ANALYSIS OF SENSORS FOR WATER LEVELLING IN EARLY WARNING SYSTEM

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Abstract

Majalaya is a low-lying area in the Bandung regency, large frequent rain that falls in the highlands Bandung caused the overflow of river water in the Majalaya area that lowland , so that causing flooding suppossed damage and good losses materially or immaterially. Along with technological advances today, for that it can be anticipated by relying on an early warning system so that it can minimize losses due to flooding. In making an early tool warning system compatible sensors are needed. Therefore in this final project an analysis is performed on several sensors by measuring how accurate the sensors are such sensors can provide water level information with several media different and with several types of water. The sensors analyzed are ultrasonic sensors type SRF-08, then lidar with type VL53L0X, and infrared sensor with type SHARP GP2Y0A21YK. The results of this thesis research are to determine sensors that are able to support an early warning flood system, so that of the three sensors that have been analyzed, sensors that are able to measure, have a performance that supportsthe early warning system of floods, and provide accurate information about water levels in real- time wherever and whenever. The results of the final project for each sensor in the experiments performed have varied results. Experiments carried out on two clean and dirty water media were given different results, the highest average accuracy value of the sensor in detecting water levels up to 2 meters was SRF-08 up to 90

Keywords: Water level sensors, early warning system, SRF08, VL53L0X, GP2Y0A21YK.

1. Introduction

1.1 Background

The recent occurrence of natural disasters makes peoples uneasy, natural disasters cause both material and non-material losses. The lack of rapid response information circulating in the community resulted in the community not being able to know when there would be a flood due to sudden arrival. Many ways can be done to anticipate and minimize losses, one of which is the implementation of an early warning system that provides information directly to the public. Flooding is a problem of natural disasters that often occur in all regions in Indonesia. One of the causes of flooding is that high rainfall causes the water not to be accommodated in rivers so that water overflows to the mainland. Walkie-Talkie's communication that causes the information conveyed is not responsive. In addition to the information delivered is fairly long and not efficient. For that, we need a water level measurement tool that can measure in real-time, which is then sent through a long-distance communication system so that information about the water level can be obtained at any time. Given the importance of monitoring when rainfall is high so that it is easy for land areas that are lower than sea level to flood, the authors would like to contribute by making an early warning system that is efficient and easy to use. The design is to first analyse the 3 sensors namely SRF08, VL530X, and IR Infra red, with the results obtained on the three sensors, the sensor will be selected for use.

Research [1] developed VoIP for telemetry flood early warning system. In the warning system flood early there are two stations, namely monitoring stations and

warning stationsthat are not in one location, by because of that by utilizing VoIP that functions for telephones can function as telemetry, so as to provide early warning of disasters flood. Similar research utilizes a database from various sources of internet sites. Each sensor is seen from the ability to measure which measurements are effective, then which are easy to use. There are several method to measure identify the water level, including the automatic water level estimation using mobile phone and then the arduino using sensor capacitive[2]. Previous research is using the principle of modulation of the laser pad sensor 1 2 Fiber Bragg Grating (FBG).

Optical methods are considered more resistant to environmentsthat are conductive and explosive compared to other methods. In addition, the optical method is also resistant to magnetic wave interference. Several optical fiber-based liquid level sensors have been developed in recent years [3] In addition, the study developed VoIP for telemetry flood warning systems. In the early warning system floods detect moving objects by using the background substraction method and the Kalman filter. The results obtained are the background substraction method can detect object motion on the video and the Kalman filter can estimate the movement of the object. Other than that other research [4] Using background substraction and frame differencing techniques to detect motion. The results obtained are able to detect the movement that occurs, this method is also sensitive to threshold values and changes in light are considered moving objects. It's just a drawback in this study is that the tracking test only shows water conditions in normal conditions and hazard conditions only.

This study aims to develop a water level level tracking system by utilizing a sensor by utilizing a sound that is a sensor that functions to convert physical quantities (sounds) into electrical quantities and vice versa. How this sensor works is based on the principle of reflection of a sound wave so that it can be used to interpret the existence (distance) of an object with a certain frequency. In addition this study also uses a remote sensor technology using scattered light properties to find the distance and information of an object from the intended target. The method for determining the distance of an object is to use a laser pulse.

1.2 Problems Formulation

In the undergraduate thesis, the solution presented was the analysis of 3 sensors in the measurement of water elevation, processing of sensor data and monitoring of changes in water elevation so that systems and sensors could be used to serve as early warning systems for flood hazards.

1.3 Objective

The final goal of this final project is to analyse 3 sensors that are used to monitor water levels in real-time.

1.4 Scope and Limitations

The scope and limitations of problem that this final project is:

1. The microcontroller used in this undergraduate thesis is ARDUINO UNO R3.
2. Analysing 3 Types ofsensors used in thisfinal project are VL53LOX, SRF08, IR infrared sensors. 3
3. The maximum limit for measuring the height of the water be measured in no more than 6 meters.
4. Measurement only use in cylindrical media.
5. Do the analysis in clear water and mud water.
6. Frequency and amplitude used fabrication.
7. Get sample in specific time •In experiment, temperature and condition in firld ignored

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1.5 Research Methodology

The method that will be used to complete this undergraduate thesis is:

1. Study of literature

   At this stage, the identification of existing problems is carried out such as learning the basic theories about the sensors used, microcontroller and C programming language.

2. Planning

   System design is done by designing a network based on the function of each working system block and software design, in this case, the C programming language design.

3. System Testing and Analysis

   At this stage, the system testing has been made and then continued by taking data from the results of testing the system and analysing the system. The data obtained in this process will be verified in advance so that it is by the parameters and the desired experimental scenario.

2. Basic Concepts

2.1 Internet of Things (IoT)

Internet of Things is a virtual world concept of information technology integrated with the real world, the aim of the real world to be more easily accessed through devices connected to the network and integrated into the business and daily life scenarios. The Internet of things is a concept of progress in the future, where the internet of things is an integrated part of the internet in the future which is a dynamic global network infrastructure with independent configuration capabilities based on standard communication protocols and physical and virtual objects possessing identity and using intelligent interfaces and integrated into information networks [5].

2.2 Flood

Flooding is a natural disaster that occurs due to the increase in the volume of water that exceeds the normal limit in a place [6]. Flooding is a part of the hydrological cycle, which is the part of water on the surface of the earth that moves to the sea. Floods occur because the volume of water that flows in a dominant place is determined by the level of rainfall and water infiltration into the ground. There are many causes of flooding including poor waterways, poorly absorbed water catchment areas and the most significant is poor public awareness[6].

2.3 Microcontroller

The microcontroller is a chip that can control electronic circuits and store programs and generally consists of a Central Processing Unit (CPU), I / O, memory, 5 6 supporting units such as Analog-to-Digital Converter (ADC) that have been integrated therein [7] as shown in the figure 2.1

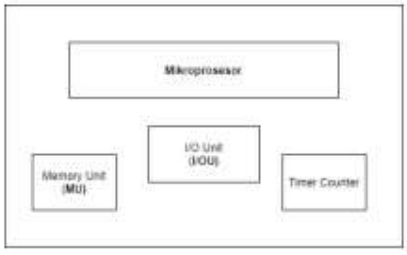

Figure 2.1 General Description Of The Microcontroller

Arduino is one type of circulating microcontroller which is found by Massimo

Banzi and David Cuartielles that aims to help students create design and interaction devices at low prices [8]. Arduino is also a microcontroller-based electronic device that is flexible and open-source, so it has various boards such as Arduino UNO, Duemilanove, Leonardo, Nano, Mega 2560 / Mega ADK, Mega (ATMega1280), Esplora, Micro, Mini, NG / Older and others [8]. Arduino Uno or commonly known as ATMega 328P is a microcontroller that is often used as an open-source electronics platform based on flexible software and hardware for testing with various sensor systems that can detect and respond to situations and conditions, the figure of arduino uno device show in figure 2.2.

Figure 2.2 Arduino Uno

Arduino Uno is a microcontroler also called ATMega328p which has a 5v source voltage. arduino to also have a volatge recommendation that is 7 - 12v and has a volatge limit of 6 - 20v. Digital I / O PINs on Arduino Uno total 14, of which 6 are 6 PW, Output. with a weight of 25g and a length of 68.6mm and a width of 53.4mm make Arduino easy to apply because it has a small and light weight.

2.4 Sensor

The sensor is a tool to detect/measure something that is used to convert mechanical, magnetic, heat, light and chemical variations into voltage and electric current. In the control and robotics system environment, sensors provide similarities that resemble the senses of the eye (vision), ears (hearing), nose (smell), tongue (taste), skin (taste/touch) which will then be processed by the controller as the brain [9] The sensor gets data from the environment which is a mechanical quantity and displays the data in the form of electrical quantities. The measurement and regulation technique electronically functions to change the physical stress. Examples such as temperature, light, force, rotational speed become proportional to electricity [9].

2.4.1 Ultrasonic Sensor

The working principle of this sensor is converting ultrasonic waves intoelectrical signals and vice versa and is used to detect the presence of a particular object in front of it, the frequency of its operation in the area above the sound wavesfrom 40 kHz to 400 kHz, by measuring the period of the beam emitted by measuring 9 the distance at reflector.

2.4.2 SRF08

Sensor SRF08 ultrasonic sensor is the development of the HCSR-04 sensor, thisdevelopment is carried out to improve the quality of HCSR-04. SRF08 is the most popular class of ultrasonic sensors and is widely used in robots and microcontrollers. SRF08 ultrasonic sensors are also categorized in a proximity sensor, in the detection of the distance using ultrasonic waves generated by this sensor.

2.4.3 VL53L0X Sensor

The VL53L0X type Micro LIDAR (Light Detection and Ranging) sensor has a high degree of accuracy in readings. The VL53L0X is a fully integrated miniature module that integrates an embedded infrared starting sensor, VCSEL (VerticalCavity Surface-Emitting Laser), paired with an internal physical infrared filter and SPAD array. front (Single Photon Avalanche Diode) [12]. This sensor is commonly used as a navigation robot with good accuracy values. However, the tool still has a weakness when in extreme weather that is the appearance of noise at the time of reading. VL53LOX is a type of sensor that can measure an absolute distance of 2m with fast start frequencies up to 50Hz. The VL53LOX uses the latest generation ST technology ToF which allows measurement of absolute distances regardless of target color and reflection. ToF (Time-of-Flight) is a method used to measure the distance between a sensor and an object, the distance calculation is obtained from the difference in signal transmission and when the signal sent is received back by the sensor [13].

2.4.4 IR INFRARED

SHARP GP2Y0A21YK is an IR sensor used to measure distances and also used to detect obstacles for robots . Usually, the sensor is used fatherly measuring in the range of 10-80cm as show in figure ?? Sharp GP2Y0A21YK sensor has 3 pins namely voltage, ground and signal. The output on this sensor is an analog sensor that can connect to an analog to digital converter so that it can take distance measurements if it detects that the output threshold can be connected to thecomparator [14].

3. System Design

This research aims to analyse the three sensor by calculating the accuracy and performance of the three sensors,especially knowing the distance that can be detected by the sensor. The desired result is to get the results of the analysis of the three sensors which will then be applied to the flood early warning system. This study aims to develop a water level level tracking system by utilizing a sensor by utilizing a sound that is a sensor that functions to convert physical quantities (sounds) into electrical quantities and vice versa. How this sensor works is based on the principle of reflection of a sound wave so that it can be used to interpret the existence (distance) of an object with a certain frequency. In addition this study also uses a remote sensor technology using scattered light properties to find the distance and information of an object from the intended target.

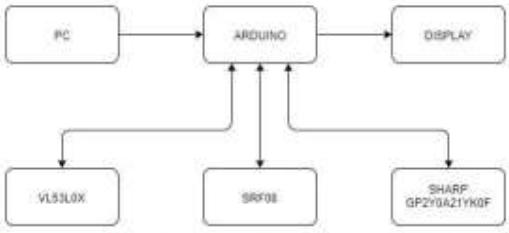

Figure 3.1 System Block How Arduino Connect With Other Sensors

in the block system figure 3.1, the authors describe how sensors work. the first connection is made between Arduino Uno to the PC which then uses

the Arduino IDE application to program so that the sensor can run which then results from measurements are shown on the serial monitor already available on Arduino IDE. the results of the measurements are displayed on the display, then captured to be entered into ms excel for analysis on the sensor, so it can determine which sensor is the best among the three sensors being analyzed This study aims to develop a water level level tracking system by utilizing a sensor by utilizing a sound that is a sensor that functions to convert physical quantities (sounds) into electrical quantities and vice versa. How this sensor works is based on the principle of reflection of a sound wave so that it can be used to interpret the existence (distance) of an object with a certain frequency. In addition this study also uses a remote sensor technology using scattered light properties to find the distance and information of an object from the intended target. The method for determining the distance of an object is to use a laser pulse.

Realization of the system on the three sensors is done by connecting sensor legs on the arduino pin that have been determined using a breadboard as a connector. This system is realized figure 3.2 as follows

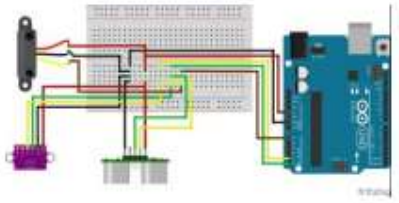

Figure 3.2 System Diagram to Show Arduino connect to Sensors

Data collection in each medium will be carried out as an illustration above figure 3.3, where the device will be allowed to fire the transmitter waves in the direction any reflectance medium that you want to test. After that the reflected media willbe shifted every 10 cm as far as 200 cm, then continued every 100 cm as far as 500 cm either toward the media. After sliding, while recording the value of the distance listed on the device and then compared with a distance from the ruler.

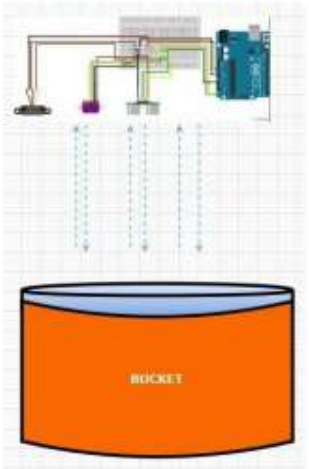

Figure 3.3 Illustration of how Arduino measurement the distance

4. Result and Analysis

Experiments were carried out on two different media, namely clean water and dirty water. In the first experiment, the calibration process on every Arduino hardware and every sensor was carried out. Calibration is done at a point of 10 cm which is done within 30 ms. by performing a calibration and equating it with a manual ruler calibration measurement carried out by observing the results issued by Arduino and likened to manual measurement using a ruler. Here are the results of the calibration that we observed.

Figure 4.1 Measurement With Arduino and Sensors Using Clear Water

After performing the calibration, the first experimental process was measured in Clean water media. The experimental process was carried out consecutively starting from 10 cm to 200 cm, in this chapter the analysis of each condition is discussed to get the difference of each condition and get accurate information.

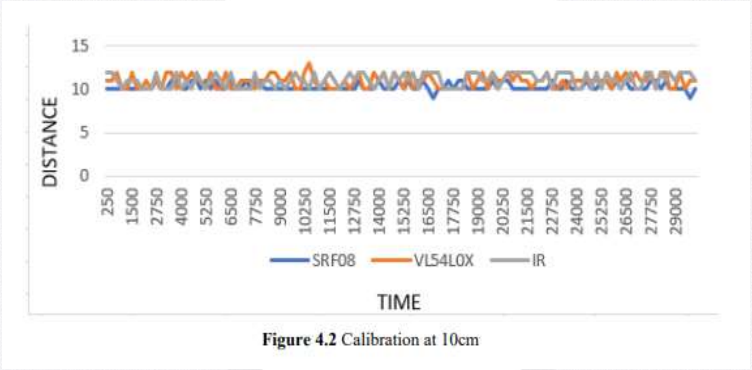

Figure 4.2 Calibration at 10cm

The calibration results are analyzed to fit the desired calibration process until the data obtained is accurate, vulnerable to calibration levels made from 7-13 cm.The calibration results obtained from the three sensors are very accurate and only make 3 changes to the measurement to get the desired results then proceed to the experiment stage.

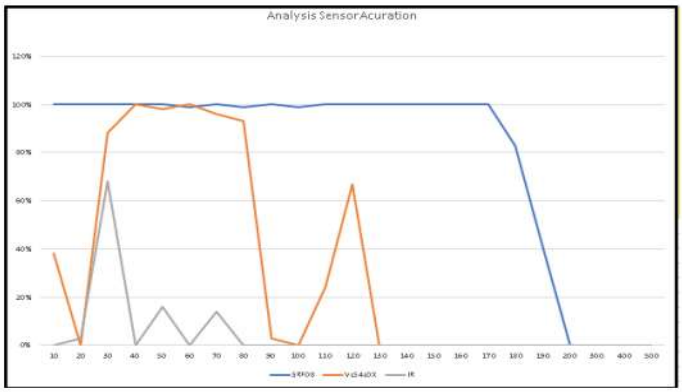

Figure 4.7 Measurement Using Clear Water

From the analysis conducted Ultrasonic sensors according to the datasheet range in the shooting signal up to 11 m. But in the Accuracy experiment, the sensor only reached 170 cm, after an analysis that affected the transmission distance and received a widening signal bandwidth so that the sensor detected objects that were not objects. VL sensor itself is theoretically a sensor with measurements using the concept of TOF so that the sensor will reflect back the received signal where the signal can only be reflected through solid fields, so that if the water media that is still able to penetrate the light will violate the rules of theoretical physics because light can only be reflected in the field dense. So that the data obtained on the VL sensor measurement is accurate up to a distance of 50 cm. The IR sensor cannot measure accurately even if it starts from the lowest distance after some analysis has been carried out and is linked to the basic theory that the sensor cannot be directly exposed to light because it can interfere with the accuracy of the exposed ethical sensor detector. to direct light from the sun, tungsten lamps and so on, there are some cases where you cannot measure distances correctly. Please pay attention to the design that the detector is not exposed to light directly from a light source. angles also affect the process of data retrieval, such as IR sensors, the results that are not maximized on sensors that are approved in the compilation of data capture where angles are not received. beamwidth on the SRF08 sensor also affects the measurement process where the compilation process takes the beamwidth data on 23 the SRF08 sensor by 22.5 degrees. and for the VL53L0X sensor it is necessary to pay attention to the compilation pattern of retrieving data. Because according to the data sheet the process of taking data on the sensor VL53L0X sensor will emit a unique pattern on the surface.

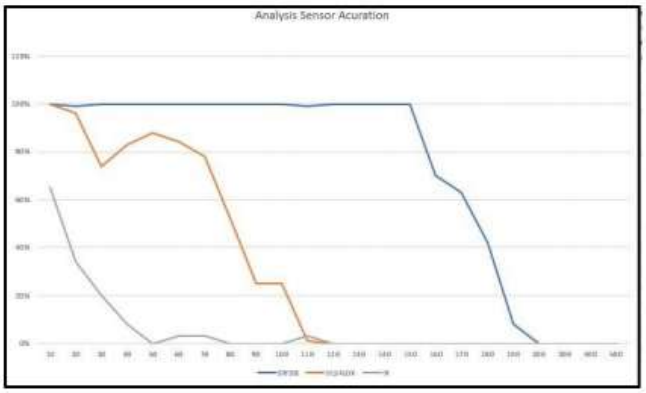

Figure 4.11 Measurement water level mud water media

From the table, we can determine that the SRF08 can measure the height of dirty water accurately up to 160 cm even though in the data sheet (call the data sheet in chapter 2) it is written that the srf08 sensor can measure heights up to 11 m, but in reality, on the ground, it was found that the sensor after we did experiment several times which were then analyse in several media, namely measurement using a bucket with dirty water and then in the river it turns out that the sensor has some disadvantages namely very wide bandwidth (call chapter 2 basic bandwidth theory in srf08) so it must measure in a wide field so that no interference occurs and can measure height accurately. VL sensor itself is theoretically a sensor with measurements using the concept of TOF so that the sensor will reflect the received signal again where the signal can be reflected only through solid fields, so if the water media is dirty even though the sensor is still able to penetrate the light will violate the rules of theoretical physics because light only can be reflected on a solid plane. So that the data obtained on the VL sensor measurement is accurate to a distance of 50 cm. The IR sensor has flaws even though the sensor is still able to penetrate the light will violate the rules of theoretical physics because light can only be reflected in a solid plane. So that the data

obtained on the VL sensor measurement is accurate to a distance of 50 cm. The IR sensor has a disadvantage, this sensor has a weakness when the object detected is in the form of a wavy wall where the sonar signal will be reflected in the other direction so that the distance is not detected, the infra red sensor does not calculate the beam time but instead calculates where the returned infra red ray is received by photo transistor circuit. The farther the distance, the more right the infra red ray is received on the photo transistor circuit and the smaller the output voltage. Therefore this sensor outputs in the form of a voltage so that it is not accurate when 27 measurements are made using water because water is a wavy media so that it is unable to detect objects correctly. On the data sheet, the sensor is able to measure height to a distance of 20 to 80 cm..

5. Conclusion

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In this thesis, the author has tested and analyzed the three sensors using Arduino Uno as a microcontroller and as a medium in the form of clean water and dirty water. In this final project, three sensors have been analyzed, namely SRF08, VL and IR sensors. A third sensor has been tested which is then analyzed to obtain the accuracy of the sensor in measuring water level or water level measurement. Experiments carried out in the measurement of water in clean water media were carried out with a displacement distance of 10cm to reach the sensor limit which was no longer able to detect objects. Measurements were also carried out in the river media to prove the accuracy of the work of the three sensors. In measurements made on clean water media, the accuracy of the water level for the SRF08 sensor is accurate to a distance of 200 cm even though data sheets are obtained for the measurement range up to 11 meters. Then in dirty water, the sensor works with clean water, the SRF sensor is able to measure water levels up to 200 cm very accurately, but at measurements above 200 cm the sensor does not work well, because after that distance there are only a few disturbances in detecting objects because bandwidth widening sensor. The VL sensor only has accuracy at a few measurement points, this is because the sensor has flaws and lacks competition for water level measurements. IR sensors are not accurate at all points because these sensors are not competent to measure water levels. as for it is very necessary to pay attention to the performance of each sensor. because each sensor has different differences. it is not enough to analyze each sensor only based on the height. Because to measure the distance each sensor has a different way. In the initial purpose of this analysis I targeted the SRF08 sensor to measureup to 6 meters. because according to the data sheet srf08 sensor is able to measure with a range of 6 meters. but the result of the field that I get is srf08 able to measure with a maximum height of 2 meters. in this sensor analysis, the best sensor in the measurement results is the sff08 sensor, because the sff08 sensor is able to measure up to 2 meters compared to the VL53L0X sensor and IR sensor. and the price of the srf08 sensor is expensive compared to the VL53L0X sensor and IR sensor.

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