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Prototype of Solar Fuel Monitoring And Security System in Dump Truck Tank Based on SMS Gatway

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ABSTRACT: The process of security and monitoring of fuel oil is one of the activities that is often overlooked. Fuel oil is a driver of industry on a large scale. The use of fuel is less controlled, so many people abuse the use of diesel fuel which has a fairly high selling price among the public. , so this research was built by utilizing an Arduino microcontroller, proximity sensor, ultrasonic sensor, LCD and utilizing a cellular network with a GSM module 900 device which can send messages. Through this research a system was obtained that can be used for security and monitoring of diesel fuel in tanks. truck to provide information on the condition of the amount of fuel in the tank whether it is suitable for use or not.

KEYWORDS: solar, ultrasonic, arduino, gsm module

1. INTRODUCTION

Information technology is a technology used to process data with the aim of processing, compiling, storing and manipulating data into quality information. Apart from that, information technology also includes communication technology used to transmit information. One example of an application of information technology is SMS Gateway, which allows sending information via SMS with certain codes for transaction activation.

Dump trucks are a type of vehicle that is often used to lift heavy materials such as ore, coal and materials. Dump truck engines usually use diesel or diesel fuel to drive the engine and complete these heavy tasks. However, fuel use that is not properly monitored can cause problems such as fuel loss, engine damage, and fire hazards. Therefore, a security and monitoring system for diesel fuel in dump truck tanks based on short messages is very necessary to ensure that fuel is always available and safe to use. This system can help users to monitor fuel levels, pressure and temperature remotely, and provide automatic notifications and messages if there are problems that require immediate attention.

Several theft problems according to media reports occurred "sucking diesel from truck tanks, company employees reported to the police" theft at PT Indelko, a mining company located in Palembang by sucking diesel in the company's operational truck tanks (6/1/2013) Palembang. tribunnews. These problems that often occur in dump trucks are fuel leaks, fuel theft, and non-compliance with accurate fuel levels. This can cause significant fuel loss, engine damage, and other hazards associated with unsafe or poorly monitored fuel use. Therefore, this system needs to develop a security and monitoring system that can minimize these risks. One example of research carried out is a prototype of the HSD tank monitoring and controlling system at PLTGU Grati which uses infrared sensors, ultrasonic sensors and GSM modules for sending short messages (Mokhammad Saddam Yusuf, et al. 2022). This research was also carried out in 2019 which carried out Liquid Volume monitoring of liquid fuel in a tank with an ultrasonic sensor using an Arduino PIC16F887A controller and relay. which can monitor the amount of fuel in the tank to make it easier to monitor and see engine performance, (M, Husni, et al, 2019)

Several methods have been used to reduce existing fraud. Research conducted by Popescu Daniela et al in 2020 controlled the fuel tank level in the tractor tank using several sensors, namely volumetric, DUT-E S7, Titan Farms, Titan Machinery (Popescu Daniela , et al 2020. From the results of this research, similar research can be developed using an Arduino Uno microcontroller which can be combined with a GSM module, namely with short messages that can monitor bahar materials which will create a system. From existing research, researchers will create a system a simpler and easier system using new innovations, namely by adding security that is different from previous research with several sensors, GSM module 900a, infrared sensor, ultrasonic sensor, microcontroller that has never been used before and is different from the one used by previous researchers, namely the Arduino microcontroller, GSM module 900a, infrared sensor, ultrasonic sensor and LCD, are able to provide ease of use.

The research carried out with this background aims to create a security and monitoring system for diesel fuel in dump trucks using infrared sensors, ultrasonic sensors,

microcontrollers, and GSM modules for sending short messages in real time so that data can be sent accurately. With this system, it is hoped that it will make it easier for users to monitor fuel levels and prevent fuel leaks and theft. However, it should be remembered that this research only focuses on diesel fuel.

2. METHODOLOGY

The author uses analysis, research and final testing methods. In this research process, the author carries out design, which is one of the main stages, such as planning the use of components, compiling a block diagram of a tool circuit, then assembling the components according to needs. The author also uses

2.1 Tools and Materials

1. Arduino Uno

Arduino is an open-source platform used to build and program electronics. Arduino can receive and send information to most devices, and even via the internet to command certain electronic devices. It uses hardware called Arduino Uno circuit board and C++ program software. Arduino can help in reading information from input devices such as sensors, antennas. , trimmer (potentiometer), and so on. Arduino Uno has 14 input and output pins, including 6 digital pins and 6 analog pins. To program the Arduino, you can use a USB type A to type B connection or a USB printer cable.

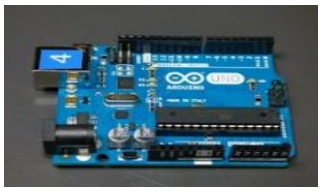

Figure 1. Arduino Uno

2. Ultrasonic Sensor

An ultrasonic sensor is a type of distance sensor that uses ultrasonic waves with a frequency of 40,000 Hz. This sensor can measure the distance between the transmitter and receiver. The principle of measuring distance using the HC-SR04 ultrasonic sensor is as follows: when a trigger pulse is given to the sensor, the transmitter will emit ultrasonic waves. At the same time, the sensor will produce a rising transition TTL output indicating the start of measurement timing. Once the receiver receives the wave reflection from the object, the time measurement is stopped with the down transition TTL output. The distance between the sensor and the object can be calculated using the following equation if the measurement time is t and the speed of sound is 340 m/s: S = t x (340 m/s)/2.

Figure 2. Ultrasonic Sensor

3. Proximity Sensor

A proximity sensor is a type of sensor that can detect objects in its surroundings without the need for physical contact. Proximity sensors work on the principle of magnetic induction. When there is a metal object in the sensing area, the magnetic induction of the sensor will change. This change indicates a change in the distance of the object in the sensing area. Inductive proximity sensors can only detect changes in the distance of objects made of metal.

Figure 3. Proximity Sensor

4. GSM SIM900

SIM900 is a GSM module that is widely used in communications using the GSM protocol. The GSM SIM900 module has been connected to an LPC2148 microcontroller based on a 32-bit ARM processor. The connection between the SIM900 GSM module and the LPC2148 is done via a USB to RS232 driver. The SIM900 module has a SIM card slot, an RS232 serial port for connection, an antenna for sending and receiving signals to the SIM, as well as an LED as an indicator of power, signal and incoming call status [5][6]. The SIM900A GSM/GPRS module functions to communicate between the main monitor and the cellphone. GSM technology is still the most widely used technology in the world, including in Indonesia, because one of its advantages is the ability to carry out extensive roaming, so it can be used in various countries. However, the data access speed on the GSM network is limited, around 9.6 kbps, because it was originally designed for voice use (Mikail Eko Prasetyo Widagda, et al, 2021). The protocol used by this system is the standard modem communication protocol, namely AT Command.

Figure 4. GSM SIM900

5. LCD

LCD (Liquid Crystal Display) is used as a system to display numbers, letters and symbols with good quality and low current consumption. In this research, an LCD with 16 x 2 characters was used, which means it is 16 characters long and 2 characters wide. This LCD has 16 pins which function as connectors to connect it (Figure 4. Yohanes C, et al. 2018). The advantages of using an LCD include relatively low power consumption and a small current draw, only a few microamperes, thus making the device or system portable

because it can use a small power supply. Another advantage is that the LCD is the right size, not too small or too big, so that the LCD display can be read easily and clearly. Specifications for 16x2 LCD pins can be found in the relevant documentation.

Figure 5. LCD.

6. I2C

I2C (Inter Integrated Circuit) is a two-way communication standard that uses 2 dedicated channels to send and receive data. The I2C system consists of several channels, including SCL (Serial Clock) and SDA (Serial Data), which are used to transmit data information between I2C and its controller. Devices connected via the I2C Bus can function as master or slave. The master is a device that initiates data transfer on the I2C Bus by sending a start signal and ends the transfer with a stop signal, as well as producing a clock signal. The slave is a device that is observed by the master (Yohanes C, et al. 2018). The I2C converter module uses the PCF8574 IC chip from NXP as the controller. This IC is an 8 bit I/O expander for the I2C bus which is basically a shift register.

Figure 6. I2C

2.2. Tool Block Diagram

The block diagram of this tool is composed of an Arduino Uno microcontroller as the center for controlling input and output, where the input consists of ultrasonic and proximity sensors. Meanwhile, the output consists of the GSM module 900 as a message sender to the cellphone or better known as the output of this system. The block diagram of the tool is as shown in the following image.

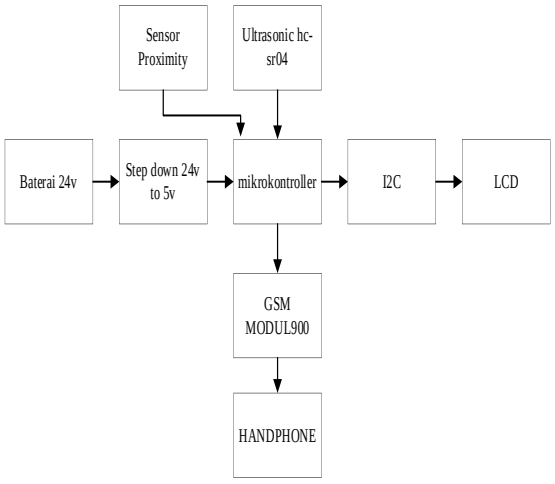

Figure 7. Tool Block Diagram

The explanation of the function of each part in the tool block diagram is as follows:

a) Arduino Uno, functions as a central control device that processes input from sensors and sends data to a smartphone connected via the GSM network.
b) Proximity sensor, functions as a detector of objects in front of the sensor which will provide security in this system.
c) Ultrasonic sensor hc-sr04, functions as a measure of the level of diesel fuel in the vehicle tank which will monitor use during use.
d) GSM module 900, functions as a sender of information obtained from sensor readings.
e) Then it will be processed by the microcontroller and then sent to the cellphone.
f) LCD and I2C, as displays to determine whether the delivery is taking place.
g) Smartphone, functions as a medium for receiving SMS notifications.
h) 24v truck battery, functions as an electrical power supplier for connected devices.
i) Step down 24v to 5vdc, as a voltage reducer according to the needs to be used.

3. RESULTS AND DISCUSSION

The result of the tool design is the implementation of a design combining microcontroller components with sensors. By carrying out electrical installations starting from connecting the power socket to the battery input terminal block, the output terminal block to the sensor pins, the system that has been created can be adjusted to the needs of the desired measurement results from the average use of a dump truck in 1 hour can consume 20 liters of diesel fuel/ hour, then a system can be created to send notifications every 1 hour, and then placed in the box as in the following image.

Figure 8. Results of tool design

3.1 Input Voltage Results

Table 1.Tension Testing

No.	mponents	Voltage
1	*Step Down regulator 5 volt*	12volt DC to 5 volt
2	*Arduino Uno*	5 Volt
3	*gsm module 900a*	5 Volt
4	*Sensor Proximity*	5 Volt
5	*Sensor Ultrasonic*	5 Volt
5	*LCD & I2C*	5 Volt

3.2 ECHO HC-SR0 Voltage Results

Table 2. HC-SR04 Voltage

No	Object Distance	Volt echo(receiver)	Volt trigger(transmitter)
1	2 cm	0,4 vdc	0,4 vdc
2	4 cm	0,8 vdc	0,4 vdc
3	6 cm	0,6 vdc	0,8 vdc
4	8 cm	0,6 vdc	0,44 vdc
5	10 cm	0,4 vdc	0,43 vdc
6	12 cm	0,5 vdc	0,41 vdc
7	14 cm	0,4 vdc	0,43 vdc
8	16 cm	0,5 vdc	0,46 vdc
9	18 cm	0,5 vdc	0,46 vdc
10	20 cm	0,6 vdc	0,45 vdc
11	22 cm	0,5 vdc	0,47 vdc
12	24 cm	0,3 vdc	0,47 vdc
13	26 cm	0,4 vdc	0,45 vdc

The ultrasonic sensor voltage on the echo pin has different characteristics for reading results on each existing object. when a trigger pulse is given to the sensor, the transmitter will start emitting ultrasonic waves, at the same time the sensor will produce an up transition TTL output the sensor starts calculating the measurement time, after the receiver receives the reflection produced by an object then the time measurement will be stopped by producing a down TTL output.

3.3 HC-SR04 Ultrasonic Sensor Transfer Function

The transfer function can be found using the equation $Y_i = a + bX_i$ but first an auxiliary table is needed which can be seen in table 4.3. Variable X in table 3 is data from ultrasonic sensor measurements (S) while variable Y is the echo pulse value (T).

Table 3. Sensor Measurement Data and Echo Pulse Calculations

No	X_i(cm)	Y_i(µs)	X_i^2(cm^2)	X_iY_i(cm µs)
1	2	58,82	4	235,28
2	4	117,64	16	1882,24
3	6	176,47	36	6352,92
4	8	235,29	64	15058,56
5	10	294,11	100	29,41
6	12	352,94	144	50823,36
7	14	411,76	196	80704,96
8	16	470,58	256	120468,48
9	18	529,41	324	171528,84
10	20	588,23	400	235292
11	22	647,05	484	313172,2
12	24	705,88	576	406586,88
13	26	764,70	672	513878,4
Σ	182	5.352,88	3.272	1.916.014

The transfer function equation for the HC-SR04 ultrasonic sensor can be found using equation $Y_i = a + bX_i$, so the transfer function is obtained as follows $T = a + bS$.

Where T = The result of resource leveling shows:

Optimization of pulsa *echo* ultrasonik (µs)

a = intersep

b = slope

S = ultrasonic distance sensor HC-SR04 (cm)

The transfer function is a sensor characteristic which is a comparison between the output produced by the sensor and the stimulus provided.

The sensitivity of the HC-SR04 ultrasonic sensor can be seen from the slope value obtained so it can be seen that the sensitivity value is 72,937 µs/cm, which means that every 2 cm increase in the measurement will produce a T output of 72,927 µs/cm.

Table 4. Ultrasonic Sensor Tests on tanks

Distance (cm)	Ultrasonic Sensor Distance Measurement Results (Cm)						Average	Difference	
	X1	X2	X3	X4	X5	X6		Cm	%
2	4	4	4	6	8	8	5,6	3,6	180
4	4	6	6	4	6	10	6	2	50
6	6	10	10	6	8	6	7,6	1,6	2,6
8	8	8	12	10	12	12	10,3	2,3	2,8
10	10	10	10	10	10	10	10	0	0
12	12	12	12	14	12	12	12,3	0,3	2,5
14	14	14	14	14	16	16	14,66	0,66	4,7
16	16	16	16	16	16	16	16	0	0
18	18	18	18	20	10	18	18,6	0,66	3,6
20	20	20	22	22	20	20	20,6	0,66	3,3
22	22	22	22	22	22	22	22	0	0
24	24	24	24	24	26	24	24,3	0,3	1,2

The largest measurement error was at a distance of 2 cm, while at distances of 10 cm, 16 cm and 22 cm, there were no errors or differences in measurements. The average measurement error of the ultrasonic sensor on the water faucet is:

$$\bar{x}\frac{180 + 50 + 2{,}6 + 2{,}8 + 2{,}5 + 4{,}7 + 3{,}6 + 3{,}3 + 1{,}2}{12} = 20{,}8\%$$

The average measurement error of the ultrasonic sensor on the fuel tank is 20.8%, which means the accuracy level of the sensor is: 100% - 20.8% = 79.2%.

distance (cm)	average
2	5,6
4	6
6	7,6
8	10,3
10	10
12	12,3
14	14,66
16	16
18	18,6
20	20,6
22	22
24	24,3

Figure 9. Graph of average measurement distance

Figure 9 shows that the ultrasonic sensor measurement graph of the average distance from the fuel level measured by the ultrasonic sensor can show that the accuracy of the sensor can be determined between the actual distance and the distance read by the sensor.

3.4 Proximity Sensor Test Results

In designing this tool, it uses a proximity sensor. This section contains the type of command that has opened or closed the tank lid. The sensor can be used to control the safety of diesel fuel.

Table 5. Proximity Sensor Test Data

No	Open State	Closed State	Status
1	Read	Read	Read
1	Read	Read	Read

3.5 GSM Module Testing

In testing the speed of data sent, it is carried out by measuring the distance between the device and the destination cellphone. The GSM 900A module used in this test is the cellphone.

Table 6. GSM module test data

No	Sensor	Description	Status	Network	Distance (KM)	Time
1	*sensor proximity*	Open	Sent	4 bar	<1	8 Second
2		Closed	Sent	4 bar	<1	10 Second
3		Open	Sent	2 bar	<10	15 Second
4		Closed	Sent	2 bar	<10	10 Second
1	*sensor*	Distance 2 cm	Sent	2 bar	<10	15 Second
2	*ultrasonic*	Distance 4 cm	Sent	2 bar	<10	13 Second
3		Distance 6 cm	Sent	2 bar	<10	15 Second
4		Distance 8 cm	Sent	2 bar	<10	10 Second
5		Distance 10 cm	Sent	2 bar	<10	10 Second
6		Distance 20 cm	Sent	4 bar	<1	10 Second
7		Distance 22 cm	Sent	4 bar	<1	10 Second
8		Distance 22 cm	Sent	4 bar	<1	10 Second
9		Distance 24 cm	Sent	4 bar	<1	10 Second
10		Distance 28 cm	Sent	4 bar	<1	10 Second

The GSM module test results for sending data as in table 6 show the results of data obtained with different network qualities and different distances. It can be concluded that data can be sent well at different times which is influenced by the quality of the network obtained at the test location.

Network (bar)	Distance (km)	Time (s)
4	1	8
4	1	10
2	10	15
2	10	10

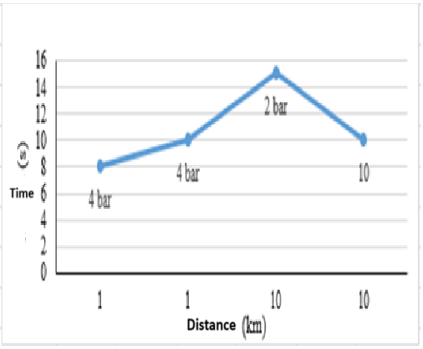

Figure 10. GSM proximity sensor module test graphic

Figure 10 shows that the proximity sensor measurement graph of the distance from fuel oil security at this time can show that the accuracy of the GSM module for sending data, with the quality of the existing network, can be determined between the distances that have been carried out in the experiment.

Network (bar)	Distance (Km)	Time (S)
2	10	15
2	10	13
2	10	15
2	10	10
2	10	10
4	1	10
4	1	10
4	1	10
4	1	10
4	1	10

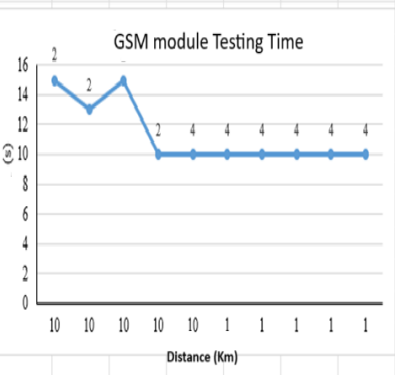

Figure 11. GSM ultrasonic sensor module test graphic

Figure 11 shows that the ultrasonic sensor measurement graph of the distance between the height of the fuel oil in the tank at this time can show that the accuracy of the GSM module for sending data, with the quality of the existing network, can be determined between the distances that have been experimented with with different sending distances. different and network quality from 1 bar to 4 bars here the data that has been read by the sensor can be sent properly by the GSM 900a module.

4. CONCLUSION

1. The conclusions obtained by researchers on the safety and monitoring system for diesel fuel in truck tanks based on short messages using the Arduino Uno microcontroller are as follows.
2. Creating a security and monitoring system for diesel fuel in truck tanks based on short messages consists of two important aspects, namely hardware and programs which are connected and integrated so that it can produce a good system to control and provide security for fuel in truck tanks. .
3. From the results of operating the ultrasonic sensor system, it functions as an object detector located in the fuel tank, the information is then sent to the Arduino Uno microcontroller. If an object is detected between a distances of 2 cm to 24 cm in the fuel tank, the Arduino Uno microcontroller will send a command to the GSM module 900a, then the data is sent to the destination cellphone, and the proximity sensor as a security system. Sending messages can be arranged according to the desired needs every 1 hour or every 30 minutes according to the overall consumption of the truck.
4. The GSM 900a module in sending messages is very accurate and fast from the results obtained in testing between 1 bar and 2 bar network quality with distances <1 km and <10 km.
5. To detect height using the HC-SR04 ultrasonic sensor, it produces an accuracy of up to 79.2%. which means it is very good for use as a diesel fuel detector in tanks, from the test results obtained an average accurate value at a height of 10.16 cm and 22 cm and a height of 2 cm has a very low level of accuracy

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