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Measurement System Of Damage Road Surface Volume With Ultrasonic Sensor Based Atmega 328

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Abstract: *As the main road that connects one region to another, damaged roads is a complex problem and causes huge losses, especially for road users. Therefore, in this study will be designed a system for measuring the volume of damage road surface by using ultrasonic sensors. This system uses ATMega 328 microcontroller interface and applications are made from Visual Basic 6. From this study, we got the best measurements results of road surface damage volume in a short time and the data stored on the pc directly get in Microsoft Excel format.*

Keywords: *Ultrasonic Sensor (Ping), Optocoupler, microcontroller ATMega 328, Visual Basic 6*

Abstrak: Sebagai jalan utama yang menghubungkan satu wilayah dengan wilayah lainnya, jalan rusak merupakan permasalahan yang kompleks dan menimbulkan kerugian yang sangat besar, terutama bagi pengguna jalan. Oleh karena itu pada penelitian ini akan dirancang suatu sistem untuk mengukur volume kerusakan permukaan jalan dengan menggunakan sensor ultrasonik. Sistem ini menggunakan antarmuka mikrokontroler ATMega 328 dan aplikasi dibuat dari Visual Basic 6. Dari penelitian ini didapatkan hasil pengukuran terbaik volume kerusakan permukaan jalan dalam waktu singkat dan data yang tersimpan di pc langsung didapatkan dalam format Microsoft Excel.

Kata Kunci : Sensor Ultrasonic (Ping), Optocoupler, Mikrokontroler ATMega 328, Visual Basic 6

INTRODUCTION

The highway is a major road or main road that connects one region to another. Roads damage will be causing a huge loss, especially for road users, such as the occurrence of long journey times, congestion, traffic accidents and other losses. The individual losses will be accumulated as global economic losses to the region. To determine the magnitude of the volume of damage road surface needed a system that can measure the volume of damage road surface directly (real-time).

Therefore, in this study will be designed a system for measuring the volume of damage road surface by using ultrasonic sensors. This system uses ATMega 328 microcontroller interface and applications are made from Visual Basic 6. Methods performed in this preliminary study is deductive method is to apply the knowledge into the design to be made and tested. Testing was conducted to determine the performance of the system. From the test results it is known that this study aims to get a good measurement result of road damage volume in a short time.

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THEORY

1.1. Ultrasonic Wave

Ultrasonic waves are mechanical waves with a frequency above 20 kHz and can be spread in a solid medium, liquid and gas [1]. The ultrasonic wave is a vibration of substances molecules and clashing with each other and yet these substances coordinated produce waves and transmits energy even never become particle displacement [2].

Characteristics of ultrasonic waves through the medium resulted vibrations in particles with medium amplitude parallel to the direction of propagation, causing the medium particles forming density and strain. Continuous process which resulted density and strain in the medium caused by the vibration of particles periodically during the ultrasonic wave through it [2].

Ultrasonic waves are used to inspection quality of production in the industry. In the medical field, the high frequency of the ultrasonic wave is able to penetrate a very strong network, so it is often used for the diagnosis, destructive, and treatment [3].

1.2.*Principle of Ultrasonic Sensors Work*

Transducer of the ultrasonic sensor will emit bunyo wave which is an acoustic pulse. When a wave on an object, it will experience a reflection of a sound echo. An object located in the area of sonar range and reflects pulses. t0 is the time it takes when a pulse is emitted and received back by the transducer known as the method of time of flight (TOF). Object distance FR can be measured by the equation

$$r_0 = \frac{C_0.TOF}{2}.\cos\theta$$

Object distance from the transducer (r_0) has a proportional relationship to the travel time of the current pulse is sent and received by the transducer (TOF). The speed of sound waves in the medium (C_0) is considered constant [4].

1.3. Photodiode Sensor

Optocoupler is a device that consists of 2 parts: a transmitter and receiver, which is between the light separate with the detection of light source. Usually optocoupler used as electrical switches, which work automatically. Basically Optocoupler is a connecting component (coupling) that works based on optical light trigger.

The transmitter is built from an infrared LED, whereas the receiver is built with the basic components of photodiode. Photodiode is a power transistor that is sensitive to light [5]. Phototransistor type is also the same in general transistor such as the PNP and NPN. The

difference of transistors and phototransistor only in the walls that allow infrared light to activate the base, while ordinary transistor is placed in a closed metal wall [5].

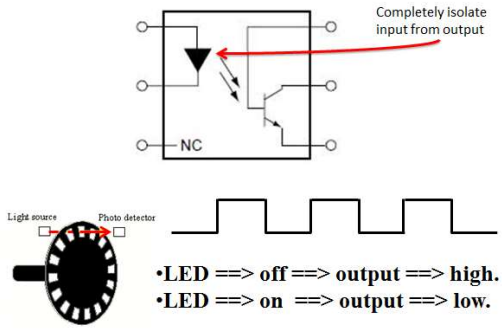


Fig. 1. Work processes of sensor and forms output

The working principle of the optocoupler is:

a. If between Photodiode and LED hindered then the Photodiode will be off so that the output of collector becoming logic high.
b. Instead if between the photodiode and the LED does not hindered then the photodiode going on so output becoming logic low.

RESEARCH METHOD

The research begins with the design tool. This step includes the design of the assembly, create a framework of aluminum material and create a design composition of ultrasonic sensor and put an optocoupler sensor. Once the hardware is finished, done programming the microcontroller using the Arduino software-1.5.6-r2, then program is implanted into the microcontroller.

Next step is the preparation of a program for the system to perform the interface with the computer. The program makes using Visual Basic 6 software. Final step is calibration and adjustment. This step is performed so that the sonar system and an optocoupler that have been made can be responsible for its accuracy. Calibration is performed by comparing the measurement tool and has standarization. The research procedures were performed in this study is described by the flow chart as shown in Fig.2.

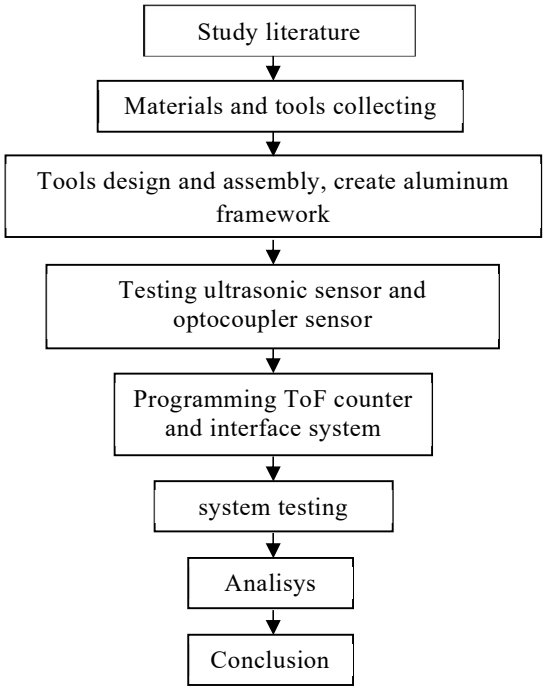


Fig. 2. Flowchart of research procedures

Block diagram of the design of the volume measurement tool of damage in the form of pit road as shown in Figure 3.

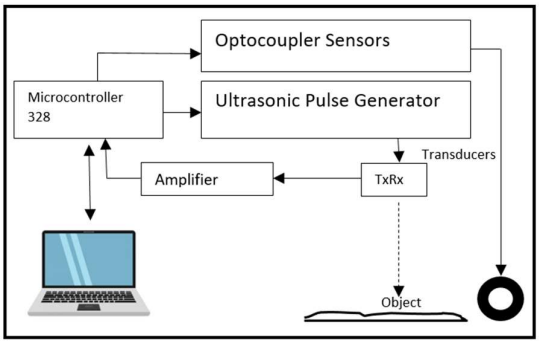


Fig. 3. Block diagram to measure volume of hole in damage road

Object is a medium that is used for observation, the transducer through the transmitter (Tx) functions as a modifier electrical signals into ultrasonic waves and reflected back by the object. Microcontroller circuit serves as a measuring time of flight.

Time of flight generated by shooting of pulse on an object. The data is then processed by microcontroller and sent to a PC (Personal Computer). Once the data is received PC then the data is processed in the Visual Basic 6 software so that the data obtained from the depth of the hole and the hole contours are displayed graphically.

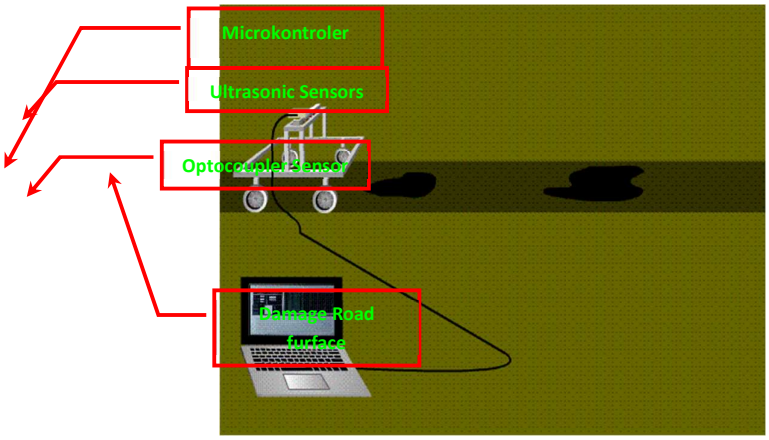


Fig.4. The design tool of measurement system of damage road surface volume

In Figure 4 above, can be seen in the design of the tool path of damage volume measurement system using ultrasonic sensors (ping). Framework tool is designed with aluminum rod, which 5 ultrasonic sensors placed at the top of the tool. While optocoupler sensor that functions as a counter of displacement position sensors mounted on one of the wheels. Distance and displacement positions data obtained directly sent to the pc.

RESULTS AND DISCUSSION

The test of sensor characteristics as well as microcontroller is performed by varying the distance of object. Object distance calculated by the microcontroller and displayed in the form of system sonar applications as distance. The reference point is at zero distance piezoelectric transducers.

The results of testing the characteristics of the sensor is shown in fig 5.

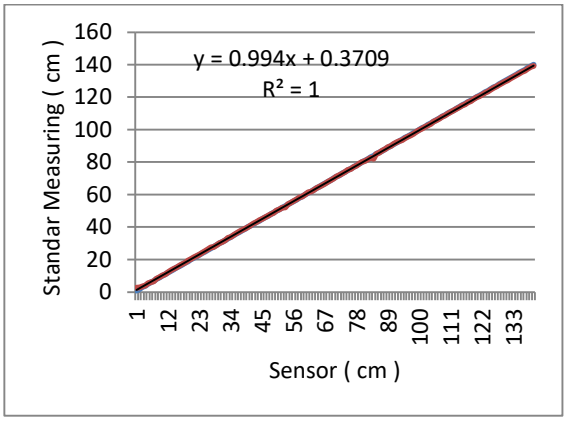


Fig. 5. Variation of the object distance to the ultrasonic sensor distance readings

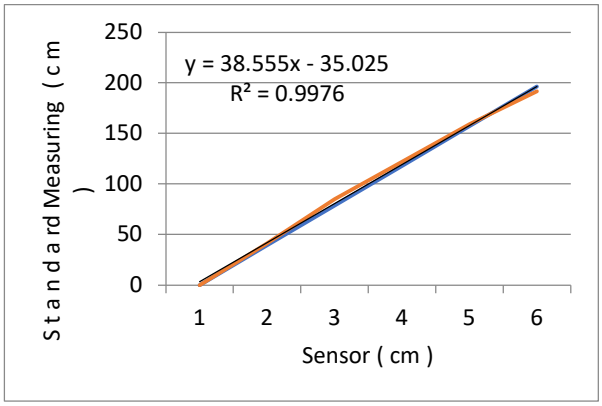


Fig.6. Variation of distance to the ultrasonic Optocoupler sensor distance reading

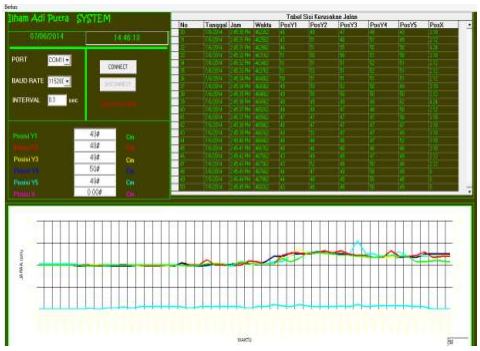
In Fig.5 and Fig.6 above shows that the relationship between the distance to the sensor readings have a linear regression equation for ultrasonic sensors at y = 0.994x + 0.3709 and R^2 value of the linear correlation of 1, and optocoupler sensor for y = 38.555 x-35.025 and the value of the linear correlation R^2 of 0.9976. Coordinates y indicate the distance measured object using standard measuring devices, and x indicates the distance changes the sensor readings.

This test is performed to determine the proximity of depth measurement values to the depth gauge manually. From the above results obtained linear correlation R 2 value of 1 for the ultrasonic sensor to sensor optocoupler and 0.9976, where all the value is close to the value 1 data indicate that the depth gauge has a good accuracy.

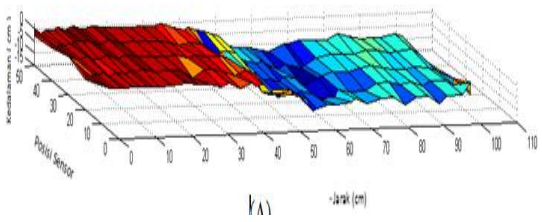
Results of Testing Equipment

The tool running positioned in a oordinate to get the contour of the road. The sets of coordinates are then processed using the software Matlab R2012a, see the results of testing equipment in fig.7.

(a)



(b)



(c)

Fig.7. Serial data test results on the application system (a) the measurement object, (b) the capture results Visual Basic application, (c) the capture results of the application system

Based on the results of the scanning and processing of data, the comparison between the results of scanning in Fig.7, in general the scanning result almost matches the shape of the original object. Overall scanning results can already be approaching the original form of the object, which can follow the rise and decline of the object distance. The results of data processing with Matlab R2012a software can visible state of the object indicated by the graph.

CONCLUSION

Design and manufacture of volume measuring system on the damage road surface using a microcontroller and a computer by using ultrasonic waves, microcontroller and computer as a data processor. Obtained by means of the characteristic equation of the line with a correlation coefficient R 2 = 0.999 1 against standard measuring tools. Tools made with accuracy ± 0.5 mm depth. Sonar system data can be retrieved automatically and can be stored in a computer database as distance data and stored in Microsoft Excel format. In this study, the minimum horizontal velocity for the system is v = 0.05 m/s.

Based on the research that performed, it is expected to do more in-depth study of ultrasonic and the optocoupler sensors, and then apply it in variety of fields. Need more to the development of sonar systems for mapping the road surface damage in the form of holes and map the contours of the damaged road surface and can be moved quickly.

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