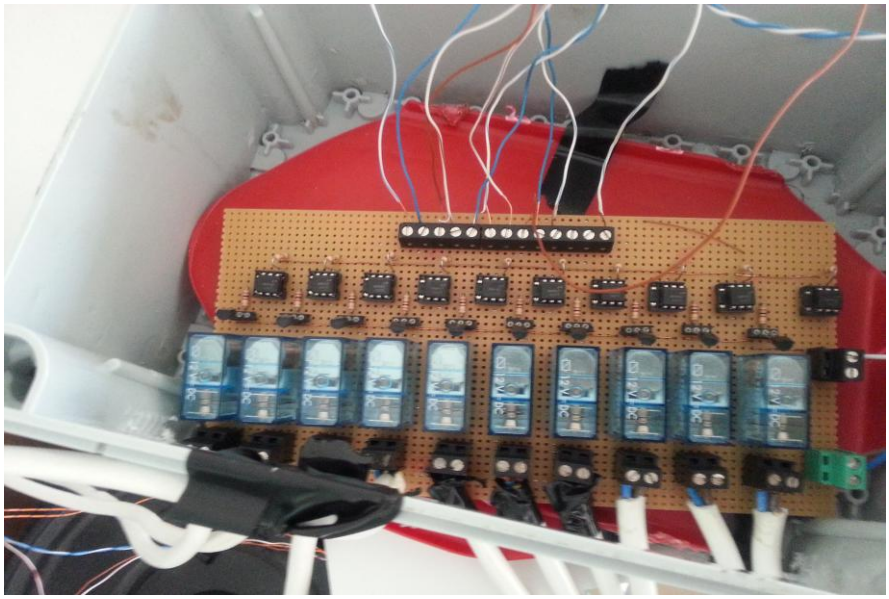
Figure(6.11): GSM Running on Network.

We have inserted the AT commands via Arduino program, for example the commands for sending sms, receive sms, making call for testing…

Also, we have used functions for sending character sms (the water availability at the line) and integer sms for returning the water level. Finally we wrote the READ_SMS function to perform the proper action depending on the arrived sms.

4.Valves and Pumps Testing :

The valve and pump were tested by giving a command from the serial monitor. Firstly we were sure that the relay kit is working well through giving the run command from arduino.



Figure(6.12): Relay Kit Test.

For the valve test, we gave it a command from arduino, and the power from AC source, the output is either open or close the valve depending on the command case.

Figure(6.13): Electric Valve

For the motor test, we gave it a command from arduino, and the power from AC source, the output is either turn on or turn off the motor depending on the command case.

Figure(6.14): AC Motor.

6.3 Software Testing:

After we have made the PC and mobile applications, we have tested the system using breadboards and group of LEDs that represent valves, motors, and their states (either ‘on’ or ‘off’) for open, close, run, stop run cases.

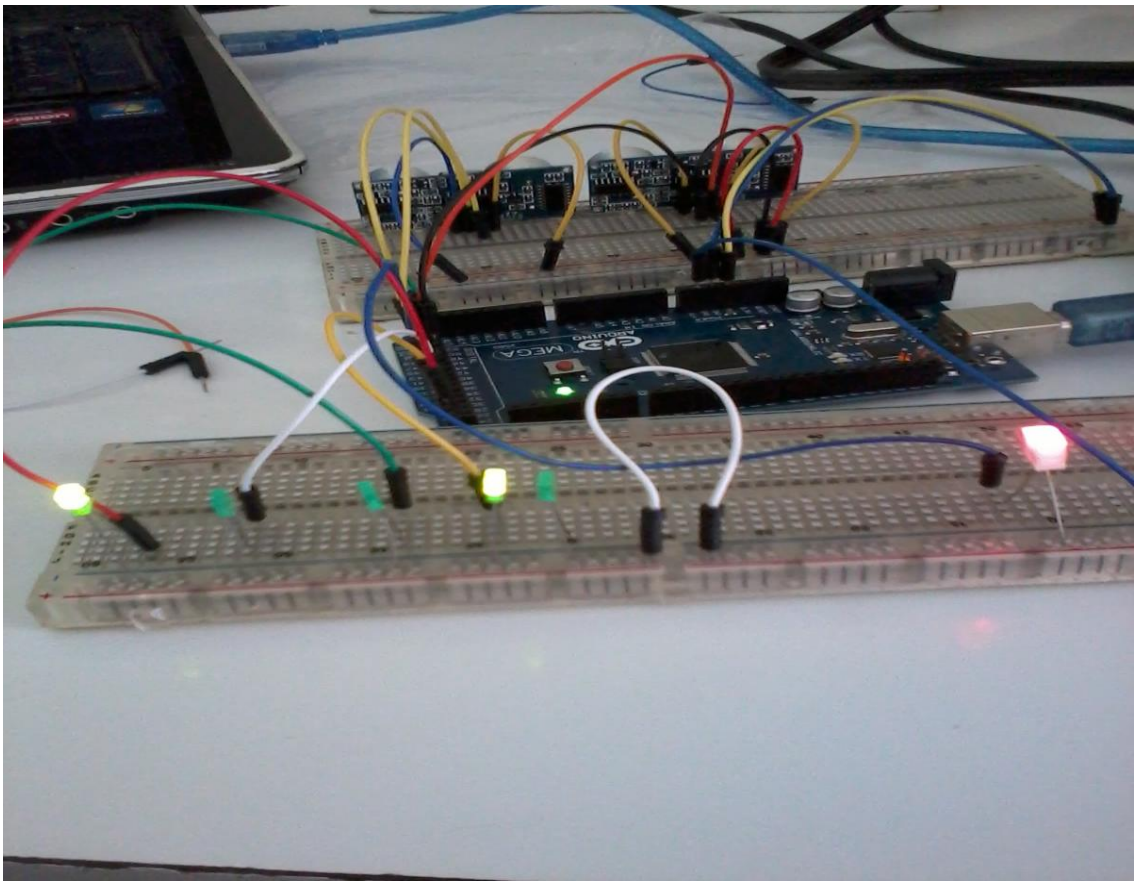
The testing is done through many stages :

Firstly: for the PC application we have tested the manual controlling, that represents the user fully controlling on the system(checking , pumping, stop pumping) ,the results are shown through number of LEDs on the breadboard.

The same test for manual controlling is done for mobile application, here the commands from the user for checking, pumping or stop pumping is sent via sim card on the GSM network instead of sending them on the serial port for PC application.

Then the test is made for automatic controlling, in which the user lets the system to perform the proper action depending on the current case. Just the user sends a command either from PC or mobile applications to start running automatically.

Secondly, after we made sure the manual and automatic controlling are working well separately for both PC and mobile applications, we have collected the codes and tested them at the same application for PC, then for mobile. And finally, the overall system is made with the two applications (mobile & PC).



Figure(6.15):Software Test On LEDs.

Then we connected all units(hardware components) with each other and applied the software applications on the real hardware system.

Figure(6.16):Final Implementation.

6.4 Chapter Summary:

At this chapter we talked about the whole system testing, in both hardware and software sides, and be sure that they did their work correctly and perform the proper functions in the system, also the initial results we have achieved to produce the required system.

7

CHAPTER SEVEN

Implementation and Results

7.1 Introduction.

7.2 Results and Outcomes.

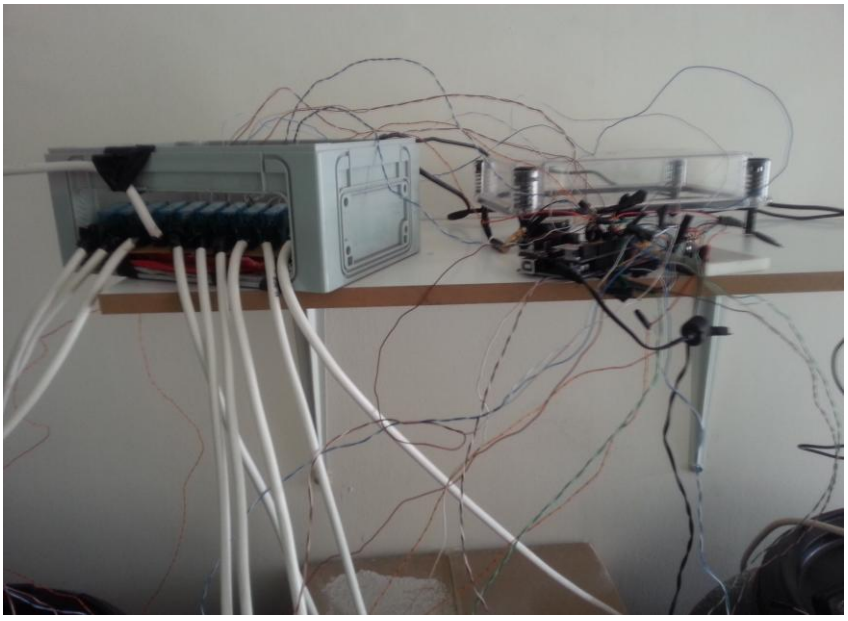
7.3 Conclusion .

7.4 Learning Outcomes and Future Works :

7.5 Chapter Summary.

7.1 Introduction:

At this chapter we will talk about the implementation of the whole system, the hardware with the software units, and the outcomes and results of the management system.

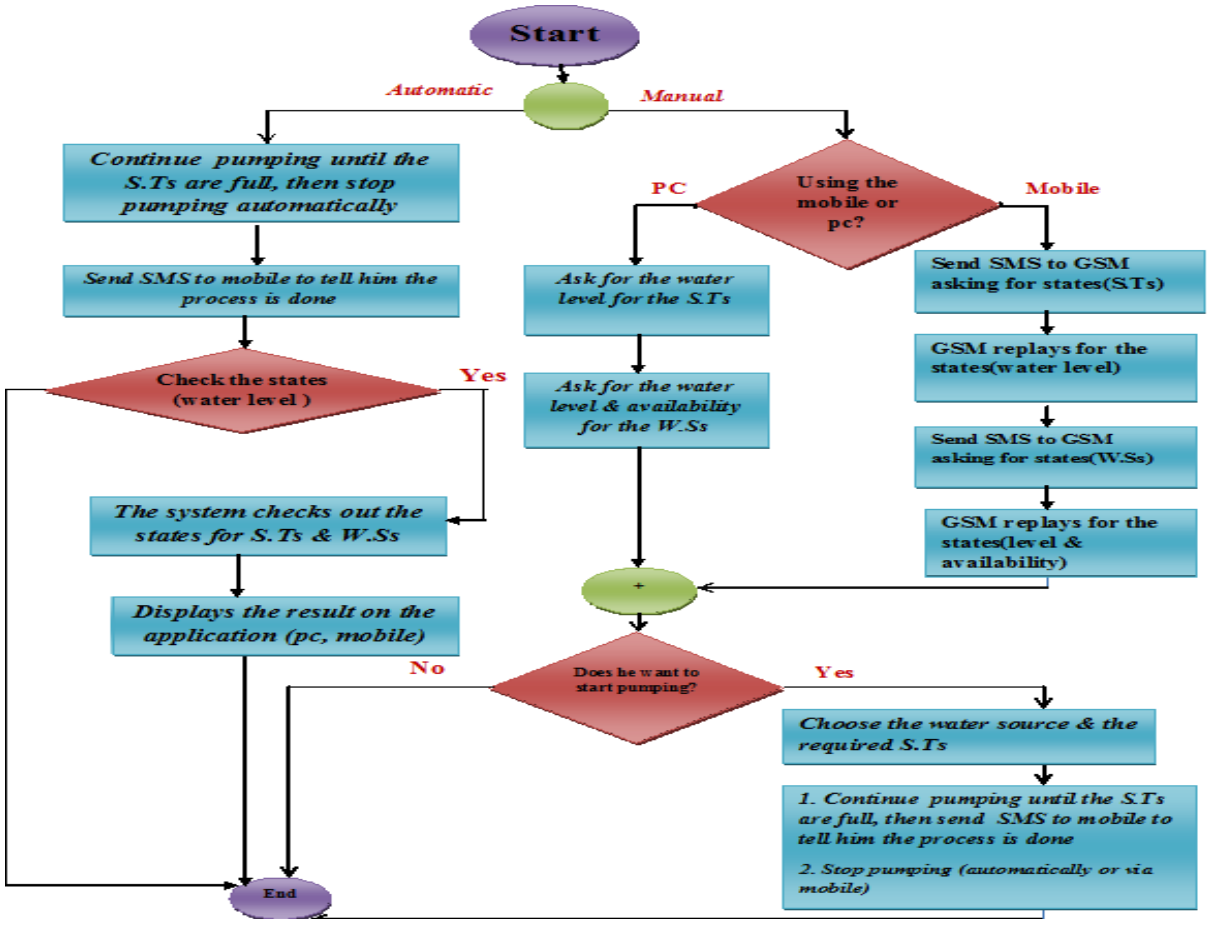


Figures(7.1): System Implementation

7.2 Results and Outcomes:

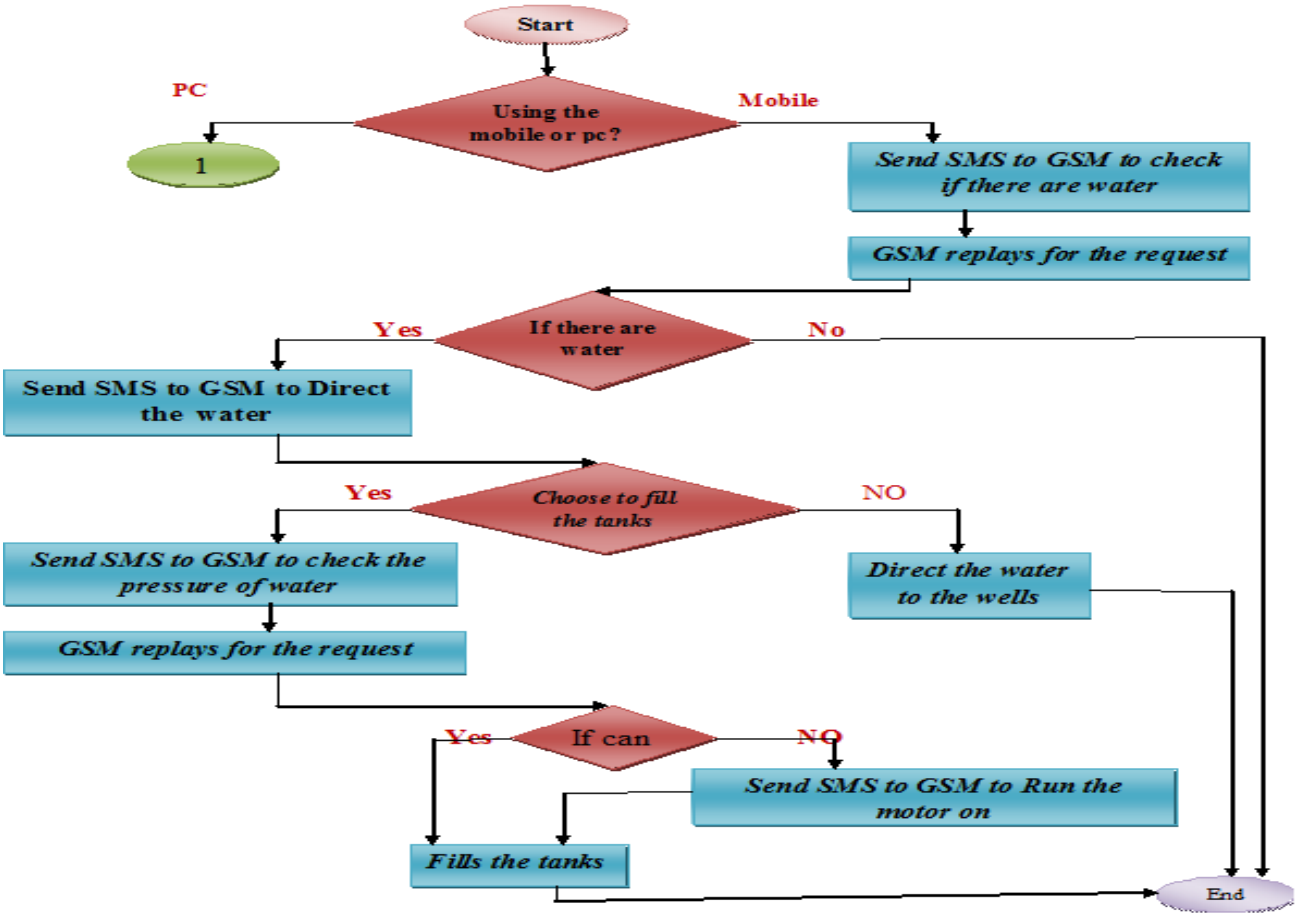
In this section, we will display the actual scenario goes through running the project, using either mobile or PC.

Firstly, for the flow charts which display the scenario of the system for both mobile or PC (manually and automatically).



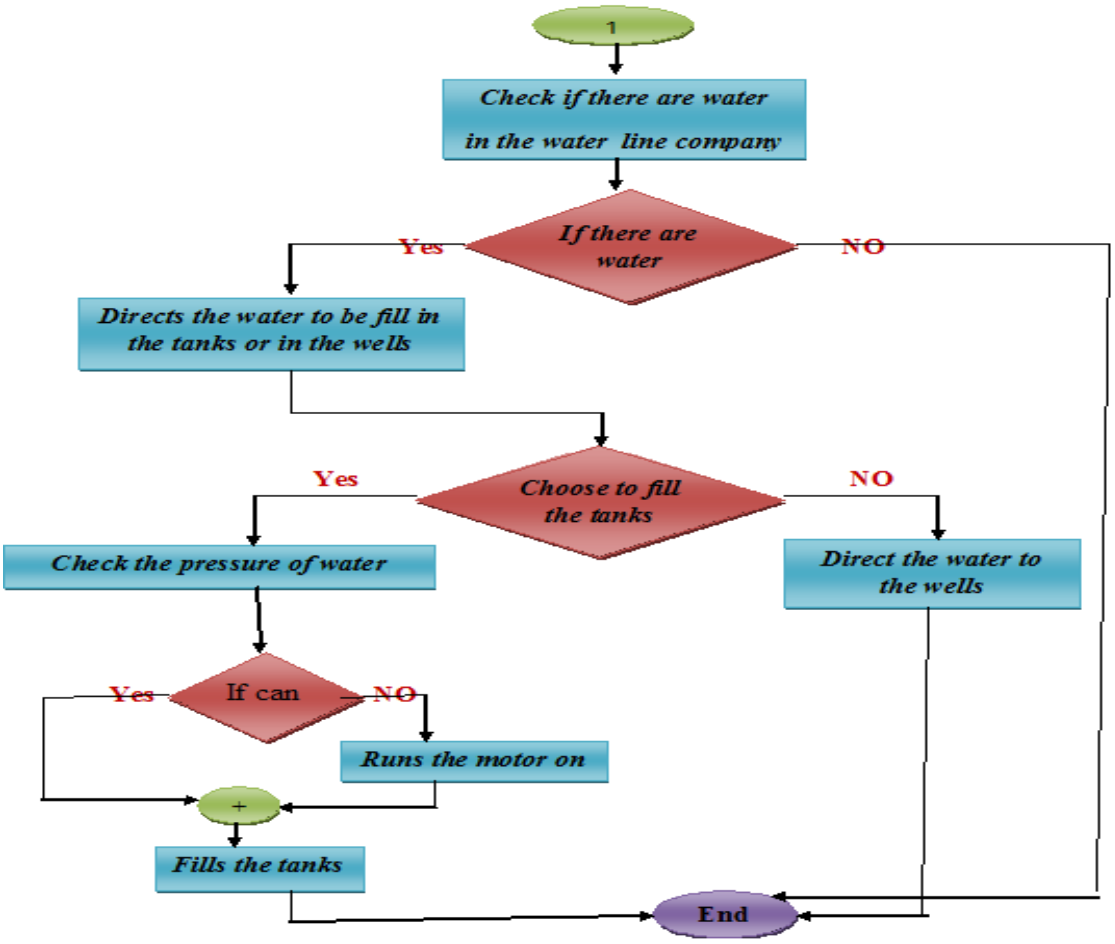
Figure(7.2): System Main Flow Chart

For this one, the user can choose the controlling method (manual, automatic), if it is manual, either using mobile ore PC.



Figure(7.3): Flow Chart For Water Line Management On Mobile

Here the user check the water availability on the line, and choose to fill the water on the line in wells or tanks if any via mobile app on GSM network.



Figure(7.4): Flow Chart For Water Line Management On PC

Here the user check the water availability on the line, and choose to fill the water on the line in wells or tanks if any via PC app.

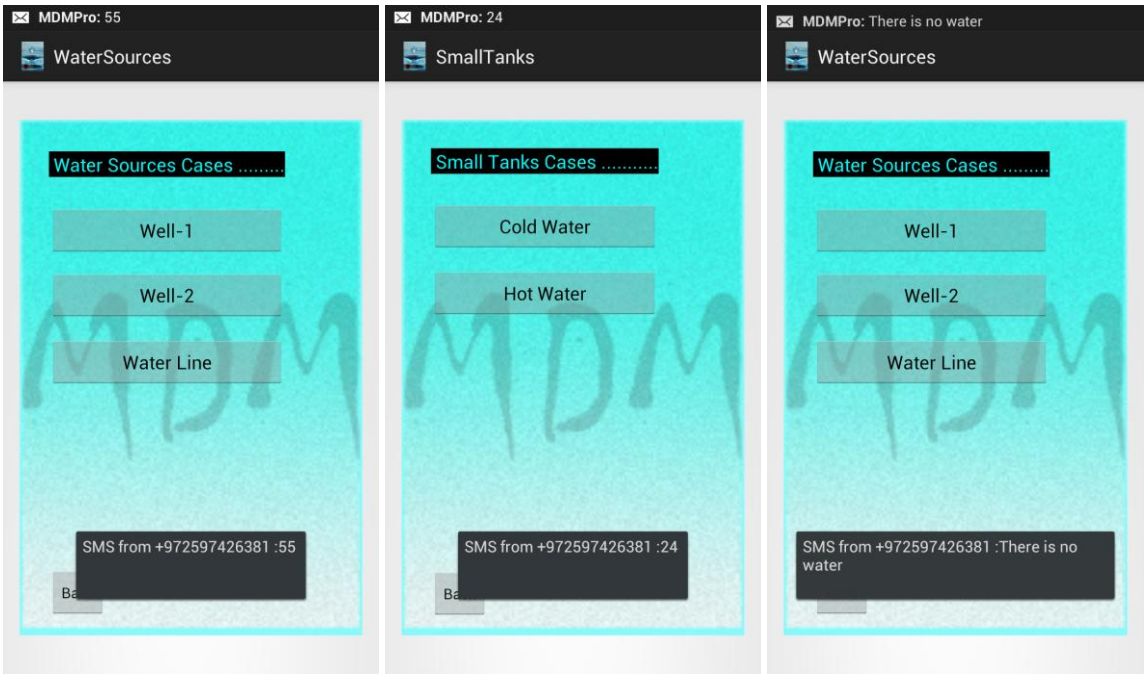
Now, we will talk about the actual result for the whole system:

A-Results For Mobile:

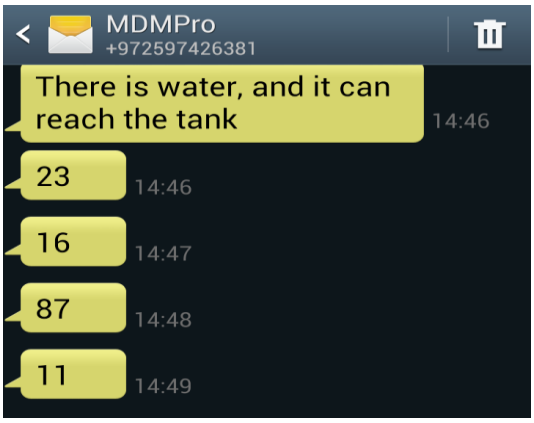
For controlling the system from mobile, as we have said before, it can be done either manually or automatically.

For manual choice, the options are:

1.Checking the states: here the user can press the button of any water source or the small tank to know the exact water level in it, as will as the water availability at the water line, the response from the system appears as "toast sms" on the application platform, also this sms will be saved on the mobile inbox.

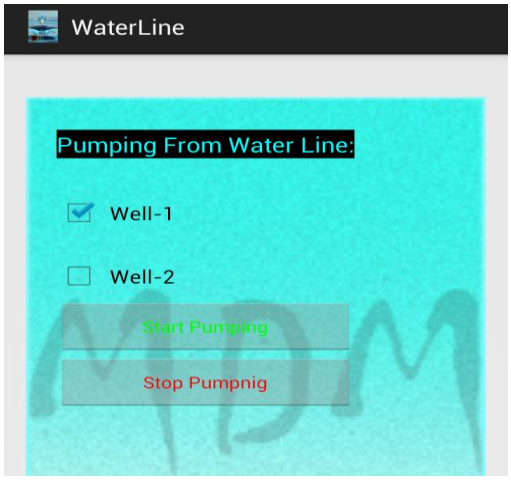


Figures(7.5): States Checking On Mobile App



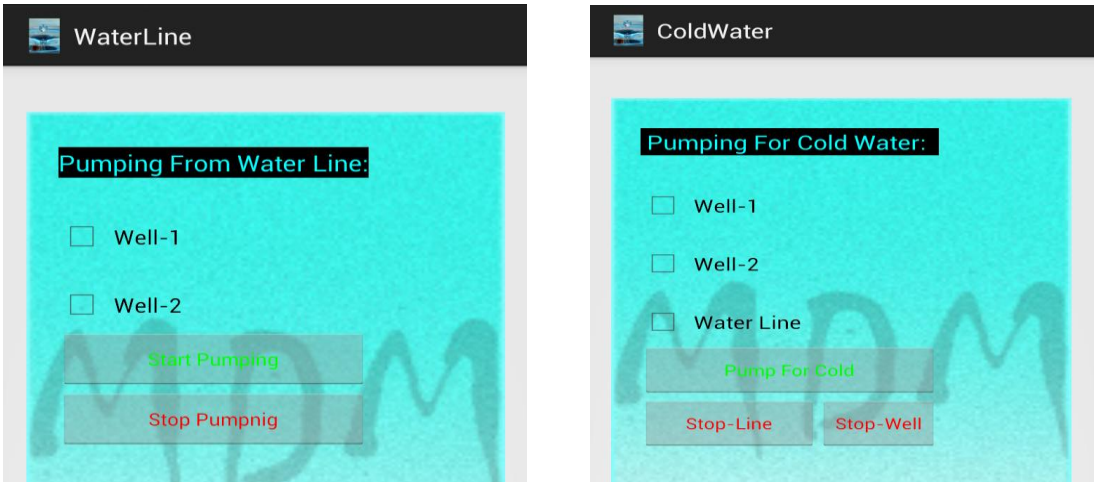
Figure(7.6):Checking States On Mobile Inbox

2.Pumping: here the user choose the source for pumping water to (well1,well2) from the water line if any, or to (cold water, hot water) from (well1,well2,water line). Just after he checks the box and presses "start pumping" button, the water will take its path.



Figure(7.7): Pumping For Water Line Case

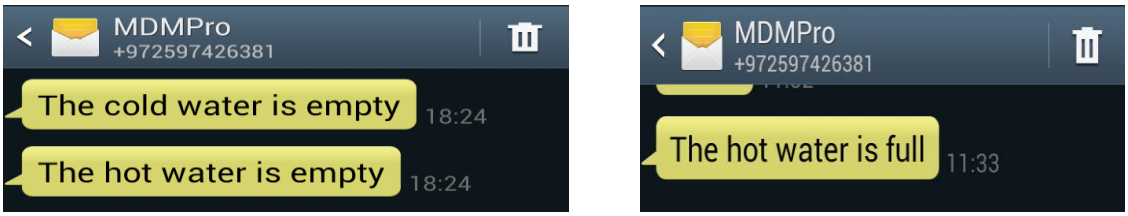
3.Stop pumping: here the user can stop pumping water to (well1,well2) from the water line if any, or to (cold water, hot water) from (well1,well2,water line) by pressing the wanted "stop pumping" button, either from well or line.



Figures(7.8): Pumping and Stop Pumping Choices On Mobile App

If the user doesn't stop pumping, and the tank goes full, then the system will stop the pumping process automatically, and sends sms to the user that the tank is full.

Also, if the user gives a command to start pumping without checking state, and the source is empty, or it goes empty while pumping, then the system also will stop the pumping process automatically, and sends sms to the user that the tank is empty.



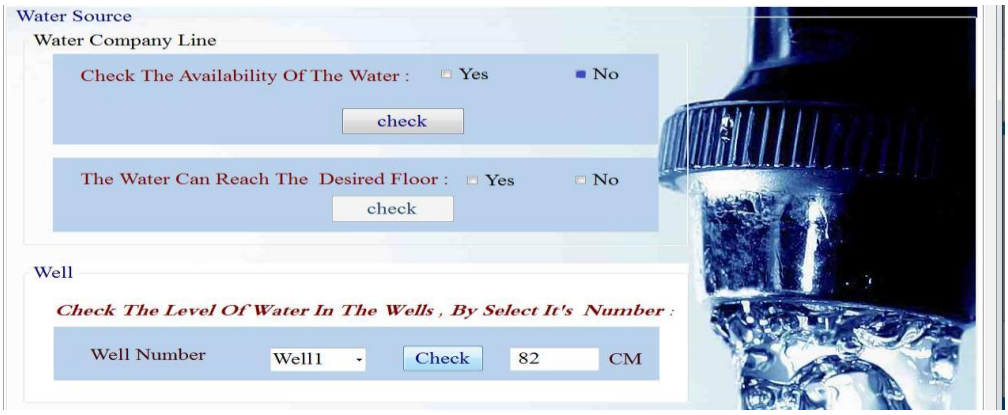
Figures(7.9):State Alarm Via Mobile App

For *automatic choice*, pumping will start when any tank is empty, the water at the line will be filled in the wells if any, and the stop pumping will be automatic when any tank is full. Here the user can check the state of any tank too.

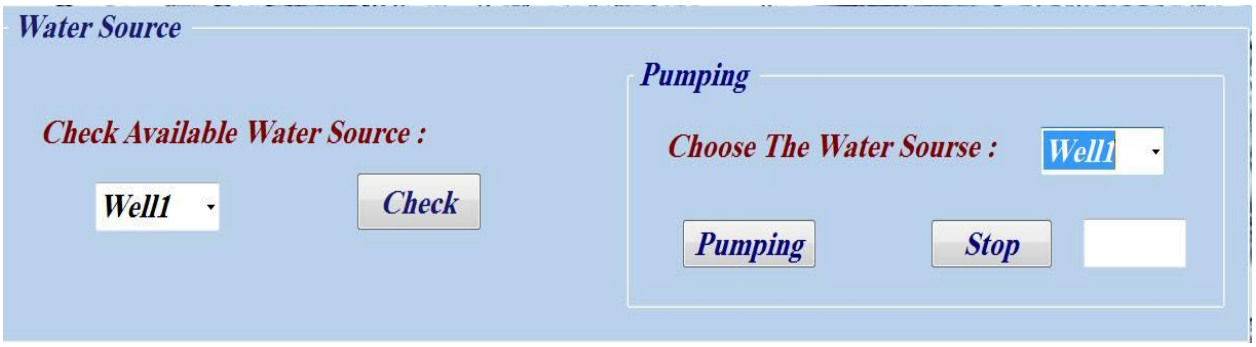
B- Results For PC :

The same scenario is done for PC application, here the commands from the pc to the system, and the results from the system back to the PC go through the serial line.

As before, the user first choose the control method either manual or automatic, then he can check the states, pump, stop pump (in the case for manual) or just checking (in the case for automatic).



Figure(7.10): Checking States On PC App



Figure(7.11): Pumping Choice On PC App

Figure(7.12): Pumping and Stop Pumping For Water Line On PC App

7.3 Conclusion:

Finally , all thanks for our great God , we achieved the desired goals, however many problems faced the work, either in software or hardware, some programs took time to work well through the system, other didn't work well any more, for the hardware, the response cane take time more than needed, or not compatible with other components.

We have deal with these problems and more, and the attended system worked well with the desired outputs, so now, the user can use the management and controlling system via mobile and PC.

7.4 Learning Outcomes and Future Works :

In this section we will talk about the talents and abilities we have been achieved, and finally the future works.

Learning Outcomes:

After accomplishing the project tasks many talents and abilities have been achieved such as:

1. We have learnt c# language that is used to program the platform application on the PC.
2. We have learnt android environment that is used to program the platform application on the mobile.

3. We have learnt how to interface the microcontroller(Arduino) with different sensors, valves, motors and with the GSM modem.
4. We have developed our abilities in troubleshooting and problem solving.

Future Works :

At the end, some ideas can be given to develop the system or extend its duties and functions, and some recommendations can be given to avoid the problems that may happen in the future as:

1- Instead of using sms in sending commands and receiving states to and from the system, GPRS can be a suitable and efficient solution, especially for regions where the internet is available all the time and anywhere.

2- Also for PC application, and to overcome the need for serial port to access the system, it can be integrated using Wi-Fi network.

7.5 Chapter Summary:

At this chapter we have talked about the actual scenario goes through the project, and the results have been achieved from the management system via mobile and PC, the new abilities we learned after this work, and finally the future work can be added to improve the system work.