Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT-BASED SMART WATER QUALITY MONITORING SYSTEM FOR BORE WATER SOURCE

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Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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I declare that this project report entitled "DEVELOPMENT OF IOT-BASED SMART WATER QUALITY MONITORING SYSTEM FOR BORE WATER SOURCE" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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DEDICATION

This project report is dedicated to my dear father, Mohammad Denis bin Abdullah who has been nicely my supporter until my research was fully finished, and my beloved mother, Hanisah binti Khalil Azmi who, for months past, has encouraged me attentively with her fullest and truest attention to accomplish my work with truthful self-confidence. I also dedicate this project to all the people who have worked hard to help me complete this project.

ABSTRACT

Water shortage and degradation is a growing concern as it is necessary for all human survival. Without water, people can only survive for a few days to a few months before serious health problems and even death. Due to the ongoing water crisis, such as in Kelantan, many households rely on bore water as an alternative water supply. Bore water is groundwater that has been accessed by drilling a bore into underground aquifers and pumping to the surface. Aquifers may contain chemicals and micro-organisms that are potentially harmful. Some of these chemicals are naturally occurring while others are a result of contamination. Therefore, it is well known that the water is not always drinkable as contaminated water can cause sickness such as gastroenteritis and diarrhea. The objective is to create a smart water monitoring system to monitor water quality and compare it to WHO standards, and to assess the accuracy and consistency of the device and its feedback to the user. In this project, IoT is used to monitor and analyze water data. The pH level and turbidity of water are measured to check its quality. The ideal pH value is between 6.5 and 8.5 and turbidity should be below 5 NTU (ideally below 1 NTU) according to World Health Organization (WHO). The data is processed by an Arduino and can be monitored online via Wi-Fi. 5 water samples were tested and their pH and turbidity values were measured. The conclusion is that sample 3 is safe for domestic use as its pH and turbidity values fall within the safe range compared to the other samples. The system is reliable as the pH values from water samples were similar to those from a pH meter. Other than that, the system gives consumers the option to customise the monitoring intervals to their liking and at the same time able to detect the water quality and make their own assessments of the water quality with the aid of the graph. The project is a success as all the objectives are achieved and could be improve by adding the number of sensors to assist in measuring water quality.

ABSTRAK

Kekurangan air dan pengurangan kualiti air menjadi satu masalah yang semakin menjadi-jadi kerana ia penting untuk kelangsungan hidup manusia. Tanpa air, manusia hanya boleh bertahan selama beberapa hari sehingga beberapa bulan sebelum mengalami masalah kesihatan yang serius bahkan kematian. Oleh kerana krisis air yang berterusan, seperti di Kelantan, ramai rumah tangga bergantung pada air bor sebagai sumber alternatif air. Air bor adalah air tanah yang diperoleh dengan membuat bor ke dalam aquifer bawah tanah dan memompa air ke permukaan. Aquifer mungkin mengandungi bahan kimia dan mikroorganisma yang berbahaya. Beberapa bahan kimia itu berlaku secara alami, sementara yang lain adalah hasil dari pencemaran. Oleh itu, diketahui bahawa air itu tidak selalu boleh diminum kerana air yang tercemar boleh menyebabkan sakit seperti gastroenteritis dan cirit-birit. Tujuan adalah untuk mencipta sistem pemantauan air pintar untuk memantau kualiti air dan membandingkannya dengan standard World Health Organization (WHO), dan untuk menilai ketepatan dan konsistensi peranti dan maklum balas kepada pengguna. Dalam projek ini, IoT digunakan untuk memantau dan menganalisis data air. Tahap pH dan keruh air diambil untuk menilai kualitinya. Nilai pH yang ideal adalah antara 6.5 dan 8.5 dan keruh seharusnya di bawah 5 NTU (ideal di bawah 1 NTU) menurut World Health Organization (WHO). Data diproses oleh Arduino dan boleh diamati secara dalam talian melalui Wi-Fi. 5 sampel air diuji dan nilai pH dan keruh mereka diambil. Kesimpulannya, sampel 3 selamat untuk kegunaan domestik kerana nilai pH dan keruhnya berada dalam julat yang selamat berbanding sampel lain. Sistem ini boleh dipercayai kerana nilai pH dari sampel air sama dengan nilai pH dari meter pH. Selain itu, sistem memberikan pilihan kepada pengguna untuk menyesuaikan selang masa pemantauan kepada pilihan mereka dan pada masa yang sama mampu membuat pengukuran kualiti air dan membuat penilaian sendiri mengenai kualiti air dengan bantuan graf. Projek ini berjaya kerana semua objektif tercapai dan boleh ditingkatkan dengan menambah bilangan sensor untuk membantu mengukur kualiti air

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CHAPTER 1

INTRODUCTION

1.1 Background

Bore water comes from groundwater, which in turn comes from rainwater that naturally seeps into the ground and is stored in the crevices between the ground and the rock. The formations and bodies of water in these subterranean spaces are called aquifers. Groundwater is brought to the surface through bores (wells) or a network of bores. Due to the anthropogenic factors affecting water quality such as excess use of fertilizers, manures and pesticides and much more, the bore water is no longer assured safe to drink as it can cause sickness such as gastroenteritis and diarrhoea. My motivation to undertake this project stems from its alignment with my personal values and areas of interest. I have a strong desire to address real-world issues and this project provides me with the chance to create a noticeable and meaningful difference.

1.2 Problem Statement

Bore water consists of radioactive minerals such as uranium which may found naturally within the ground. This radioactive element can dissolve in borewell water and can harm users to a greater extend. Other than that, nitrates and nitrites found in fertilisers (from agricultural run off), animal wastes, septic tanks and sewage treatment systems are a common problem with ground water. High salt level and pesticide used by farmers can also easily dissolve in underground water and hence effecting out health greatly. Moreover, after storms or floods, bore water could be contaminated by water borne diseases which causes sickness to

users. For example in Kelantan, people uses bore water as their water supply. According to Environment And Water Minister, Tuan Ibrahim Tuan Man, only 71.7% of the 1.7 million people residing in Kelantan have clean water supply. The statement given highlights the water crisis in Kelantan. This may result in increasing number of health cases occured due to the polluted water supply.

1.3 Project Objective

The main aim of this project is to propose a systematic and effective methodology to develop an Iot-based water quality monitoring system for bore water source. Specifically, the objectives of the project are as follows :

a) To develop a smart water monitoring system which helps in monitoring the water quality status.
b) To design monitoring system for the pH and turbidity of the water are measured and compared to the World Health Organization's intended values (WHO).
c) To analyse the accuracy and consistency of the device in terms of results and the feedback of the system to user.

1.4 Scope of Project

The scope of the project is defined as follows :

a) To measure the pH and turbidity value of the water and update the result to an application so that it could be observed by the user through their phone.
b) To develop a system where user could monitor the water quality through a WI-FI system.
c) To develop a connection between the Arduino board and phone and ensure the data given by both sensors is correct on the application used.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses current frameworks that have been investigated and developed by previous research groups. The scope of the project encompassed both general Arduino development and IoT applications, with a focus on creating a water quality monitoring system for bore water supplies. In addition to showcasing previous similar projects, relevant publications and journals will also be examined.

2.2 Importance of Clean Water

Freshwater is a world resource that is a gift of nature and important to farming, manufacturing, and the life of human beings on earth[1]. Anyone, regardless of ethnicity, religion, race, income, or faith, has the right to clean drinking water. Without water, life as we know it would not exist[2]. According to World Health Organization, contaminated drinking water and poor sanitation are linked to transmission of diseases such as cholera, diarrhea, dysentery, and polio. Poor water quality spreads disease, causes death and hampers socio-economic progress[3]. Poor drinking water quality is significantly affecting the health of consumers. According to the World Health Organization, at least 2 billion people worldwide drank from feces-contaminated water sources. Many developing countries have made waterborne disease reduction and the development of safe water supplies their significant public health priorities in recent years, and the situation has improved slightly. However, the

situation is far from ideal, especially in the rural areas such as Kelantan, where bore water is the primary supply of water.

2.3 Water Quality Monitoring of Bore Water

Water quality has become a critical issue in many countries, especially due to concern that fresh water will be a scarce resource in the future, so a water quality monitoring program is necessary for the protection of fresh water resources[4]. Monitoring water quality can be accomplished across both microbial and physiochemical measurements. Physiochemical parameters include electrical conductivity, pH,oxidation reduction potential (ORP), turbidity, temperature,chlorine content and flow[5]. Bore water is groundwater that has been extracted from an underground aquifer. Bore holes are named after the French word for boring or digging, which is where one could expect to find it. Bore water can be used for domestic and agricultural purposes, but it must first be treated before it can be used safely. The quality of bore water can vary widely depending on thequality of ground water that is its source[6]. The most common variables used to evaluate water quality in groundwater are pH, turbidity, salinity, oxygen content, and nitrate content. Other variables include heavy metals like iron and manganese, hardness minerals like calcium carbonate, and organics like arsenic, which can be poisonous in high concentrations.

2.4 Previous Related Research Work

Previous researches or articles are revised before moving forward with the development of the smart water quality monitoring project. The primary goal of reading previous research work is to discuss the theories and concepts which were used to solve the problems that will be encountered during the project's development. These sources have all been chosen as they were relevant to the project's purpose.

2.4.1 Arduino Microcontroller Processing for Everyone

The journal, "Arduino Microcontroller Processing for Everyone" by Barrett, Steven F brief on the various types of microcontrollers under Arduino such as the Arduino Uno, Mega 2560, memory of each microcontrollers and it's port systems. According to the researcher, the microcontroller is well equipped with various features such as memory system, port system, timer system, analog–to–digital converter (ADC), interrupt system, and serial communications. The figure below shows the systems in an Arduino Mega 2560.

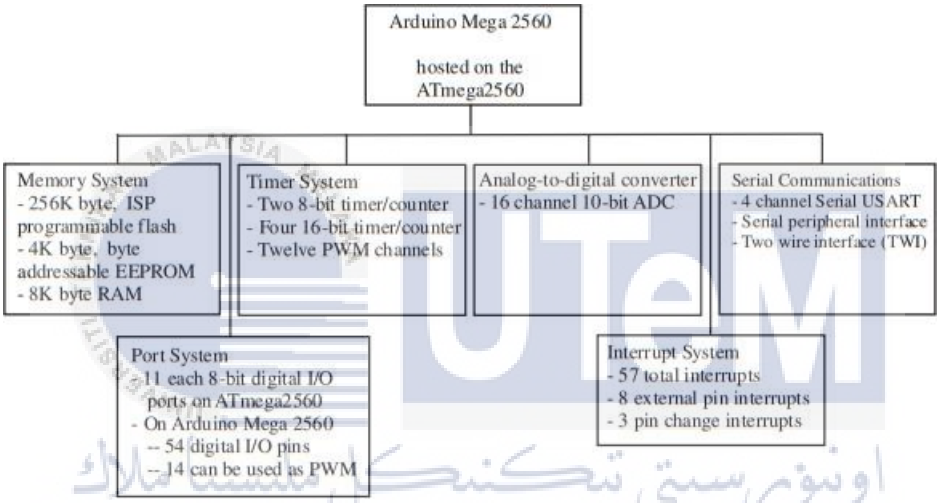

Figure 2.1 Arduino Mega 2560 Systems [7]

The Arduino Mega 2560's processing power is provided by the ATmega2560[7]. According to the researcher, the Atmega2560 too have three main memory sections which are flash electrically erasable programmable read-only memory (EEPROM), static random access memory (SRAM), and byte–addressable EEPROM for data storage.

2.4.2 Smart water quality monitoring system with cost-effective using IoT

According to Pasika S, Gandla S on their research on "Smart water quality monitoring system with cost-effective using IoT", the proposed system opreates with several sensors to define the water quality and Arduino Mega 2560 microcontroller as the most preparing

module and one information transmission module ESP8266 Wi-Fi module (NodeMCU). Arduino Mega is used in the project as it have low power consumption and small in term of size. Figure below shows the block diagram of the project.

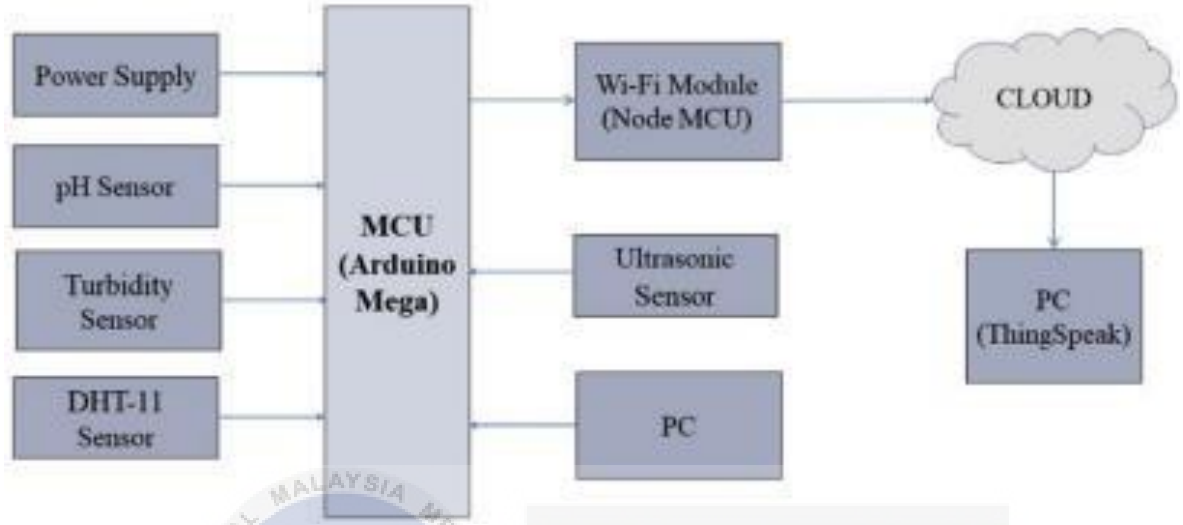

Figure 2.2 System Block Diagram [1]

Other than that, the researcher wrote that the ESP8266 is a low-cost Wi-Fi module that includes a full TCP/IP stack Wi-Fi chip and Tx and Rx serial transceiver pins are used by the ESP8266 to send and receive data, change wireless module settings, and change serial query commands. Figure below shows the hardware setup of the project.

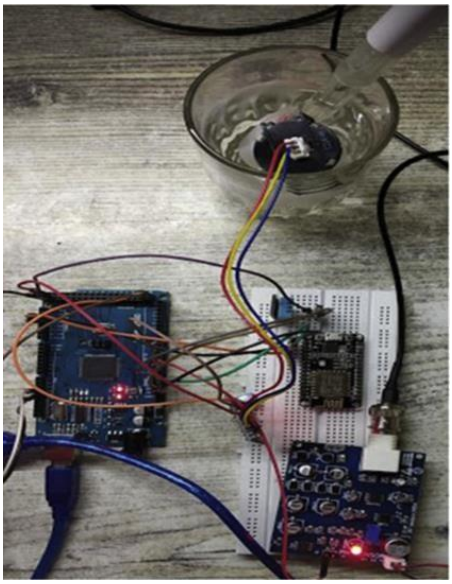

Figure 2.3 Hardware Setup of ProjecT[1]

2.4.3 Smart Water Quality Monitoring System Using Iot Environment

According to Nikhil , Rajender , Dushyantha G , M N S Khadri4, Jagadevi N Kalshetty on their research on "Smart water quality monitoring system using IoT environment", the proposed system is a reconfigurable smart water sensor interface device that includes data storage, data processing, and wireless transmission. The system measures five (5) different parameters which are pH value, water level, temperature, conductivity and turbidity of the water.

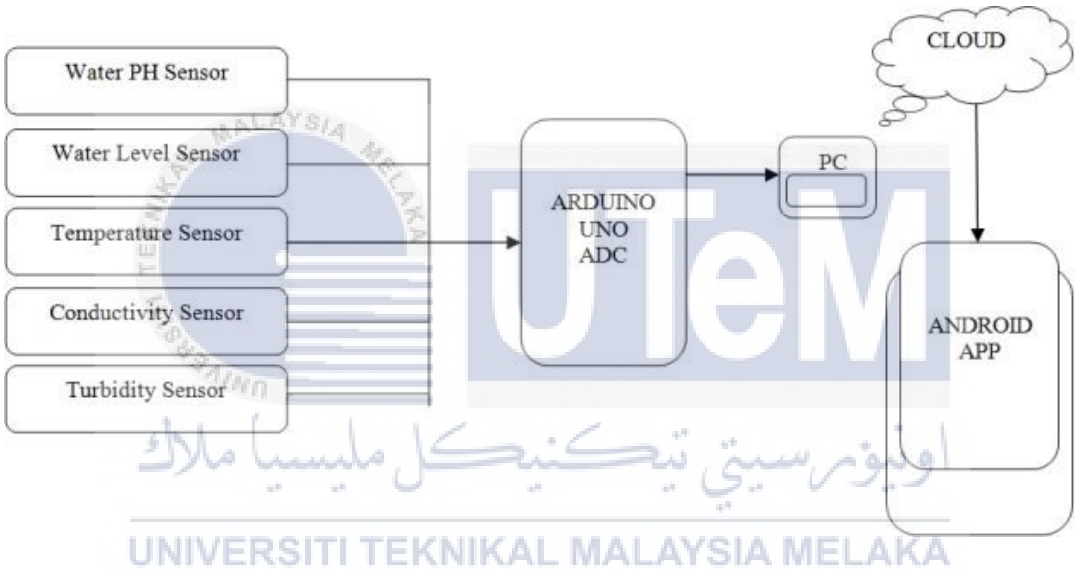

Figure 2.4 Smart water quality monitoring system in IOT environment [8]

Based on **Figure 2.4** above, it could be observed that all the sensors used are connected to the microcontroller, Arduino Uno which is used in this project. The heart of the hardware components is the Arduino board and Wi-Fi module helps in transmission of the data[8].

2.4.4 Reconfigurable Smart Water Quality Monitoring System in IoT Environment

The Wireless Sensor Network (WSN) and wireless communication technologies have been increasingly developed to assist human's personal and professional daily tasks[9]. According to Myint C, Gopal L and Aung Y on their research on "Reconfigurable smart water

quality monitoring system in IoT environment", the proposed system which is the smart water quality monitoring (WQM) system is a combination of FPGA design board, sensors, a Zigbee-based wireless communication module, and a personal computer (PC). The designed WQM system gathers five water data parameters which are pH level, water level, turbidity, carbon dioxide (CO2) and the water temperature.

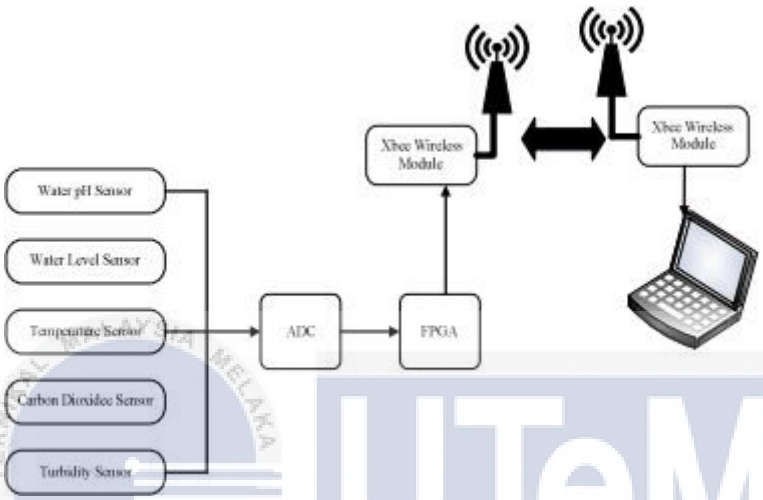

Figure 2.5 Block diagram of smart water quality monitoring system [9]

Based on the **Figure 2.5** above, it can be seen that the data transfer is from the sensors, to the FPGA board, then to the Xbee Wireless module and lastly could be monitored on a personal computer (PC). The Altera DE1-SoC board is utilised to control the entire system of the proposed smart WQM system[9]. The DE1-SoC development board features 85K programmable logic components, 4,450Kbits of embedded memory, 6 fractional phase locked loop (PLLs), and two hard memory controllers.

2.4.5 Internet Of Things Enabled Real Time Water Quality Monitoring System

Acccording to the research made by Geetha S, Gouthami S with the title of " Internet Of Things Enabled Real Time Water Quality Monitoring System ", the root drivers of water quality issues involve overexploitation of natural resources. Therefore, the researcher proposed

a system that measures conductivity, turbidity, pH level and water level. A controller forms the central part of the IoT enabled water quality monitoring system[3]. The microcontroller used in the project is known as TI CC3200 which have a built in Wi-Fi module and ARM Cortex M4 core which allows the micrcontroller to connect to the nearest Wi-Fi hotspot for internet access. Based on the research, the parameters were measured by placing the sensors into several different solutions.

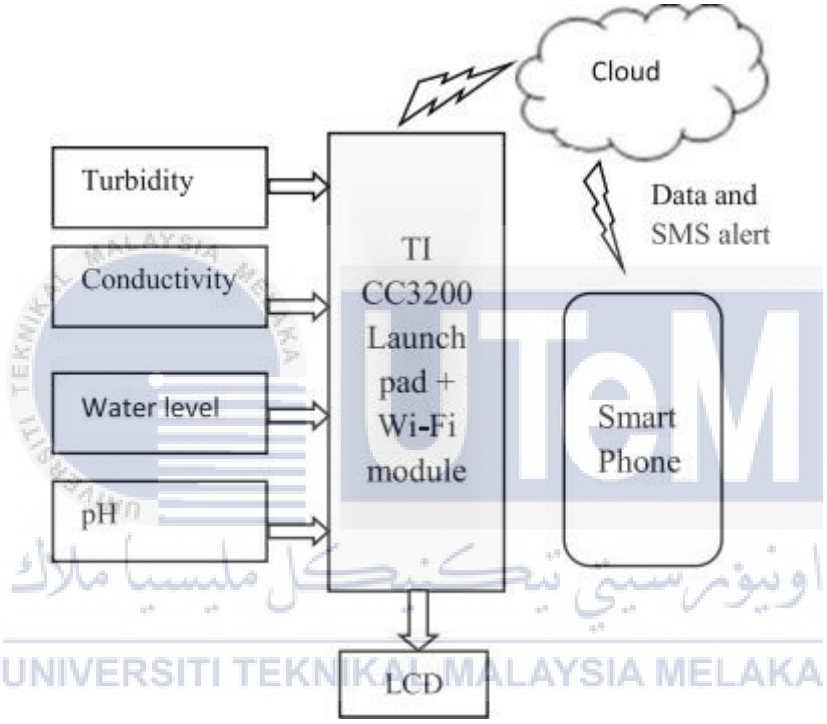

Figure 2.6 Block Diagram of The Proposed System [3]

Based on **Figure 2.6** above, the sensors and the liquid-crystal display (LCD) are connected to the microcontroller, TI CC3200. The datas obtained from the sensors are transmitted to the cloud with the help of the microcontroller. The values obtained by the sensors in the cloud can be accessed by the user via mobile application.

2.5 Previous Researcher Works Comparison

After reviewing previous researcher works, the microcontroller used, the variables measured and the monitoring device in each of the researcher's work is organized.

Table 2.1 Comparisons of Previous Researches

NO	Author	Year	Title	Variables	Controller	Monitoring Device	Market Price (microcontroller)
1	Pasika, S., & Gandla, S. T	2020	Smart water quality monitoring system with cost-effective using IoT.	• pH value of water. • Turbidity of the water. • Water level. • Temperature and humidity of the surrounding atmosphere.	Arduino Mega	PC	RM 59
2	Nikhil,R., Rajender, R. , Dushyantha, G. R., & Jagadevi, N.	2018	Smart Water Quality Monitoring System Using Iot Environment	• pH value of water. • Turbidity of the water. • Water level. • Temperature • Conductivity	Arduino Uno	Smart Phone	RM 44
3	Myint, C. Z., Gopal, L., & Aung, Y. L.	2017	Reconfigurable smart water quality monitoring system in IoT environment	• pH value of water. • Turbidity of the water. • Water level. • Temperature. • Carbon Dioxide level.	FPGA	PC	RM 102
4	Geetha, S., & Gouthami, S. J. S. W.	2016	Internet of things enabled real time water quality monitoring system. Smart Water	• pH value of water. • Turbidity of the water. • Water level. • Conductivity.	CC3200	Smart Phone	RM 212