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Design and construction of measuring the height underground tank SPBU using raspberry pi

Wisnu Franca Irahadiputra [a,1], Abdul Fadli [a,2,*]

[a] Department of Electrical Engineering, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[1] wisnu1600022060@webmail.uad.ac.id; [2] fadlil@ee.uad.ac.id

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ABSTRACT

A fuel Station or commonly abbreviated as a gas station, is a place to refuel motor vehicles. At gas stations, there are submersion tanks to store oil reserves. In checking, it is still used manual method. The manual method that is still carried out today is considered less efficient in terms of time and accuracy of measuring instrument readings. Moreover, nowadays, it is possible to create digital measuring instruments. In this study, a digital measuring instrument will be designed using raspberry pi. In this study, a prototype of a tubular gas station submersion tank will be made. The measuring instrument consists of raspberry pi as the main processor of the system, using HCSR04-type ultrasonic sensor and LCD as the result viewer. From the research that has been made, a prototype of a submersion tank with dimensions of 60 cm long and 30 cm in diameter has been made. Volume analyzers are able to read with an error percentage of 0.9% in horizontal tube testing and 0.6% in vertical tube testing. The prototype of the gas station submersion tank as an oil container was successfully made and measured in volume by a digital measuring instrument using raspberry pi.

1. Introduction

In cases that often occur at gas stations, the manual method is still used to check the remaining fuel in the reservoir. Not all conditions allow direct observation. Under extreme conditions in a place and high temperatures, it is often not possible to make direct observations or measurements [1]. The rapid increase in the number of motorized vehicles from year to year makes the need for fuel oil also increase. Gas stations (Public Fuel Filling Stations) are infrastructure provided by the public and private parties to meet fuel needs [2].

As well as in manual measurements have several factors that cause errors [3]. One of the factors that cause the source of the error is a parallax error that occurs when using manual measuring instruments. Parallax error itself is a form of reading error of measuring results caused by limited vision function [4]. In this all-digital era, such manual methods seem to be less efficient. Current technological advances allow the creation of digital measuring instruments that can help facilitate human work [5]. This measuring instrument is usually an instrumentation system consisting of electronic sensors, signal conditioners, controllers, processors, and measuring instrument result viewers [6].

This study was conducted to overcome errors arising from measuring instrument scale readings that are still done manually [7]. Build a system using raspberry pi connected with ultrasonic proximity sensor type HCSR04. Later the sensor will read the distance of free space in a tubular container which is used as one of the variables in the calculation of oil volume in the program on the raspberry pi [8].

Research related to making height measuring instruments has been carried out as in research by R. Wahyuni entitled Water Level Control Monitoring Based on Arduino Uno R3 Atmega 238p Using Lm016l LCD at STMIK Hang Tuah Pekanbaru [4]. Then W. Hong's research entitled Water Quality Monitoring with Arduino Based Sensors [9]. By S. R. Pereira, *et al.* entitled Evaluation of Water Level in Flowing Channels Using Ultrasonic Sensors [10]. F. Jan, *et al.* conducted a research entitled IoT Based Smart Water Quality Monitoring: Recent Techniques, Trends and Challenges for Domestic Applications [11]. By B. B. Koshoeva, *et al.* his is research is entitled Arduino-based automated system for determining water flow consumption in open flow [12]. Therefore, this research is also expected to be able to become reference material for future studies.

2. The Proposed Method/Algorithm

In designing a system, researchers divide it into 2 stages, namely hardware design and software design. System Design is certainly inseparable from previous references.

2.1. Perancangan Perangkat Keras

System hardware design aims so that later the tool can work with the desired conditions [13]. At this stage will be explained the diagram of the hardware block and the appearance of the design to be created. Fig. 1 is a system block diagram where the hcsr04 sensor will emit ultrasonic waves by the transmitter then bounce back and be received by the receiver [14]. Fig. 2 is a diagram of the hardware blocks built in this study. Raspberry pi as the main processor of the system that obtains the oil level value from the hcsr04 sensor reading process then the liquid crystal display final viewer of the remaining oil volume [15]. Fig. 3 shows the design drawing of the measurement tool to be made.

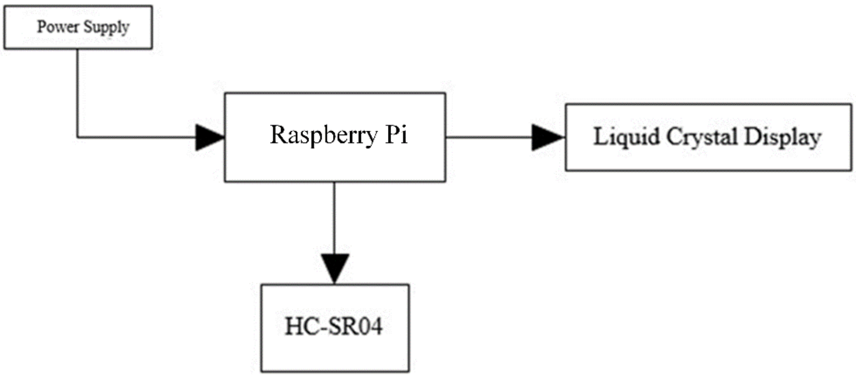

Fig. 1. System device block diagram

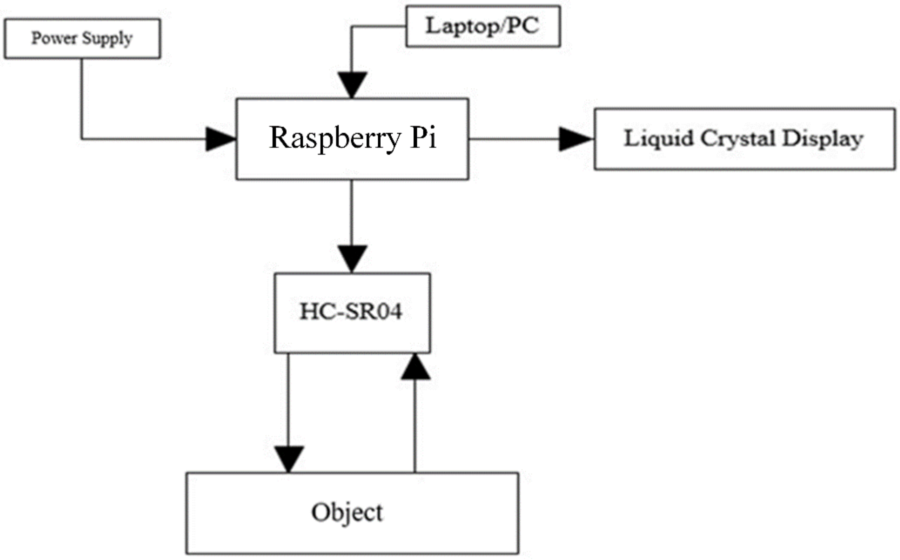

Fig. 2. Hardware block diagram

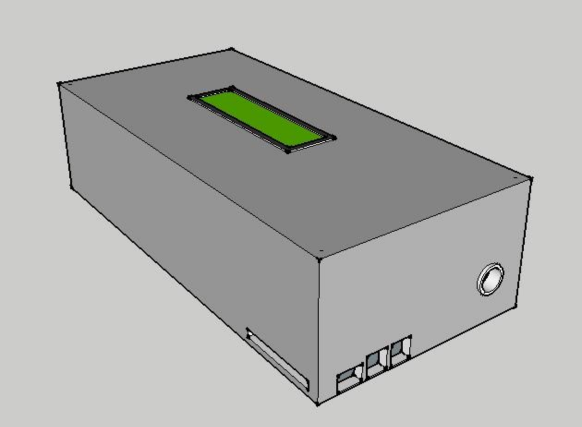

Fig. 3. Tool design

To find out the wiring of this system design, it can be seen in Fig. 4. After following the wiring correctly, then all equipment is prepared to measure the tank that has been prepared by the author. Fig. 5 is a prototype of a tank ready for measurement.

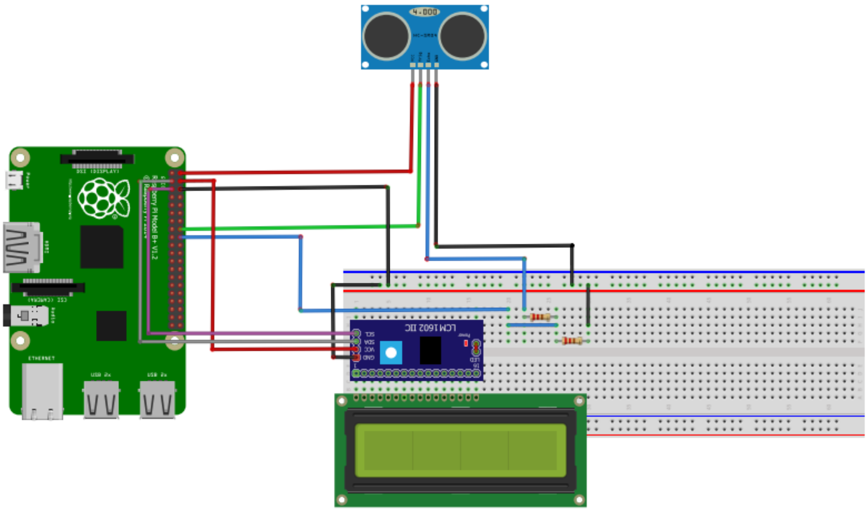

Fig. 4. Wiring system

Fig. 5. Tank prototype

2.2. Software Design

Software design on the microcontroller is to conFig. the Raspberry pi which then enters commands with the C language in Python software available on the Raspberry pi OS [16]. The command will have a function, namely, Receiving input from the ultrasonic sensor sensor which is then read by the Raspberry pi, the value read will later be displayed on the LCD. Fig. 6 is a flow diagram of the system.

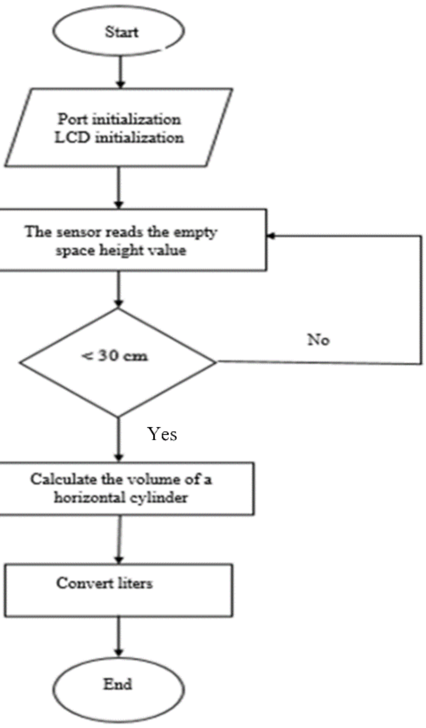

Fig. 6. Flow chart

2.3. System Testing

System testing aims to make the tool run well without any problems when implemented later [17]. The system test this time is divided into several tests. That is sensor testing, sensor testing, and tool volume measurement testing. Sensor testing is carried out first by taking several measurement samples. Manual reading with a ruler is carried out as a comparison of data. Testing of tool volume measurements was carried out by taking 70 measurement samples where 35 sample data were taken with a horizontal tube position and another 35 samples were taken with a vertical tube position.

3. Results and Discussion

System testing aims to determine the level of accuracy of tools that have been successfully made [18]. Previously a study was made conducted by the previous researcher, S. L. Mohammed, *et al.* entitled highly accurate water level measurement system using a microcontroller and an ultrasonic sensor [19]. Previous research showed that the actual HC-SR04 sensor reading had an error value of 0.26%. At this stage, researchers divide 2 tests, namely sensor testing and volume measurement testing. The available data can calculate the percentage of errors obtained.

3.1. Sensor Testing

This test is carried out to test the accuracy of the sensor in reading distance. It is done by comparing with the actual distance using a ruler. The ultrasonic waves emitted by the transmitter will bounce and be received by the receiver when there is an obstruction hitting it [20]. From Tabel 1 can be calculated average, standard deviation or deviation, average of standard deviation and standard deviation. That is shown in Table 2.

Table 1. HCSR-04 sensor readings

Actual Distance (cm)	Measurement 1 (cm)	Measurement 2 (cm)	Measurement 3 (cm)	Average (cm)	Error (%)
5	4.97	4.96	4.98	4.97	0.6
10	10.13	10.17	10.15	10.15	1.5
15	15.16	15.15	15.15	15.15	0.99
20	20.02	20.03	20.05	20.03	0.1
25	24.90	25.02	25.01	24.97	0.1

Table 2. Calculation of the obtained sensor value

Reference	Measurement	$\bar{X}$	D	$\|D\|$	D	Σ
5	4.97	4.97	0	0	0.006	0.01
	4.96		-0.01	0.01		
	4.98		0.01	0.01		
10	10.13	10.15	-0.02	0.02	0.013	0.02
	10.17		0.02	0.02		
	10.15		0	0		
15	15.16	15.15	0.01	0.01	0.003	0.007
	15.15		0	0		
	15.15		0	0		
20	20.02	20.03	-0.01	0.01	0.01	0.01
	20.03		0	0		
	20.05		0.02	0.02		
25	24.90	24.97	-0.07	0.07	0.16	0.94
	25.02		0.05	0.05		
	25.01		0.04	0.04		

3.2. Tool Volume Measurement Testing

70 experiments were collected. 35 experiments were conducted with the sleeping tube position and another 35 experiments were conducted with the standing tube position. Horizontal tube experiment data shows in Table 3. Vertical tube experiment data shows in Table 4.

Table 3. Horizontal tube experiment data

No	Sensor Readings (cm)	Tool readable volume (liter)	Volume Testing with Excel (liter)	Error (%)
1	27.2	1.98	1.99	0.5
2	27.18	1.96	1.97	0.5
3	27.4	1.6	1.7	6.25
4	27.17	2	2.02	1
5	27.2	1.98	1.99	0.5
6	26.03	3.29	3.31	0.6
7	26.15	3.09	3.17	2.5
8	26.11	3.15	3.22	2.2
9	26.2	3.08	3.11	0.9
10	26.33	2.89	2.96	2.4
11	25.11	4.46	4.49	0.6
12	25.2	4.44	4.37	-1.5
13	25.05	4.54	4.57	0.6
14	25.15	4.4	4.44	0.9
15	25.21	4.33	4.36	0.6
16	24.01	5.94	6.01	1.1
17	24.11	5.8	5.87	1.2
18	24.07	5.9	5.93	0.5
19	24.19	5.7	5.76	1
20	24.2	5.69	5.74	0.8
21	23.02	7.42	7.48	0.8
22	22.98	7.5	7.54	0.5
23	23.08	7.34	7.39	0.6
24	23.04	7.39	7.45	0.8
25	23.06	7.38	7.42	0.5
26	21.98	8.98	9.1	1.3
27	22.04	8.9	9	1.1

No	Sensor Readings (cm)	Tool readable volume (liter)	Volume Testing with Excel (liter)	Error (%)
28	22	9.02	9.07	0.5
29	22.12	8.84	8.88	0.4
30	22.15	8.79	8.83	0.4
31	21.09	10.44	10.54	0.9
32	21.05	10.56	10.61	0.4
33	21	10.6	10.69	0.8
34	21.13	10.39	10.47	0.7
35	21.18	10.35	10.39	0.3
		Average Error		0.9

Error value obtained by equation (1).

$$error\ (\%) = \frac{nilai\ hasil\ pengukuran - nilai\ yang\ diinginkan}{nilai\ yang\ diinginkan}\ \text{x}\ 100\% \qquad (1)$$

After looking for errors in each experiment data, an average error of 0.9% was obtained.

Table 4. Vertical tube experiment data

No	Sensor Readings (cm)	Tool readable volume (liter)	Volume Testing with Excel (liter)	Error (%)
1	55.11	3.4	3.45	1.4
2	55.02	3.49	3.51	0.5
3	55.2	3.34	3.39	1.4
4	54.97	3.53	3.55	0.5
5	55.22	3.33	3.37	1.1
6	54.01	4.23	4.23	0
7	54.27	4	4.04	0.9
8	54.11	4.1	4.16	1.4
9	54.15	4.08	4.13	1.2
10	54.19	4.05	4.1	1.2
11	53.01	4.89	4.93	0.8
12	53.13	4.85	4.85	0
13	53.22	4.73	4.79	1.2
14	53.02	4.9	4.93	0.6
15	53.11	4.84	4.86	0.4
16	52	5.6	5.65	0.8
17	52.01	5.6	5.64	0.7
18	52.13	5.52	5.56	0.7
19	52.19	5.49	5.51	0.3
20	52.21	5.48	5.5	0.3
21	51.03	6.3	6.33	0.4
22	51	6.28	6.35	1.1
23	51.01	6.3	6.35	0.7
24	51.11	6.25	6.28	0.4
25	51.19	6.19	6.22	0.4
26	50.22	6.87	6.9	0.4
27	50.18	6.9	6.93	0.4
28	50.11	6.93	6.98	0.7
29	50.01	7	7.05	0.7
30	50.16	6.92	6.95	0.4
31	49.21	7.59	7.62	0.3
32	49.11	7.65	7.69	0.5
33	49.02	7.73	7.75	0.2
34	49.13	7.65	7.67	0.2
35	49.01	7.73	7.76	0.3
		Average Error		0.6

4. Conclusion

Based on what was made and tested, conclusions can be drawn Volume gauges on gas station stockpile tanks managed to read with an error percentage of 0.9% in testing tubes with horizontal positions and 0.6% in testing tubes with vertical positions. Systems built based on Raspberry pi using HC-SR04 sensors can run well. The hope is that after this research can get a smaller percentage of errors and can develop using other methods. And it is hoped that further research can add sensors to the comparison tools made so that more comparison data is obtained.

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