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# Design of a fuel oil measuring device for on arduino mega based SPBT tank at Indonesian army unit

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## ABSTRACT

Fuel storage in storage tanks (SPBT) generally uses manual methods, causing inaccuracies and inefficiencies. To overcome this problem, this research focuses on developing a microcontroller-based automatic measuring instrument with a PING ultrasonic sensor. Manual methods are often prone to human error, while these automated tools are designed to improve measurement accuracy and efficiency. By using a PING ultrasonic sensor, this tool can measure liquid levels with a higher degree of accuracy, reducing the potential for error. This automated process enables real-time monitoring, with measurement results directly displayed on the monitor or LCD. The use of this method also allows measurements based on cylindrical tank type, increasing operational flexibility. The research results show that this tool is more efficient than manual methods, minimizing errors and increasing information availability. Evaluation of the entire system shows that the desired fuel oil stock monitoring system can provide adequate performance, as well as ensure stock maintenance is maintained properly. However, there is an average error of about 0.11% in the tank volume measurements, which is caused by slight curvature in the tank structure. In conclusion, the use of this technology in SPBT is expected to increase fuel management efficiency, reduce operational costs, and provide information on fuel availability accurately and quickly. Thus, this research makes a significant contribution to the development of more effective storage tank monitoring and management systems

**Keywords**: Microntroller; ultrasonic; volume; LCD; silinder

## 1. INTRODUCTION

TNI Fuel Filling Station (SPBT) is a place where official vehicles and private vehicles of TNI personnel, such as cars, motorbikes or trucks, can refuel. Inside the SPBT, there is a storage tank that stores fuel which will be pumped to vehicles that need it [1] Each SPBT has a storage tank below ground level as a fuel tank [2].

The BMP loss calculation time is carried out every month. Fuel supplies in tanks must always be monitored to maintain the availability of fuel to be distributed to TNI personnel. The shrinkage rate for the diesel type is 0.33%, and for the premium type it is 0.41% [3]. Measuring the capacity of fuel oil tanks at SPBT is currently still carried out using the mechanical dipstick method or direct measurement. Taking measurements manually can be more difficult and less accurate, especially at night with little or inadequate light [4].

Manually measuring the level of petrol or diesel is less practical because the measuring rod must be located where it is submerged in the liquid. This can cause errors in reading the scale on the measuring device. Due to the uncertainty about the liquid level in the holding tank, there is a possibility of spillage or running out of the material inside due to lack of supervision [5],[6],[7].

Measuring devices like this are generally a series of instrumentation devices that involve electronic sensors, signal conditioning, controllers, and display of measurement results [8]. An example of an instrumentation system that is often used is a device for measuring the level of liquid in a fuel storage tank (SPBT) [9]. The ultrasonic sensor applied in this research follows guidelines which state that the sensor has a high level of accuracy. Ultrasonic sensors can operate in the frequency range of 20 kHz to 2 MHz with the ability to detect objects through the reflection of sound waves [10]. Adopting two structural components, namely transmitter and receiver, where an object produces waves and the receiver sensor receives reflected waves from the object [11].

Based on this description, the aim of this research is to develop a microcontroller-based automatic measuring device with an LCD screen to display liquid volume data. This device is expected to provide support in monitoring fuel oil levels, assist SPBT officers in measuring fuel levels in storage tanks with a high level of accuracy. The contribution of this research is directed at improving the fuel monitoring process at TNI Fuel Filling Stations by designing an effective liquid volume measuring device. The integration of LCD as a data display makes it easy to monitor and manage fuel supplies in real-time. The selection of ultrasonic sensors as the main component of measuring instruments provides a high level of accuracy, reduces the potential for error and increases measurement reliability. Reference to the working frequency of ultrasonic sensors also shows the use of more sophisticated technology. This research not only helps improve the efficiency of fuel management at SPBT, but also provides innovative solutions by applying modern technology in measuring liquids in storage tanks.

## 2. METHOD

The aim of determining these design specifications is to facilitate the implementation of creating an SPBT storage tank monitoring system according to the desired needs. This device acts as a control and monitoring system to determine the oil level in the tank. The ultrasonic sensor will send an ultrasonic signal through the transmitter until it reaches the barrier. The reflected ultrasonic signal will be received by the ultrasonic sensor receiver and sent to the microcontroller unit. In the microcontroller, the ultrasonic signal will be processed to calculate the distance between the sensor and an obstacle (reflecting surface), which ranges from 3 cm to 300 cm [12]. The ultrasonic sensor functions to detect the presence of objects in front of it and the output is a digital voltage which is directly processed by the ATmega8535 microcontroller [13][14]. The LCD and LCD driver are used as display media during control, while the power supply acts as an energy source for the entire system [15]. The ATmega8535 microcontroller acts as a control center which can be programmed using C language to regulate various functions, including automatic volume measurement [16] [17].

### 2.1 Research flow diagram

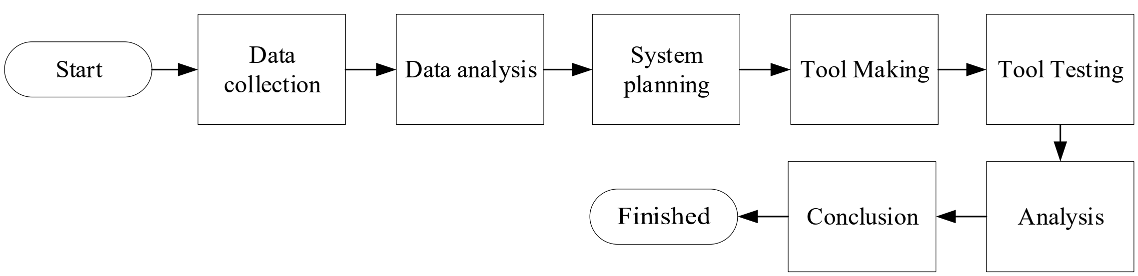


Figure 1. Research flow diagram

Figure 1, the research flow diagram shows that this research designed an SPBT fuel tank measurement system using Arduino Mega, selecting a sensor that corresponds to the desired measurement range, accuracy and level of precision, and integrating components such as pumps, valves and indicators. visual. Figure 2 by building a prototype, writing program code, and conducting field trials, this research aims to present an innovative solution that can monitor and improve fuel management efficiency, with a research report including evaluation results, data analysis, and comparison with conventional methods.

Remarks:
1. Box Panels
2. LCD screen
3. Switch
4. Pole
5. Fuel tank

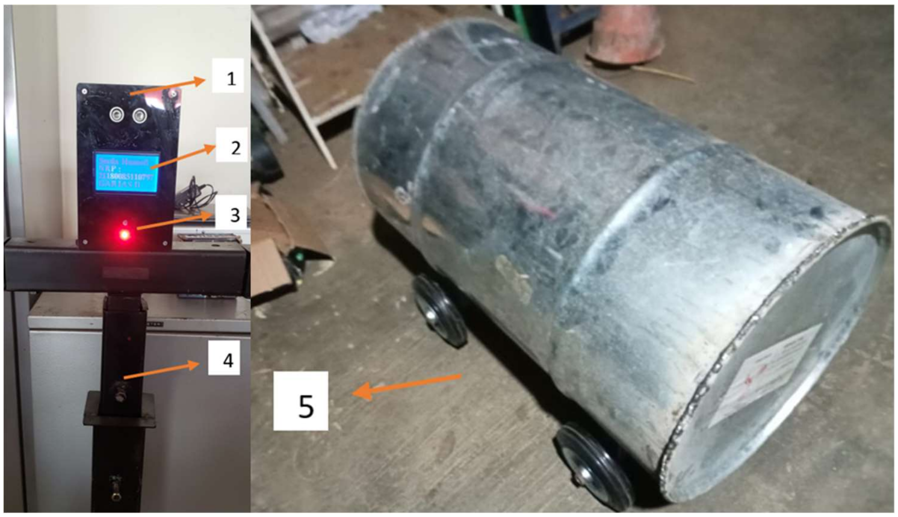


Figure 2. Tool component design

2.2 Design specifications

Determination of design specifications aims to make it easier to realize the design of fuel oil measuring devices in SPBT storage tanks which are made according to what is desired. The model specifications to be realized are shown in Figure 3. The following is a block diagram of the tool design:

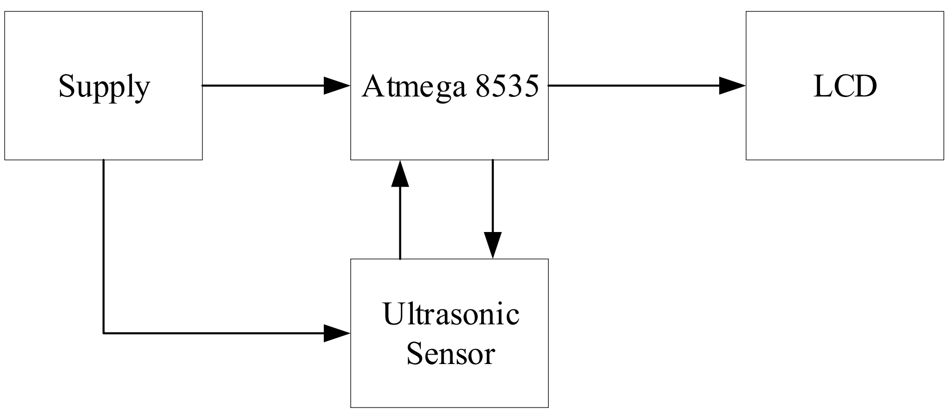


Figure 3. Block diagram of tool design

The operational steps for designing a fuel oil measuring device in the SPBT storage tank in Figure 3 can be explained as follows:

a) a) Supply is a component to ensure that electronic devices receive electrical power with appropriate parameters.
b) The ATmega8535 microcontroller is used to process the data received from the sensor and send it to the system output which is displayed via the LCD screen. The ultrasonic sensor is capable of measuring distances ranging from 3 cm to a maximum distance of 4 meters.
c) The LCD screen plays a role in displaying the results of measuring the distance between the sensor and the object in decimal number format.

## 3. RESULTS AND DISCUSSION

After completing the planned construction of the tool, the next step is to carry out measurements and tests. This action is necessary to understand the characteristics of each piece of hardware and the overall function of the tool.

### 3.1 How the tool works

In this research, a prototype storage tank monitoring system at SPBT based on the ATmega8535 microcontroller was designed. The hope is that this tool can become a device that provides information when the fuel level in the storage tank is approaching exhaustion.

The underground tank monitoring system at SPBT is based on the principle of using the reflection of sound waves to detect the presence of objects, namely fuel in buried tanks. The operation of this system involves working frequencies in the range above sound waves, namely between 40 KHz to 400 kHz. When sound waves detect the presence of fuel in the tank, the sound waves will be reflected back, and the receiving sensor will receive the ultrasonic waves back.

At that time, the receiving sensor will measure the distance between the sensor and the object, and this distance value will become input for the microcontroller which functions as the main controller. Simultaneously, the measurement results will be immediately displayed on the LCD screen.

### 3.1 Error graph

The error graph between actual and measured volume reflects the difference between the actual value and the value measured by the sensor. The error can be linear with offset, non-linear, or influenced by external factors such as temperature or humidity. After that, the tool needs to be calibrated to ensure measurement accuracy. This can be done by adjusting the measurement results to the actual fuel volume. If the measurement result is smaller than the actual volume, a calibration factor can be used.

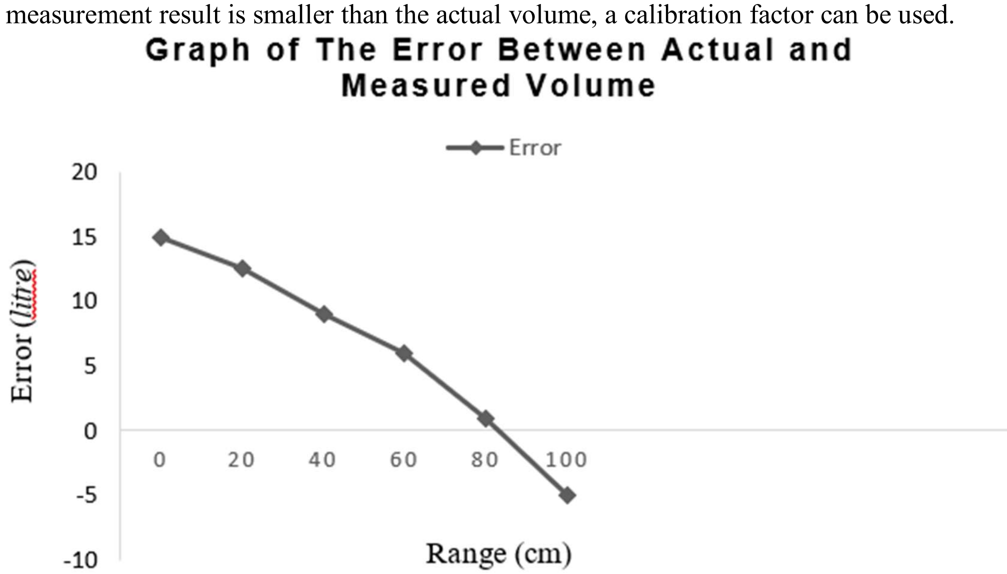


Figure 4. Error graph between volumes

Figure 4 the testing process with a calculation distance of 20 cm each, there was an error rate of up to 2.5 liters. This shows that the object being measured is farther away, the sensor detection level, the greater the error rate. This is influenced by several factors, including the characteristics of the tube and the type of liquid in the tank

Table 1. Error between actual and measured volume

| Vactually | Vmeasurement | K(Calibration Factor) | Calibration Results (k x Vmeasurement) |
|---|---|---|---|
| 100 | 90 | 100/90 | 100 |
| 150 | 140 | 150/140 | 150 |
| 200 | 180 | 200/180 | 200 |
| 250 | 220 | 250/220 | 250 |

| Vactually | Vmeasurement | K(Calibration Factor) | Calibration Results (k x Vmeasurement) |
|---|---|---|---|
| 300 | 280 | 300/280 | 300 |

Table 1 the calibration data provided involves the variable Vmeasurement and the calibration factor K. The calibration results are calculated using the formula (k x Vmeasurement) for each value of Vmeasurement. Analysis shows that the calibration results provide different values from the V measurements, indicating an accuracy correction. Evaluation of the accuracy of calibration results is needed to ensure the effectiveness of calibration factors in correcting measurement inaccuracies. It is also important to consider the reliability and maintenance of calibration factors to maintain the consistency and accuracy of the measurement system.

### 3.2 Ultrasonic sensor test results

This test was carried out to determine the accuracy of ultrasonic sensor measurements which can be monitored on the server in real time. Then the testing experiments and data collection can be seen in Table 2.

Table 2. Ultrasonic sensor test results.

| Actual Distance | Measurement | Error | Average |
|---|---|---|---|
| | 5,02 | 0,02 | |
| 5 | 5,01 | 0,01 | 0,1 |
| | 5,01 | 0,01 | |
| | 10,01 | -0,01 | |
| 10 | 10,04 | 0,04 | 0,01 |
| | 10,02 | 0,02 | |
| | 15,03 | 0,03 | |
| 15 | 15,05 | 0,05 | 0,4 |
| | 15,04 | 0,04 | |
| | 20,03 | 0,03 | |
| 20 | 19,87 | -0,13 | -0,07 |
| | 19,87 | -0,13 | |

The ultrasonic sensor functions as the main input in the system, because the distance information obtained from the sensor will be processed to be compared with minimum and maximum oil level data. Inaccuracies in reading distance sensor data will have an impact on inaccuracies in decision making in the future.

In the measurement data, there is a small variation between the Measured value and the Actual Distance. The average error of 0.07 indicates fairly good measurement accuracy in general. However, there are several cases with systematic errors, such as True Distance 15 which has a positive error of 0.4. At a True Distance of 20, there is a deviation of -0.13. Further evaluation is required to identify and correct the cause of the error.

## 4. CONCLUSION.

From the results of the tests and analyzes carried out, it can be concluded that this measurement system has the ability to provide accurate data in measuring tank volume. The quality and performance of ultrasonic sensors has been proven to have a significant impact on the accuracy of measurement results. However, there is an average error of about 0.11% in the tank volume measurements, which is caused by slight curvature in the tank structure. Nevertheless, the analysis of the entire system shows that the desired fuel oil inventory monitoring system is capable of providing adequate performance, ensuring inventory maintenance is maintained properly.

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