UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPING WATER MONITORING NETWORK SYSTEM AND WATER TREATMENT USING ANTENNA AND IOT

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Computer System) with Honour.

by

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2019

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Tajuk: **Developing Water Monitoring Network System and Water Treatment Using Antenna and IoT**

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APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of **Bachelor of Computer Engineering Technology (Computer Systems) with Honours**. The member of the supervisory is as follow:

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ABSTRAK

Projek ini digunapakai dengan menggunakan pelbagai analog sensor sebagai pengawasan air di dalam tangki. Jika air tersebut mendapati kotor atau tidak mempunyai ciri-ciri yang ideal, air di dalam tangka akan dirawat melalui kaedah yang dipanggil alumina aktif dengan menggunakan bahan asal, aluminium hidroksida.

Projek ini diberi tumpuan terhadap tiga aspek, pH, kekeruhan dan tahap paras ketinggian cecair yang hadir didalam tangki air. Alat sensor air seperti sensor analog pH dan meter kekeruhan air adalah alat yang sangat berguna yang dapat mengenalpasti tahap pH air dalam sistem tangki. Julat pH tertentu boleh menunjukkan sama ada airnya terlalu tinggi dalam keasidan atau tinggi jurang alkali di dalam air, kedua-dua tidak selamat untuk diminum. Tambahan lagi, kekeruhan air dapat mengesan bahan dan bahan yang tidak diinginkan di dalam air. Ia juga membantu menentukan jumlah zarah pepejal (TSS).

ABSTRACT

Using a multiple analogue sensor for water monitor combination to study on the characteristic of water in the tank system, hence the water can be treated with the method called activated alumina, aluminium hydroxide.

This project focusing on measuring the pH, turbidity and the level of the liquid presence in the tank. A water sensor tools such as pH analogue sensor and water turbidity meter are a very useful tools that can identify the properties of the of pH level of water in the tank system. A certain range of pH could indicate whether the water is either too high in acidity, therefore unsafe and high in alkalinity, not safe to drink as well. Furthermore, water turbidity can detect an unwanted substances and materials in the water. It also helps to determine the amount of solid particle (TSS).

The idea of maintaining quality water came with the current issue that we're having now, global warming. Human being consume water daily and water is also source oxygen. The measurement was carried out by each sensor one at a time.

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Idea untuk mengekalkan kualiti air datang dengan isu semasa yang kami alami sekarang, pemanasan global. Manusia mengonsumsi air setiap hari dan air juga merupakan sumber oksigen. Pengukuran dilakukan oleh setiap sensor satu demi satu.

DEDICATION

A special thank you to my beloved parents my dad names Mohmmad Zaidi bin Siwan and my beloved mother Norliza Binti Ayub for your unconditional, nonstop support regarding my studies from the beginning, my very first primary school until here now, on year four doing bachelor's degree. I am very honoured to have both of you as my parents and I could never repay any of these. Thank you for trusting me and giving me chance to proving my success in study and improving my journey of education here in UTeM.

CHAPTER 1
INTRODUCTION

1.1 OVERVIEW

Water is generally use for every living things and organism that includes human, flora and fauna. We human drink averagely one litre to two litre per day and according to scientific research, the human body should consume at least two litres per day, depends on the gender or location. Specifically, our main source of getting clean and drinkable water in Malaysia is through filtered water based on either water company (bottled) and our residential filter water machine. Furthermore, aside from filtered water, we can also get a pure and clean water source from blue and green capped bottled drink.

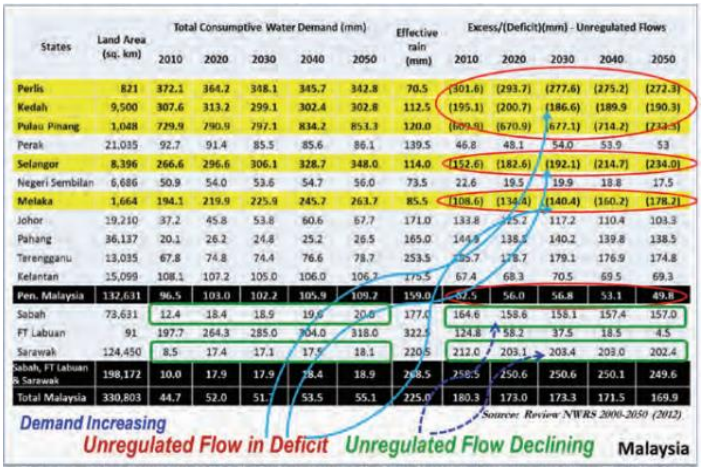
According to Ministry of Health, there are two types of bottled water, natural mineral water that specifically achieved straight from underground water or better known as subterranean water bearing strata through a spring, well, bore or another exit. The source must be approved and licensed by the Ministry of Health. Unlike natural mineral water, packaged drinking water came from the public water supply system or tap water, surface water (river, pond, and lake) and underground water (tube well, spring). This type of water is also must obtain approval and license from the Ministry of Health.

Malaysia, our developing country is yet to achieve to drink water straight from through tap water source. News has shown that tap water is drinkable, and studies have shown that the level of certain minerals water in Malaysian tap water is basically below the permitted. It means that the water that came from tap water pipes is safe to consume. What makes it unsafe is due to the residential piping whereas the pipe is and will be rusty over time and moss and algae as well grows in our PVC pipes as well the water tank in our home.

Water industry in Malaysia, generally provides us drinking water and wastewater services that including sewage treatment and water treatment. Those treatment are then goes into the industry, commercial and residential usage. In addition, water industry also play part in wastage collection and filtration.

1.2 PROBLEM STATEMENT

The issue that occurred in Malaysia is that Malaysia lack of natural water supply in a several places. The states in the north (Perak excluded), Selangor, Federal Territory of Kuala Lumpur and Putrajaya in the central region and Melaka are already facing uncontrolled flow water shortage that borders on unsustainable development conditions, as shown on table 1 below and reported in the National Water Resources Study 2000-2050 Reviewed in 2012 by NWRS 2012. (Alhabshi et al. 2013) This is due to unbalanced rainfall between two areas aside from each other in the country.



States	Land Area (sq. km)	Total Consumptive Water Demand (mm) 2010	2020	2030	2040	2050	Effective rain (mm)	Excess/(Deficit)(mm) - Unregulated Flows 2010	2020	2030	2040	2050
Perlis	821	372.1	364.2	348.1	345.7	342.8	70.5	(301.6)	(293.7)	(277.6)	(275.2)	(272.3)
Kedah	9,500	307.6	313.2	299.1	302.4	302.8	112.5	(195.1)	(200.7)	(186.6)	(189.9)	(190.3)
Pulau Pinang	1,048	729.9	790.9	797.1	834.2	853.3	120.0	(609.9)	(670.9)	(677.1)	(714.2)	(733.3)
Perak	21,035	92.7	91.4	85.5	85.6	86.1	139.5	46.8	48.1	54.0	53.9	53
Selangor	8,396	266.6	296.6	306.1	328.7	348.0	114.0	(152.6)	(182.6)	(192.1)	(214.7)	(234.0)
Negeri Sembilan	6,686	50.9	54.0	53.6	54.7	56.0	73.5	22.6	19.5	19.9	18.8	17.5
Melaka	1,664	194.1	219.9	225.9	245.7	263.7	85.5	(108.6)	(134.4)	(140.4)	(160.2)	(178.2)
Johor	19,210	37.2	45.8	53.8	60.6	67.7	171.0	133.8	125.2	117.2	110.4	103.3
Pahang	36,137	20.1	26.2	24.8	25.2	26.5	165.0	144.9	138.8	140.2	139.8	138.5
Terengganu	13,035	67.8	74.8	74.4	76.6	78.7	253.5	185.7	178.7	179.1	176.9	174.8
Kelantan	15,099	108.1	107.2	105.0	106.0	106.7	175.5	67.4	68.3	70.5	69.5	69.3
Pen. Malaysia	132,631	96.5	103.0	102.2	105.9	109.2	159.0	62.5	56.0	56.8	53.1	49.8
Sabah	73,631	12.4	18.4	18.9	19.6	20.6	177.0	164.6	158.6	158.1	157.4	157.0
FT Labuan	91	197.7	264.3	285.0	304.0	318.0	322.5	124.8	58.2	37.5	18.5	4.5
Sarawak	124,450	8.5	17.4	17.1	17.5	18.1	220.5	212.0	203.1	203.4	203.0	202.4
Sabah, FT Labuan & Sarawak	198,172	10.0	17.9	17.9	18.4	18.9	268.5	258.5	250.6	250.6	250.1	249.6
Total Malaysia	330,803	44.7	52.0	51.7	53.5	55.1	225.0	180.3	173.0	173.3	171.5	169.9

Figure 1. 1 Study reviewed by NWRS 2012 (Alhabshi et al. 2013)

During the monsoon season, there will be an extremely unbalanced heavy rainfall resulting in algae formation in the water. Furthermore, the heavy rain will cause the water level in the dam, reservoir as well the aquatic ecosystem will rise unconditionally. This will also be resulting in flooding in an eastern state of Peninsular Malaysia, Terengganu. The northeast monsoon (November-February) has a greater impact than the southwest monsoon (May-August) on the east coast of Peninsular Malaysia. Beach changes from the southwest monsoon to the northeast monsoon are abrupt, compared to the gradual recovery of the beach from the northeast monsoon to the southwest monsoon. (Wong 1981)

Since Malaysia is located near the equator, the climate and weather Malaysian experienced is categorised as equatorial, meaning that it can be hot and

humid along the year. When the monsoon season has stopped, a drought will take over. A continuous hot weather will cause dehydration in the body. When a high temperature in Malaysia exceeds 40℃, our human body will become overheating, causing a heatstroke. This can be fatality if not taken seriously.

Overwhelm drought will result a low water level due to the water evaporation. This inevitable global warming basically has caused the world a one big issue. Those are temperature risen, warming occurs in the states, ice sheets are currently shrinking in Antarctica, sea level has risen, extreme events such as ocean acidification and land surface air temperature rise.

1.3 OBJECTIVES

These objectives are focuses on:

- To monitoring water quality for quality assurance in term of water level, turbidity unit value and water acidity (pH) level
- To implement water treatment by using Aluminium Oxide:
  - As adsorbent
  - Activated alumina method
- To implement a water system with usage of IoT network

1.4 SCOPES

This project will particularly be focusing on how the environment surrounding will affect the water level, turbidity level and the acidity of the water based on the collected data. The system will be made by using a combination of raspberry pi 3 and combinational of several sensors. The creation of the system (equipment and device) and advancing of this prosperity component will be covered in this commitment.

There are few extensions considered in this undertaking can be grouped into four fundamental parts. These elements can be organized about the whole project keeping in mind the end goal to build up the project. The elements are:

i. Issue
ii. Design
iii. Testing
iv. Analyze

Lastly, the next will be proceeding on the composing the project report.

1.5 LIMITATION OF THE PROJECT

The system is designed to be used with the usage only of turbidity sensor and water level and analogue pH sensor is not presence. This project also suitable for laboratory subject and level as the sample is not graded by actual NTU unit. This is because the project isn't available yet in Raspberry Pi. Also, the system cannot be used yet for residential usage.

1.6 SUMMARY

In conclusion, from what can be concluded specifically in this first chapter is the chapter discussed the overall of the introduction of the project. It begins with the project background where the explanation of the background system used. Then, the briefing and issuing of the problem statement that usually happen annually in Malaysia's environment and also the objectives and scope of the project.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

A literature review will be carried to focus on previous current project works. Many of the application, journal, articles, websites, books and newspaper have been studied and all the analysis was identified with the point below. This chapter will be discussed more in the chosen area of study based on the articles. Furthermore, this chapter will show the summarization based on literature review for each of the analysis that has successfully develop into the system and will be compared with the upcoming project, developing water monitoring network system and water treatment using antenna and IoT.

2.1 Previous Development of Water Level Monitoring

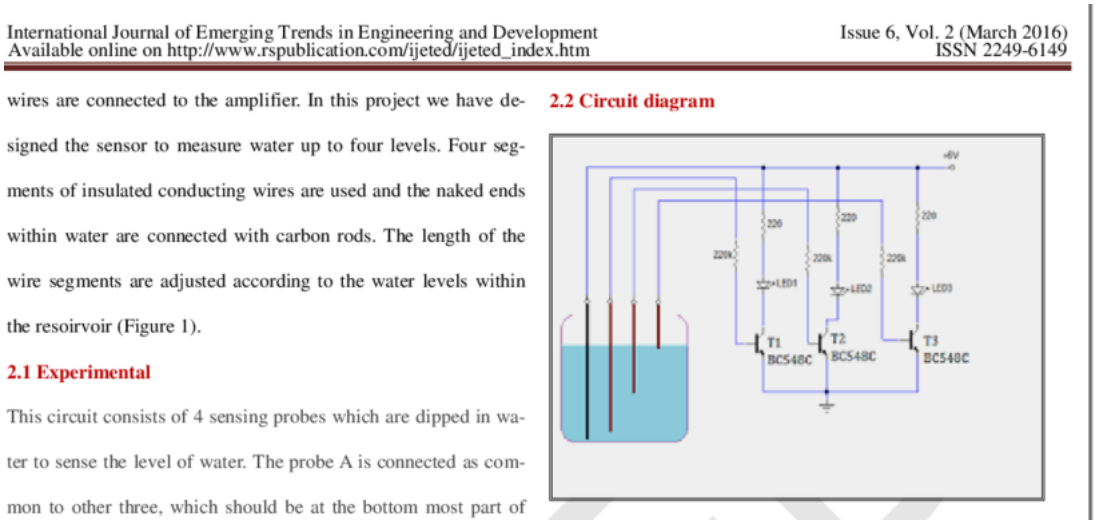
2.1.1 Automatic Water Level Indicator (Journal)

Automatic Water Level Indicator was designed to get the information of water in the reservoir. Water level indicator is a very handful project in order to reduce the usage of water. The design of project can be classified as do-it-yourself project as the project used a very minimal quantity of equipment.

The key components are the indicators where three LED consisted of different colours (Blue, Red, Green and Yellow) and as for the sensors probes, four of copper wires and carbon rod were used. Three transistors specifically BC548C was used for amplification and switching purpose. In addition, multiple resistors were used to basically control and reduce the flow of current to other components so the components will not be destroyed or broken. Moreover, a simple manual pump was used to add the water into the tank.

The flow of the project is when the sensor probe B, C and D reach the water level and probe A is connected to the rest of each probes using parallel circuit. Probe A acted as a reference sensor. Probes B, C and D on the other hand were set as minimum, middle and maximum level respectively. When the tank water is low, the pump will start working as only probe B detected the water level. When the water reached the next probe, probe C, an indicator of middle water level is switched on. The water will stop flowing into the tank after the water reach probe D.

Figure 2. 1A circuit design for the water level indicator (Roy a et al. 2016)



International Journal of Emerging Trends in Engineering and Development
Available online on http://www.rspublication.com/ijeted/ijeted_index.htm

Issue 6, Vol. 2 (March 2016)
ISSN 2249-6149

wires are connected to the amplifier. In this project we have designed the sensor to measure water up to four levels. Four segments of insulated conducting wires are used and the naked ends within water are connected with carbon rods. The length of the wire segments are adjusted according to the water levels within the resoirvoir (Figure 1).

2.1 Experimental

This circuit consists of 4 sensing probes which are dipped in water to sense the level of water. The probe A is connected as common to other three, which should be at the bottom most part of

2.2 Circuit diagram

Figure 2. 2 Top view of the proposed model of Water Level Indicator (Roy a et al. 2016)

According to the authors (Roy a et al. 2016) they stated that the design was intended to design a simple and low-cost water level indicator. The definition of simple were regarding the usage of several copper wires as a water level indicator. There are few issues here whereas the indicator itself was prone to movement as the rod was only attached to the side of the tank by only using the cello tape. The location of sensors could be change and floating if the cello tape is accidentally unattached.

Furthermore, the rod that attached to copper wire is close to the maximum level of the tank. Copper are known as a conductor and water on the other hand is another very good conductor. This could be harmful if used whether in industrial or residential. Moreover, a manual pump was used in the project. It means, a single human labour is needed, and the person needs to be existed physically and if the human is not presence, the water will continue flowing until it reaches copper wires. Ergo, a very harmful and possible fatal can be happened.

Another minor issue that occurred is the unavailability and lack of versatility of the data indicator. The indicator only specifically shows a LED indicator. The water level volume is not present and shown as there is no analogue input.

2.1.2 Automated Multiple Water Tanks Control System Using ATMEGA and FPGA Technology (Journal)

The Automated Multiple Water Tanks Control System Using ATMEGA and FPGA Technology was designed and implemented for the usefulness of household, industries and manufacturing processes. Also, for the control and monitoring of water overflow or chemicals in the overhead tanks, as result of common wastage of water run-off from the overhead tanks (Lukman et al. 2019). This project was carried out to compare the efficiency and effectiveness between microcontroller Arduino UNO (ATMEGA328) and FPGA Technology.

The core components that were used in this project are Arduino ATmega328 microcontroller, an actuator (stepper motor), buzzer and Spartan-6 FPGA development board for the comparison. Arduino Uno and ultrasonic sensor (HC-SR04) are both used as a combination to detect and monitor the liquid level of overhead water tank system. The stepper motor is use for controlling the water tank system. It acts as a switch for the water flow in the system. Spartan-6 FGPA development board was used for FPGA architecture whereas it is for industrial chemical or water tanks control and monitoring by using Xilinx 14.1 ISE field programmable gate array.

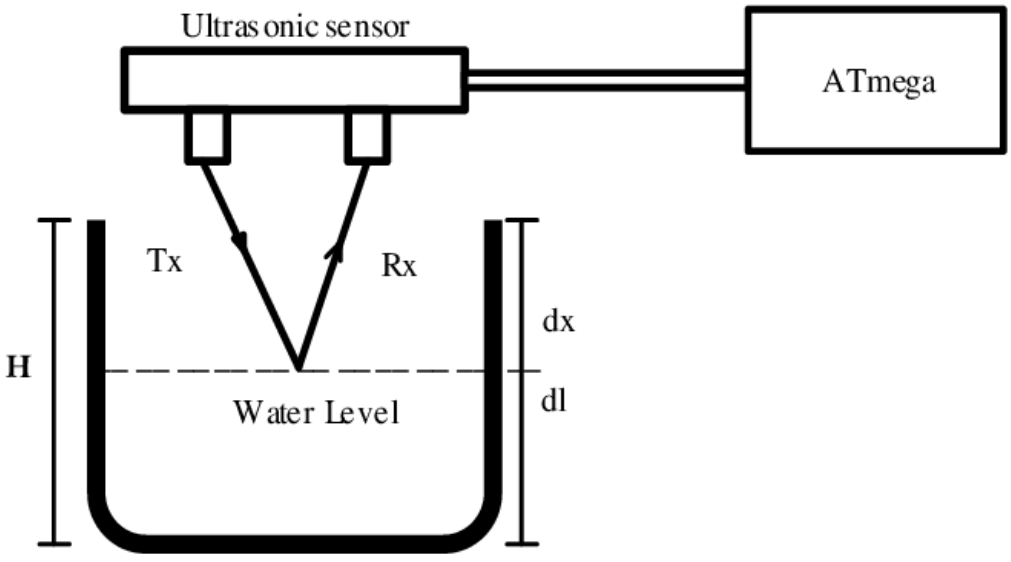


Figure 2. 3 Implementation of ultrasonic sensor in reservoir in ATmega

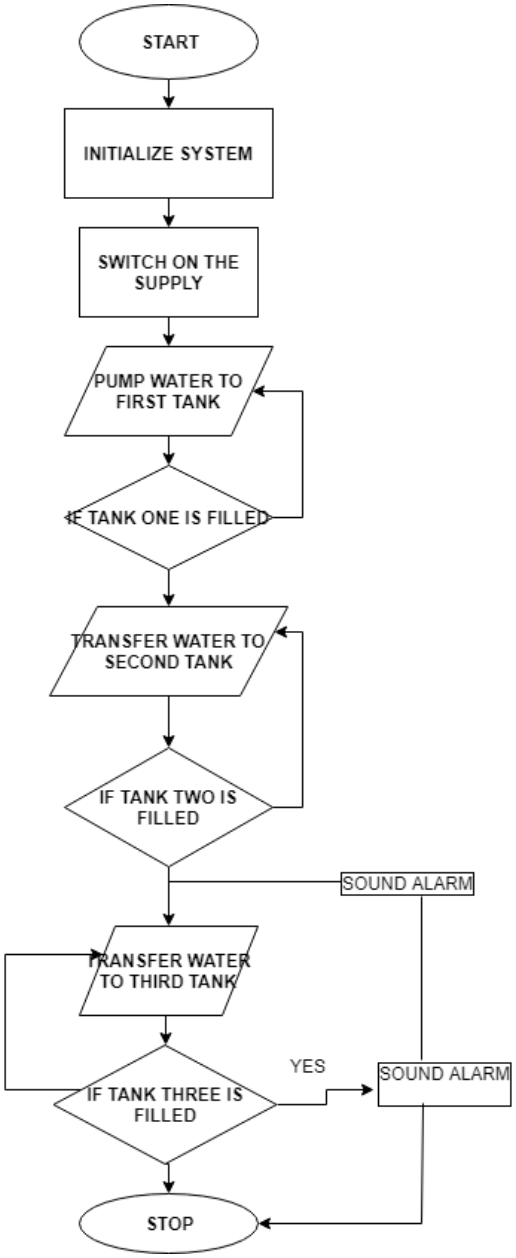


Figure 2. 4 Flow chart Automated Water Tanks on both microcontroller usage

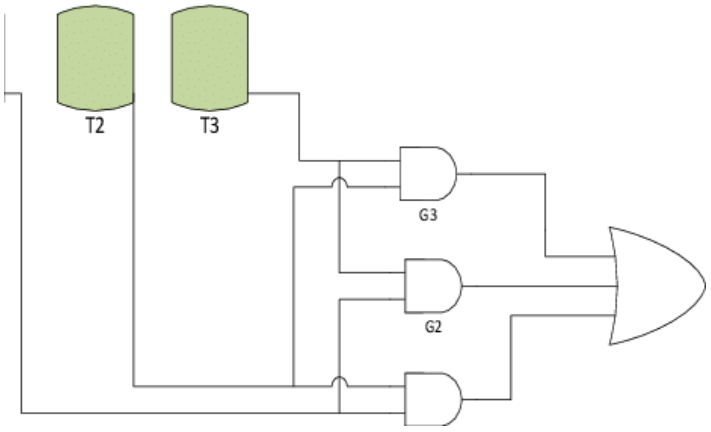


Figure 2. 5 FPGA Based Control

Based on these two comparisons between two microcontroller, Arduino Uno ATmega328 and Spartan-6 Xilinx ISE. As said by the authors (Lukman et al. 2019), microcontroller (ATmega328) for industrial application has shortage lifetime, hazard rate function as a result of its flexibility, mean-time-to-failure, (MTTF), inherent weakness and other environmental conditions (includes heat, temperature and so on).

The FPGA technology approach on the other hand is for automated multiple water tanks control and volume monitoring was implemented and simulated in the Xilinx ISE. This technology (FPGA) application is suitable for the industrial control system, since it exhibited many advantages over the microcontroller. It includes extremely low power consumption, efficient CPU utilization, memory capacity, extended system features for various applications and multiple wireless technology. It has high resistant of failure rate due to reliability predication, extended failure time distribution and gradual failure time characteristics.

From this summarization, it can be concluded that FPGA is a more suitable and better options in term of industrial usage whilst Arduino UNO microcontroller is more suite to learning kit.

2.1.3 Chemical Sensor Network for pH Monitoring (Journal)

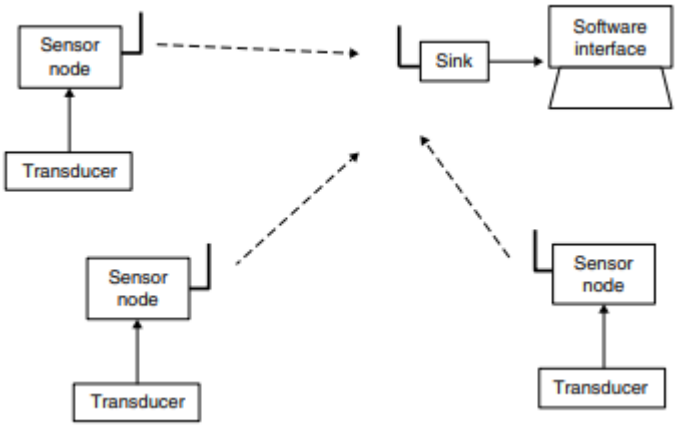
In this journal, we learned that water monitoring is important in every parts of the world due to unawareness such as the uncontrolled pollution and inevitable

global warming nowadays. The current systems that is implemented is generally employ a physical sensor and it requires and physical human interaction whereas a human labour needs to be available at the sites. The journal also explained that wireless chemical sensors for surrounding monitoring is lack of use due the autonomy of conventional sensors and the materials require are fairly expensive. This project is presented and proposed in hope to create a wireless sensor for monitoring pH level and quality based on ion selective field effect transistors (ISFET). (Manjarrés et al. 2016)

In addition of the current challenge of chemical parameters sensors, this journal explained that it is quite difficult to keep track of the sensors for long period as it requires maintenance for certain time, thus came the idea of ISFET, ion selective field effect transistors. They have a requirement characteristic whereas they have the durability, high response variability and low power consumption. This article also prepared and compared multiple entry of previous journal regarding wireless sensor network (WSN). Each of these previous projects has different range with different bandwidth and different equipment as well. Those equipments are radios antenna with 433MHZ and 868MHZ with ranged of 10m and 7.64km respectively. Furthermore, with the usage of Bluetooth module, Zigbee Pro, it can range up to 700m without any resistance or obstacle. One of the most remarkable and spark the idea of this upcoming project is wireless sensor method that came up with the usage of 2.4GHz frequency band, a radio band that is widely used as a Wi-Fi. (Chung et al. 2011)

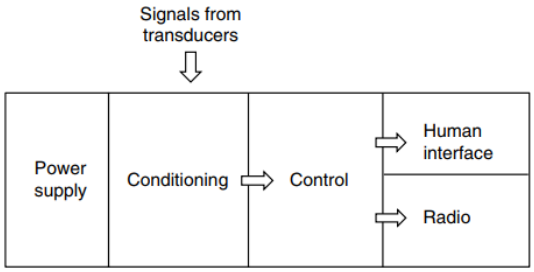
For the proposed project, the system has three sensor nodes connecting to one sink in star topology method. Wireless chemical sensor network is more essential than wireless sensor network. ISFET need a reference electrode where the function of it is to close the circuit. This project proposed the implementation of ISFET in microchip PIC 18F4553 microcontroller whereas the ISFET acted as the main transducer in the circuit. The microcontroller comes with internal 12-bit ADC module.

Figure 2. 6star topology of the system (Manjarrés et al. 2016)



One of the drawbacks of this previous project is the usage of PIC microcontroller whereas high knowledge of programming required. A beginner with no knowledge of PIC microcontroller will take some while of the programming language. Furthermore, PIC have a low power output.

Figure 2. 7 Block diagram of the ISFET network (Manjarrés et al. 2016)



To put into summarization, as the WCSN worked flawlessly, the current circuit with ISFET implementation can be compared with the commercial sensor. The journal was published in 2016 and 3 years later, it can be achieved and improvise with the implementation of IoT in the water system.

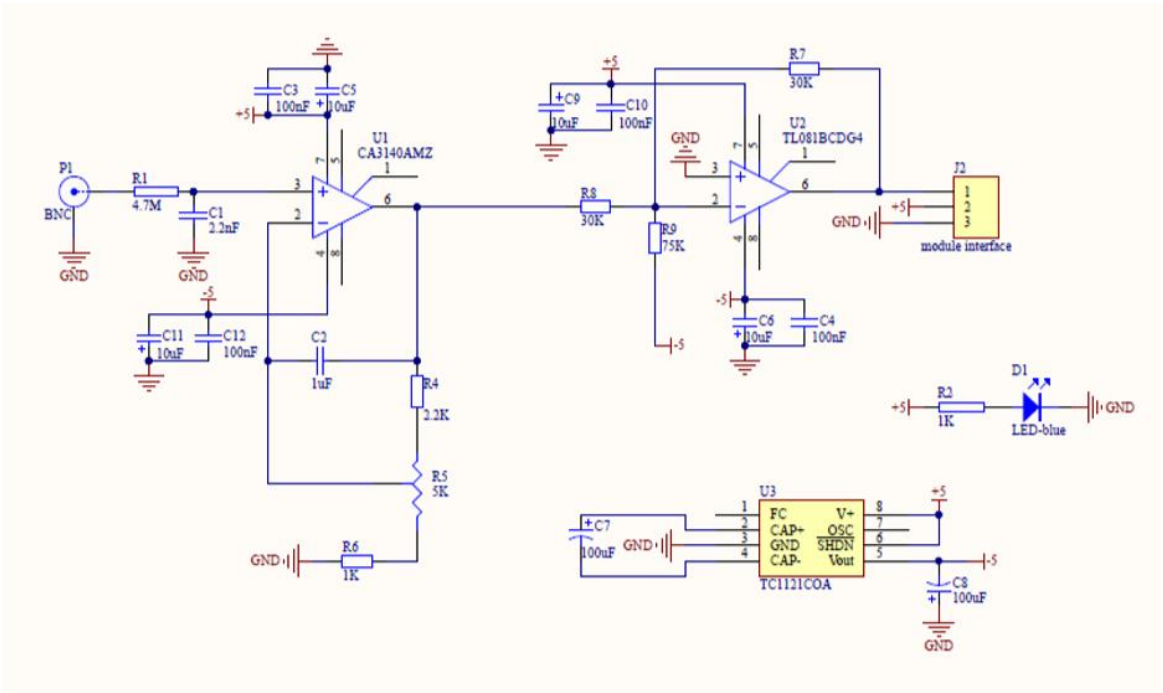
2.1.4 Water Quality Measuring Station (Journal)

This project study and carry the water quality by measuring the three types of water quality to be looked into, pH level, turbidity level and temperature. Similarly, as previous attached journal, this project acquired the usage of three analogue sensors and microcontroller Arduino UNO. This project was carried in order to study regarding the current issue that we're having now, water pollutions. (Sigdel 2017)

These three sensors will determine the properties of the water whether they are too acidic or excessively alkaline in term of pH level. More importantly, the sensors will measure the amount of total solid solution (TSS) in the water. Additionally, after the completion of sensors combination in the microcontroller, the result of each water quality properties will be displayed and presented in the LabVIEW. LabVIEW will get a better graphical user interface and better understanding of the project instructions.

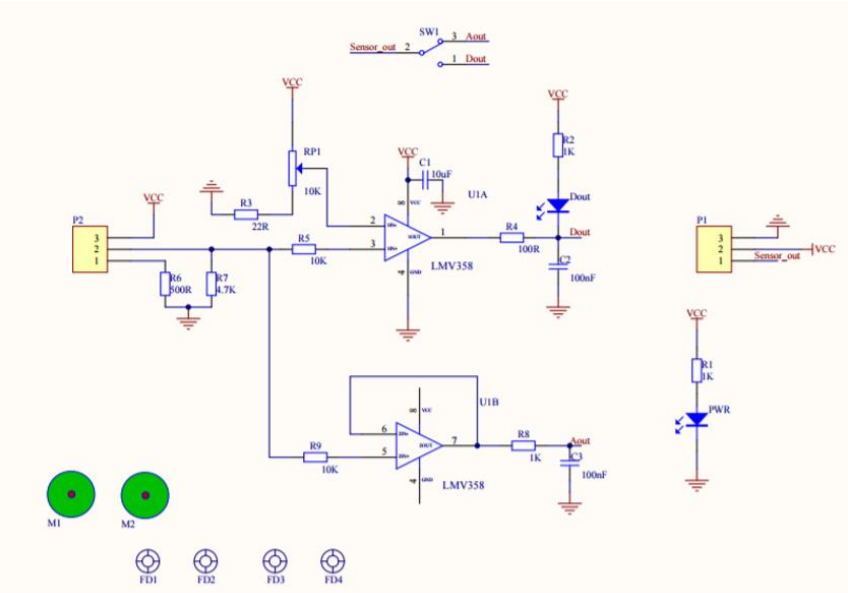
The core components of the project are those three sensors and one microcontroller as the main project board. The first sensor is the pH probe whereas is will measure the presence of hydrogen-ion concentration in the water solutions. As said by the author, the pH meter measures the difference between these two methods, measuring electrode and the reference electrode. The outcome of these comparison will be resulting an accurate pH value. Below is the pH circuit schematic for this project.

Figure 2. 8 pH circuit Schematic (Sigdel 2017)



Second component is the turbidity sensor. It is mentioned that this sensor is the hardest to analyse its' water properties due to difficult to visualise the particles in the water. Also, turbidity can also be considered as the optical property of the water where it can subjectively be seen by the eye of human. The higher the transparency of the water, the higher quality of the water which means to cleaner and purifier the properties of the water. To summarize, a high amount of solids solution in the drinking water is essentially bad for your health as it contains a massive amount of unwanted materials, particles and as well the ingredients of the water. Below is the circuit schematic for turbidity probe.

Figure 2. 9 Turbidity probe circuit schematic (Sigdel 2017)



The very last of the sensor is the temperature sensor, the sensor that was used in this particular project is DS18B20. Ironically, this sensor is a digital thermometer and so the connection from the second pin (DATA) to the analogue pin is totally unnecessary. Generally, this device has three pins, ground, data and vdd respectively. Last but not least for the hardware implementation, the microcontroller that was used in this project. An Arduino UNO was used because it is convenient and easy to use even for beginner. It comes with a 14 digital I/O pins and 6 analogue inputs. The UNO is basically equipped with tons of software and library knowing that it contains ATMega328 microcontroller whereas it is