Prototype of Microcontroller-Based Odometer Reading for Early Warning in the Vehicle Lubricants Replacement

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Prototype of Microcontroller-Based Odometer Reading for Early Warning in the Vehicle Lubricants Replacement

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Abstract— **Odometer is an instrument that functions to measure the vehicle mileage and is usually used for periodic inspection of vehicle lubricant replacement. For companies that have a large number of vehicles (for example banks, travel agencies, etc.), vehicle lubricant replacement is an important thing to do, because if it is not maintained well it may cause fatal damage to the vehicle and can even endanger the passengers who use the vehicle. Therefore, it is built an integrated system that can give early warning for vehicle lubricant replacement by using microcontroller. This system is designed in two parts; the first part is a system that is planted in the vehicle, while the second part is a system that is planted in the garage. Both systems are tested by using several scenarios, namely calculating the combination of observation parameters consisting of the size of data being sent, angle and distance that are formed between the two systems, and a barrier that may occur between the two systems. The test results showed that the angle smaller than of 30° provides correct response time and data validity between the two systems, while the angle bigger than of 30° produces an error in the data, even the data cannot be accepted by the system in the garage. Data transmission of 2-byte requires 1 ms longer time compared with the data transmission of 1 byte. Meanwhile, distance and barrier between the two systems relatively have no impact on response time and data validity; except for a distance of over 700 cm, in which the data is not received in the garage system.**

Keywords—odometer, infrared, microcontroller

I. Introduction

Along with the development of technology, the use of digital-based tools more facilitates human activities. Nowadays, nearly all systems on the motor vehicle have been digitized, including digital odometer device that functions to measure the vehicle mileage and periodic inspection of vehicle lubricant replacement. Vehicle lubricant replacement is a very important thing to do, in order to maintain the durability of the vehicle engine. In addition, if the vehicle lubricant replacement is not done on a regular basis, then the engine will quickly heat and can cause the machine broken because of friction. This would be very disadvantageous for people or companies that particularly have a large number of operational vehicles, for example travel agency, car rental, and office [6]. Due to the large number of vehicles owned, sometimes owners or companies are bothered to schedule periodic vehicle inspection. Therefore, it is needed a system that can automatically perform inspection and give notification to the user about the condition of the vehicle.

The designed system consists of a digital odometer prototype as a timer for periodic vehicle lubricant replacement. This system uses two types of RISC (Reduced Instruction Set Computers) microcontroller as a means of retrieving the data, and two infrared transceivers that are connected to each microcontroller as data sender and recipient. Then the system is divided into two parts. The first part consists of an odometer, a microcontroller, and infrared transceivers that are planted in the vehicle. Meanwhile, the second part consists of an infrared transceiver, a microcontroller, and a computer that are planted in the garage. Each of these parts is connected to infrared transceiver that sends and receives data and later the data will be displayed on the computer. After that there will be warning from the vehicle odometer.

This study aims to implement a system that can take and receive data from odometer, to subsequently transmit the data to the infrared transceiver. It is meant to make the vehicle owner accept an early warning for vehicle lubricant replacement. This study also aims to analyze the system performance by testing some parameters namely the number of bytes of data sent, the angle formed between the two systems when retrieving the data, data retrieval distance, the barrier given, and the resulting response time to the accuracy of the data generated.

II. Basic Theory

A. *ATmega8 AVR Microcontroller*

The microcontroller is a microprocessor system, in which there has been a CPU, ROM, RAM, I / O, Clock and other internal devices that are already well connected and organized by the manufacturer and also packaged in a ready for use single chip. We only need to program ROM contents according to the rules of use made by the factory that makes it. In other words, the microcontroller is a mini version and for special applications of microcomputers or computer [10].

The microcontroller used is the AVR (Alf and Vegard RISC) type, which was originally developed in 1996 by two students of the Norwegian Institute of Technology namely Alf-Egil Bogen and Vegard Wollan. AVR microcontroller was then developed by Atmel Corporation. The first series of AVR launched were 8-bit AT90S8515 microcontroller that had the same pin configuration with 8051 microcontroller. AVR uses RISC technology in which its instruction set is reduced in terms of size and complexity of its addressing mode. For AVR microcontroller with 8-bit RISC architecture, all instructions are 16 bits and largely executed in one clock cycle. It is in contrast to the MCS-51 microcontroller that its instruction varies between 8 bits to 32 bits and executed for 1 to 4 machine cycles, in which one cycle engine requires 12 clock period [2].

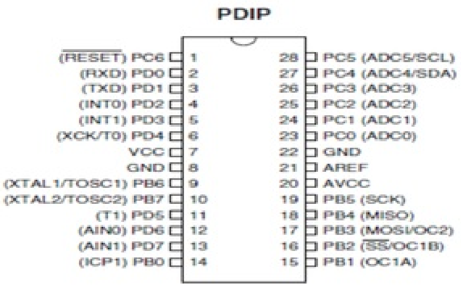

Fig.1 ATMega 8 Configuration

B. Arduino Board

Arduino is an open-source packaged solution consisting of a hardware board with AVR microcontroller and software developed by using the Java language and C language as a reference in the programming. Board used is arduino severino board with microcontroller. Arduino was chosen because in general it does not require a programmer chip device because it contains bootloader that will handle the uploading of computer programs. The following image is the hardware and software part of arduino.

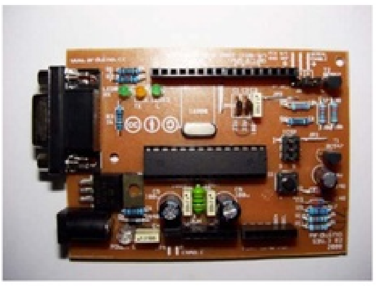

Fig.2 Arduino Seravino Board Hardware

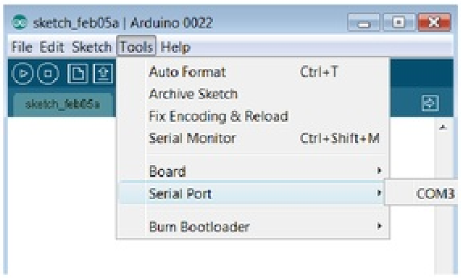

Fig.3 Arduino Seravino software

C. Infrared Receiver

Infrared Receiver is a data receiver module through infrared waves with a carrier frequency of 38 kHz [18]. This module can be used as inputs in the application of wireless data transmission, like in the system of odometer reading prototype for vehicle lubricant replacement. Data received from the transmitter is then processed by arduino severino board.

D. Odometer

Odometer is an instrument that shows the distance traveled by the vehicle, both in kilometers, meters, and other units of distance calculation. The word odometer comes from the Greek “hodos” that means way or gateways and “metron” that means measure. Odometer devices can be digital, mechanical, or a combination of both [11].

Odometer is typically located adjacent to other measurement indicators of vehicle conditions, such as speedometer, fuel quantity indicator, lights indicator, etc. Odometer becomes the main indicator for changing the car oil regularly that can be calculated from the existing mileage. In general, the odometer has a display of mileage number in a maximum of 6 digits with the initial condition is 0 KM. The maximum mileage number for odometer is 999,999 KM. After that the mileage number will go back to the setting of the initial conditions.

Fig.4 Digital Odometer

E. Serial Communication

In order for serial communication can work well, it is needed a protocol or communication rules. For example, the protocol in ATMega8 is USART (Universal Synchronous Asynchronous Serial Receiver and Transmitter). Communication using USART can be done in two ways. First is by the synchronous mode, in which the data sender spends credit or clock for data synchronization. Second is by the asynchronous mode, in which the data sender does not spend credit or clock, but do synchronization with the initialization process so that the received data is the same with transferred data. In this initialization process, firstly each connected devices must be set its baud rate or its data transfer speed [2].

III. System Design

The designation of odometer readings prototype for early warning in the vehicle lubricant replacement is aimed to provide early warning for people or companies who have a large number of vehicles. The early warning for vehicle lubricants replacement is obtained from the data captured on odometer through microcontroller that is displayed in the form of desktop-based application.

A. Diagram System Design

In general, the system made is:

- System planted in the vehicle is a system that is integrated in the vehicle. This system functions to calculate and store data from odometer, which is an indication of distance that has been taken by the vehicle, and then sent the data to the second system.
- System planted in the garage is a system that is located in the garage. This system functions to trigger the existing system in the vehicle in order to transmit the data on odometer. The data transmission is done when the first system is right in the range of data collection by the second system, and then the data is passed on to the computer.

The general overview of the system can be seen in the following picture.

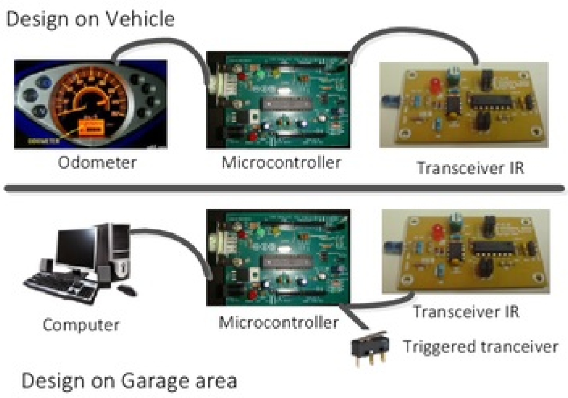

Fig 5. Diagram System Design

The workings of the overall system are as follows:

- Sensor limit switch functions as a trigger on the vehicle microcontroller. When the owner presses the limit switch, the voltage will be worth ± 5V and the data is then sent to the system in the vehicle (through serial communication 2). The system then will send odometer number as input that will be a trigger in the garage microcontroller.
- The garage microcontroller functions as an input receiver of the limit switch, functions to send and receive signals, and also functions to transfer the data obtained to the computer via serial communications.

The diagram block of how the system works shown in Fig. 6 below:

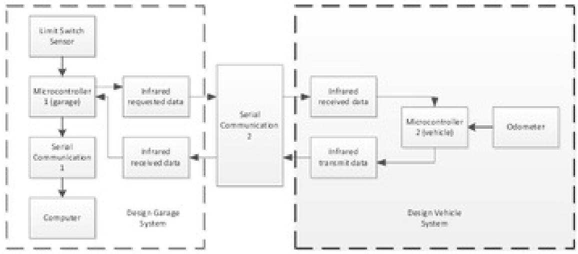

Fig.6 Diagram Block System

B. Flowchart of Sending and Receiving Data

Flowchart design of sending and receiving data transmitted by the system in the vehicle and in the garage can be seen in Figure 7 below. Figure 7 (a) is a flowchart design of sending and receiving data in the system that is planted in the garage. Meanwhile, Figure 7 (b) is a flowchart design of sending and receiving data in the vehicle.

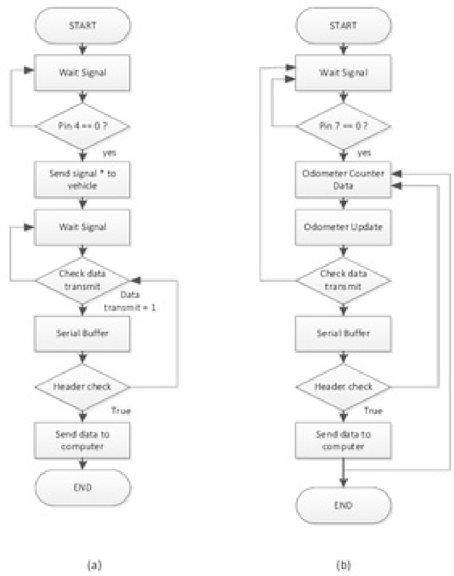

Fig 7. Flowchart design of sending and receiving data

C. Flowchart design on the computer

The computer application functions as a data storage that is received between the two systems, so it can be processed into understandable data. Vehicle data (for example vehicles ID, license plate numbers, vehicle brand, number of KM when the first time changing the oil, and phone number of each driver who is responsible for the vehicles) should already be stored in the database.

Flowchart of the system design can be seen in Figure 8 below. Data received from the odometer through Com41 port contains the ID, the number on odometer, and response time that is generated when the system is started to be triggered by limit switches, data transmission, until the data is received on the computer to be processed and stored.

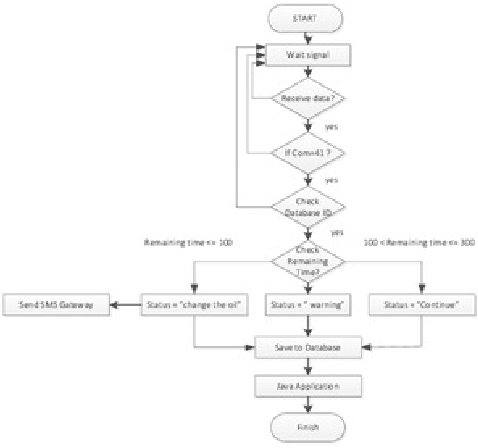

Fig.8 Flowchart design on the computer

D. *Odomotor Design*

The odometer prototype is made by using 12 volt DC motor and its holder, CD (Compact Disc) that has been perforated on one side, power supply from the DC battery, and optocoupler module. The odometer prototype is also made based on existing reference [6]. The use of CD that has been perforated on one side is because it can act as a sender of voltage captured by optocoupler modules, to be translated as a single round by the microcontroller.

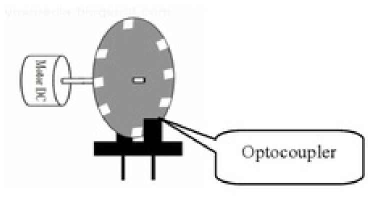

Fig.9 Optocoupler Module

DC motor will be placed in a holder that will play a CD that has been perforated. The CD will rotate between optocoupler Transmitter and Receiver. The voltage will be worth ± 0V when the light transmitted by the transmitter is managed to get to the receiver through the existing hole in the CD. The voltage will be worth ± 4V when the light is blocked by the CD. When the light is managed to get to the optocoupler receiver, the microcontroller will read the input as one full rotation, which is used as vehicle mileage. In the arduino board the input of odometer prototype is connected to pin D.7.

IV. Implementation and System Analysis

A. *Testing Scenario*

The testing implemented in the system as a whole is done by using several parameters:

- **The size of data on the odometer** with the size of data being tested is equal to 1 byte (for odometer with 255 km) and 2 bytes (for odometer above 255 km). The purpose of this testing is to see the accuracy of data sent by the odometer)
- **Distance** is the distance between systems, with the ranges tested were 10 cm, 50 cm, 100 cm, 300 cm, 500 cm, and 700 cm. The purpose of this testing is to see how far vehicle infrared can transmit odometer data correctly to the garage infrared.
- **Response time** is the time (ms) to be taken by the data when it is transmitted to the device and added by the delay of 200 ms. The purpose of this testing is to see how big the response time that is generated when transmitting data with the size of 1 byte and 2-byte.
- **Barrier** is a barrier in the form of clear glass with a thickness of 0.5 cm, window film with a 60% level of darkness and window film with an 80% level of darkness. The barrier is placed between the two systems. The purpose of this testing is to see the accuracy of data when it is transmitted from the two systems if the vehicle is using window film and the system is placed in the vehicle (blocked by vehicle glass).
- **Angle** is the angle formed by the two systems at the time of data collection is done. Tested angle were 0°, 5°, 10°, 15°, 30°, 45°, 60°, and 90°. The purpose of this testing is to determine the effect of the angle formed to the accuracy of the transmitted data

The testing system can be seen in the following figure:

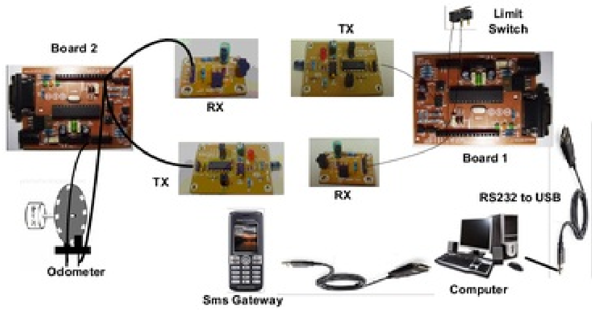

Fig.10 Implementation System

Meanwhile, the illustration of parameters explained previously can be seen in the following figure:

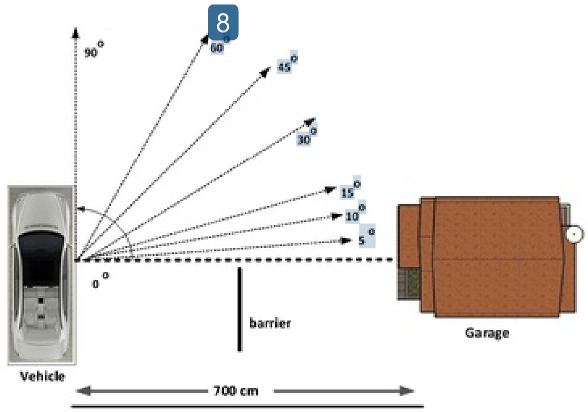

Fig.11 Illustration of measurement

B. *Testing Results*

The followings are the testing results of the effect of distance on the accuracy of data.

Table.1 the effect of distance on the accuracy of data

Distance (cm)	1-Byte (data = 32 km)							
	0°	5°	10°	15°	30°	45°	60°	90°
10	✓	✓	✓	✓	✓	✓	✓	✓
50	✓	✓	✓	✓	✓	z	x	X
100	✓	✓	✓	✓	✓	x	x	X
300	✓	✓	✓	✓	✓	x	x	X
500	✓	✓	✓	✓	z	x	x	X
700	✓	✓	✓	✓	x	x	x	X

Distance (cm)	2-Byte (data = 305 km)							
	0°	5°	10°	15°	30°	45°	60°	90°
10	✓	✓	✓	✓	✓	✓	✓	✓
50	✓	✓	✓	✓	✓	x	x	X
100	✓	✓	✓	✓	✓	x	x	X
300	✓	✓	✓	✓	✓	x	x	X
500	✓	✓	✓	✓	x	x	x	x
700	✓	✓	Z	z	x	x	x	x

In Table 1 it can be seen that in the measurement with the condition of 0° the accuracy of data is not affected by the distance between the two systems. Meanwhile, in the measurement with the condition wider than 0° the accuracy of data is predominantly influenced by the angle than by the distance. In the measurement with the condition of 30°, it can be seen that in the distance shorter than 300 cm the data is still perfectly received. Meanwhile, in the measurement with the condition of 45° the data is not successfully received even though the distance between the two systems is only 50 cm. This is because the data transmission using infrared is ideal for the condition of 0° or when the Transmitter is in line with the Receiver [12]. As long as the distance of data transmission is as far as infrared range, the data can be received correctly.

In Table 2 it can be seen that the accuracy of data is affected by the angle between the two systems at the time of data collection. In the measurement with the condition wider than 45° the data sent is not successfully received. Meanwhile, for the distance of 50 cm and 500 cm with the condition of 30° and 45° the data is successfully received and the results are inaccurate. This is because of based on the datasheet that the receiver has the maximum range of 45° [18]. Therefore, with the condition of angle equal to and wider than 45° the data transmission would be difficult to be received. Even in certain conditions as shown in Table 2 for the distance of 500 cm and 700 cm the data is not received in the condition of 30°. It is also added by the condition of the vehicle that is usually quite difficult and not necessarily able to achieve the 0° angle when exchanging data with existing systems in the garage.

Table.2 The effect of angle on the accuracy of data

Distance (cm)	1-Byte (data = 32 km)							
	0°	5°	10°	15°	30°	45°	60°	90°
10	✓	✓	✓	✓	✓	✓	✓	✓
50	✓	✓	✓	✓	✓	z	x	x
100	✓	✓	✓	✓	✓	x	x	x
300	✓	✓	✓	✓	✓	x	x	x
500	✓	✓	✓	✓	z	x	x	x
700	✓	✓	✓	✓	x	x	x	x

Distance (cm)	2-Byte (data = 305 km)							
	0°	5°	10°	15°	30°	45°	60°	90°
10	✓	✓	✓	✓	✓	✓	✓	✓
50	✓	✓	✓	✓	✓	x	x	X
100	✓	✓	✓	✓	✓	x	x	X
300	✓	✓	✓	✓	✓	x	x	X
500	✓	✓	✓	✓	x	x	x	X
700	✓	✓	Z	x	x	x	x	X

In table 3, it can be concluded that the barrier relatively does not affect the accuracy of data. In the table it can be seen that the value of data remains accurate in the condition without the barrier and with the barrier in the form of clear glass, window film with a 60% level of darkness, and window film with an 80% level of darkness. For 1 byte data transmission, the value of data is 32 KM. Meanwhile, for 2 bytes data transmission, the value of data is 305 KM. This is because of the characteristics of the infrared that it can also penetrate the invisible area. Therefore, it can be concluded that all barriers can still be penetrated by infrared light, so that the barrier relatively does not affect the accuracy of data.

Table.3 The effect of barrier on the accuracy of data

Distance (cm)	Parameter			
	1 Byte (data = 32 km) and 2 bytes (data = 305 km)			
	Without Barrier	Glass Barrier	Coated Glass with 60% darkness	Coated Glass with 80% darkness
10	✓	✓	✓	✓
50	✓	✓	✓	✓
100	✓	✓	✓	✓
300	✓	✓	✓	✓
500	✓	✓	✓	✓
700	✓	✓	✓	✓

The effect of the size of data on the response time and the accuracy of data can be seen in Figure 12. It can be seen that the size of data sent has a slight impact on the response time in the system.

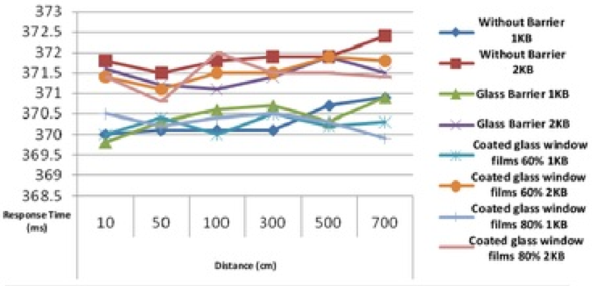

Fig.12. The effect of the size of data on response time and the accuracy of data

The effect of the size of data sent on the accuracy of the data can be seen in the following table.

Table.4 The effect of the size of data sent on the accuracy of data

Distance (cm)	Parameter			
	1 Byte (data = 32 km)			
	Without Barrier	Glass Barrier	Coated Glass with 60% darkness	Coated Glass with 80% darkness
10	✓	✓	✓	✓
50	✓	✓	✓	✓
100	✓	✓	✓	✓
300	✓	✓	✓	✓
500	z	z	z	Z
700	z	z	z	Z

Distance (cm)	Parameter			
	2 bytes (data = 305 km)			
	Without Barrier	Glass Barrier	Coated Glass with 60% darkness	Coated Glass with 80% darkness
10	✓	✓	✓	✓
50	✓	✓	✓	✓
100	✓	✓	✓	✓
300	z	z	z	Z
500	x	x	x	x
700	x	x	x	x

In the table above it can be seen the results of 1 byte and 2 bytes data transmission (the distance of 300 cm and 500 cm). For 1 byte data transmission the data is successfully and correctly received at a distance of 300 cm. Meanwhile, for 2 bytes data transmission the data is successfully received but the data is inaccurate.

V. CONCLUSION

Based on the testing and analysis results, it can be concluded that:

- The testing results of prototype of microcontroller-based odometer reading for vehicle lubricant replacement show that the size of data affects the success and accuracy of data with the response time generated. The average response time generated is at 370 ± 1 millisecond for 1 byte data transmission and 371 ± 1 millisecond for 2 bytes data transmission.
- The distance between the systems in the vehicle and the systems in the garage relatively has no effect on the accuracy of data obtained during the position of the two systems is at 0°. The optimal distance between the two systems is of 10 cm to 300 cm, in which the angle formed by the two systems is less than 30°.
- The angle formed by the two systems greatly affects the accuracy of the data. The wider the angle formed, the bigger the possibility of error will occur; even the data cannot be received at all. The optimal angle between the two systems is at 0°-30°.
- The system can still function well even though the barrier is given in the form of clear glass with a thickness of 0.5 cm, window film with a 60% level of darkness, or window film with an 80% level of darkness. The accuracy of data produced is relatively the same with the output of the system when there is no barrier between them.
- This automatic odometer reading device can be developed by replacing the infrared with other form of sensors.

References

[1] Alfa, Victor. www.bhasha.co.cc/pdf. Manual Pemakaian Arduino Severino.pdf. Tanggal Akses 11 April 2011.

[2] Angriana, Nova. 2009. Rancang Bangun Sistem Monitoring Parkir Berbasis Mikrokontroler ATmega8535 dengan Sensor Inframerah. ITTelkom. Bandung.

[3] IDC, Green. 2000. Komunikasi Data. Penerbit Andi: Yogyakarta.

[4] Haryanto, Bambang. 2007. Esensi- Esensi Bahasa Pemrograman Java Edisi 2. Penerbit Informatika. Bandung.

[5] Hermawan, Beny. 2004. Menguasai Java2 & Object Oriented Programming. Penerbit Andi: Yogyakarta.

[6] Khoswanto, H., Thiang, Kuntoro, J. 2004. Odometer Digital untuk Kendaraan dengan Mikrokontroler MCS51

[7] Putra, E., Agfianto. 2006. Belajar Mikrokontroler. Gayamedia: Yogyakarta.

[8] Winoto, Ardi.2010. Mikrokontroler AVR ATmega8/32/16/8535 dan Pemrogramannya dengan Bahasa C pada WinAVR. Penerbit Informatika Bandung.

[9] http://agfi.staff.ugm.ac.id/blog/index.php/2008/11/apakah-mikrokontroler- itu/ Tanggal akses: 11 Maret 2011.

[10] http://ali3xfun.wordpress.com/2010/11/20/tentang-avr/ Tanggal akses 28 Maret 2011.

[11] http://en.wikipedia.org/wiki/Odometer Tanggal akses 21 Maret 2011

[12] http://id.wikipedia.org/wiki/Inframerah Tanggal akses: 11 Maret 2011.

[13] http://id.wikipedia.org/wiki/Jarak Tanggal akses 3 juni 2011.

[14] http://jaenal91.wordpress.com/ Tanggal Akses 30 Maret 2011.

[15] http://pizaini.wordpress.com/2010/12/17/membaca-port-dengan-java-comm/ Tanggal Akses 15 Maret 2011

[16] http://www.arduino.cc/ .Tanggal Alses 12 April 2011.

[17] www.atmel.com/. Tanggal akses 12 Maret 2011.

[18] http://www.datasheetcatalog.com/datasheets_pdf/T/S/O/P/TSOP4838.shtml Tanggal akses 15 Maret 2011.

[19] http://www.ic2ic.com/search.jsp?sSearchWord=TSAL6200. Tanggal akses 15 Maret 2011.

[20] http://www.scribd.com/doc/17060403/TEORI-DASAR-MIKROKONTROLER Tanggal akses 10 Oktober 2010

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