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Real Time Workload Data Logger at Lathe Machine with ESP8266

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***Abstract*— The readiness of the machine is very important in practical activities so necessary to good engine maintenance system and organized. Machine maintenance scheduling can be arranged based on the time of use or component life. Recording the time of using a lathe is difficult to do manually, so it is necessary to record the time of using a lathe automatically using a data logger that can store data centrally via a Wi-Fi network. The components used in the development of the data logger consist of (1) the ESP8266 module as a data sender, (2) a 220 Volt relay as a connector between the ESP8266 and the lathe, (3) the Raspberry Pi as a local server, and (4) a Wi-Fi modem as a liaison between devices. ESP8266 will send the lathe condition data using HTTP GET method to the server and stored in SQL database using PHP code. The trial was carried out in a mechanical workshop, Universitas Negeri Malang. Tests are carried out to obtain data on the duration of time when the lathe is used until it is finished. The resulting data can be stored properly and can be exported into an excel file so that it can be processed and analyzed further. The development of a data logger using the ESP8266 has advantages, namely low manufacturing costs, can be connected via a Wi-Fi network, storage can be done centrally, can record data quickly and accurately and data in digital form so that it can be analyzed further. With these advantages, the preventive maintenance scheduling process can be carried out easily according to the workload that has been taken by the machine.**

Keywords*— *data logger, workload, preventive maintenance, ESP8266, local server

I. INTRODUCTION

One of the factors that support the smoothness of teaching and learning activities in the field of mechanical engineering is the readiness of the machines used in practicum activities, so a good and organized machine maintenance system is needed [1][2]. A good and organized machine maintenance system is a scheduled maintenance system so can minimize the occurrence of machine damage. Scheduled machine maintenance is divided into two categories, namely preventive maintenance and corrective maintenance [3][4]. Preventive maintenance is a maintenance activity carried out to prevent unexpected damage and may result in long downtime. Corrective maintenance is known as breakdown where maintenance is only carried out after the machine has failed.

Performing preventive maintenance on a scheduled basis is better than only performing corrective maintenance. If maintenance activities are only carried out when the machine has been damaged, it will cause more severe damage and the availability of replacement components is uncertain. The availability of replacement components is very important because the lathe consists of various vital components such as gears, belts, electric motors and power supplies. Preventive maintenance needs to be done to avoid possible damage and replacement of these vital components. Determination of the type of maintenance carried out on preventive maintenance activities is generally determined by two reasons, namely the need for maintenance and extending the service life of an equipment [5].

The need for machine maintenance can be arranged based on the selection of maintenance actions. The choice of action can be determined based on physical inspection, time of use or component life, and detection of damage. Considering the effectiveness of the implementation, recording the time of using the machine is an action that can be taken as a basis for consideration in the selection of actions and scheduling preventive maintenance on the lathe in the mechanical engineering workshop. Based on the results of the study, the lathe used in practical activities needs to be checked on the electrical system chart every 223 hours, the fixed head of the lathe every 502 hours, and the sledding of the lathe every 401 hours [6].

Recording the work load of a lathe is difficult to do manually because the machine is used alternately between students. Lack of coordination between students and awareness to record the time of using a lathe is the biggest obstacle in manual recording activities. To overcome these obstacles, it is necessary to record the time of using the lathe automatically using a data logger. Data loggers are often used to store information and collect data for a long time [7]. The data logger provides the function of measuring and recording data using transducers, computers and sensors [8]. By using a data logger, errors in time recording activities can be avoided because they do not depend on the human resource factor that operates the machine.

Data logger technology has been widely developed, but under certain conditions a data logger device system is needed that suits the needs of the measurement object such as the range of measurement values, accuracy and data accessibility [9]. In addition, adjustments and developments are needed such as data loggers that can be integrated with other systems. The development of data loggers is also expected to be able to connect to other devices either via cable or wirelessly such as the Internet of Thing (IoT). Online measurement technology using wireless sensors is no longer impossible to make. This development encourages people to continue to innovate and realize this technology in all fields [10].

Based on this background, a data logger will be developed to record the working time of the lathe automatically during practicum activities. The data logger will be connected to a local server via a Wi-Fi network so that the recorded data can be read in real time. The data

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recorded on the server can also be further processed to become a basis for consideration in selecting actions and scheduling preventive maintenance on lathes in mechanical engineering workshops.

II. METHOD

A. Hardware Development

The developed data logger will record the working time of the lathe by detecting changes in the condition of the electric motor that drives the lathe. The source of the electric voltage on the electric motor will be connected in parallel with a 220 v relay and then connected to the input pin of the microcontroller. The use of relays is due to the difference in working voltage between the lathe and the microcontroller.

In this proposed data logger, ESP8266 has been chosen to be the main microcontroller. According to [11][12], a high performance and a low usage of power of microcontroller is needed to build a fast as well as little cost used and it was chosen by many for their researches. The ESP8266 offers a complete and independent Wi-Fi network solution so that it can be used to control various sensors connected to the Wi-Fi network from other devices. Generally, ESP8266 consists of a microcontroller module and a Wi-Fi radio module [13].

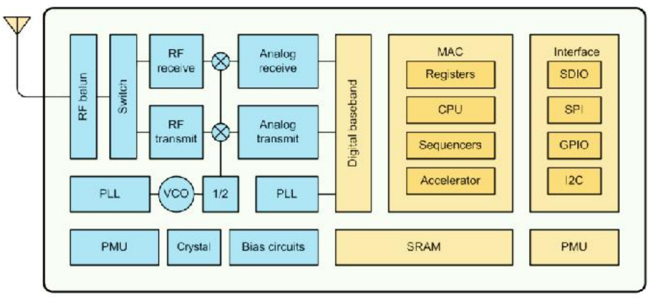


Fig. 1. ESP8266 Block Diagram

The real time data logger of lathe machine system consists of several module components, including ESP8266, power supply, 220 Volt relay, modem router, and Raspberry Pi as a local server. The reason for using the Raspberry Pi is because the development of the data logger is still on a laboratory scale so it will be more practical to use a mini server with a Raspberry Pi. The overall system block diagram is shown in Figure 2.

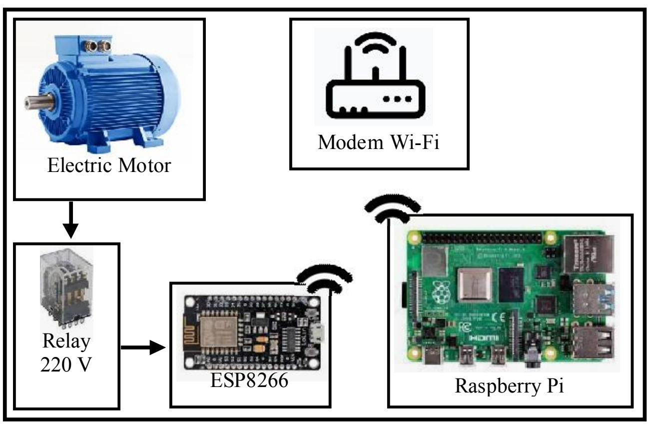


Fig. 2. Block Diagram of Lathe Data Logger

Changes in the condition of the electric motor detected by the microcontroller will be processed and sent to a local server via a Wi-Fi network using a router modem. The data received by the server will be stored in the SQL database by including the time stamp of the data. The database will record the Time stamp when the lathe is turned on and the Time stamp when the lathe is turned off.

The data in the database can be downloaded for further processing, especially to calculate the working time that has been taken by the lathe. The working time of the lathe can be used as a basis for determining the schedule of preventive maintenance. Each part of the lathe has a different work time so that by using data from a data logger, preventive maintenance scheduling can be arranged easily.

B. Program Development

The data logger will record the working time of the lathe by detecting changes in the condition of the electric motor that drives the lathe and then sending the data to the server via the Wi-Fi network. The lathe will be installed with ESP8266 and the server will use a Raspberry Pi that is connected using a Wi-Fi modem network. Flowchart of the data logger recording processes shown in Figure 3.

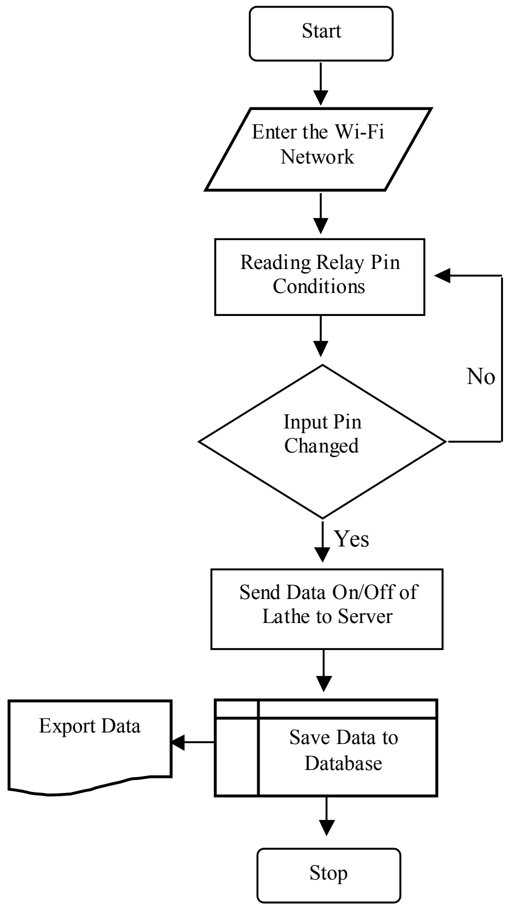


Fig. 3. Flowchart of the Data Logger Recording Process

The ESP8266 is programmed using the Arduino application and using the ESP8266Wi-Fi library. With the ESP8266Wi-Fi library, the ESP8266 can be programmed with Arduino and can be connected to other devices via a Wi-Fi network. The device that will be connected to the ESP8266 is a Raspberry Pi which is set as a local server. ESP8266 will send relay contact pin condition data to server using HTTP GET method. The GET method on HTTP is intended to retrieve data in the form of a query string sent via a url. The HTTP GET code used to send data from Arduino to the local server is shown in Figure 4.

```
client.print(String("GET ") + url + " HTTP/1.1\r\n" +
             "Host: " + host + "\r\n" +
             "Connection: close\r\n\r\n");
```

Fig. 4. HTTP GET Code on Arduino

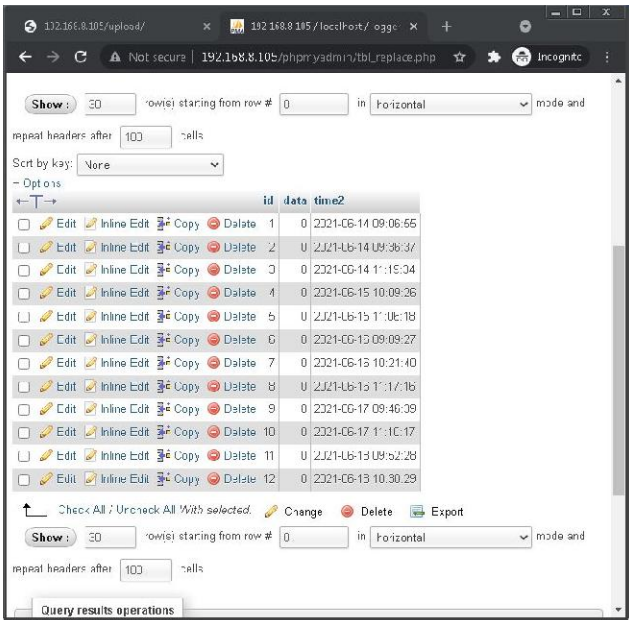
Raspberry Pi are installed phpMyAdmin, MySQL, and Apache to be used as a local server. The local server will be used to collect and store data from the ESP8266. The IP address of the Raspberry Pi is set as the host for sending data process using the HTTP GET method. The received data will be saved to the server using PHP code. When the data is received with PHP, the data in the url will automatically be decoded and will be saved to the MySQL Database. The PHP code for receiving and storing data is shown in Figure 5.

```
    $result = mysqli_query ($conn,"INSERT INTO start (data)
VALUES  ('".$_GET["data"]."')");

    if (!$result)
        {
            die ('Invalid query: '.mysqli_error($conn));
        }
```

Fig. 5. PHP Code to Save Data

The database in MySQL is divided into 2 tables, namely the start table to store data when the lathe starts and the stop table to store data when the lathe stops. Each table consists of 3 fields, namely id, data, and time. The id field is set to auto increment and becomes the primary key. id which has the same value in the start and stop tables will be a sign that the data is a data pair. The data field will store the data sent by the ESP8266, if the value is 1 then the lathe is in a start condition and vice versa if it is 0 then the lathe is in a stop condition. The time field will be filled in automatically recording the timestamp when the data is saved. Figure 6 shows an example of a table from a database.



id	data	time2
1	0	2021-06-14 09:06:55
2	0	2021-06-14 09:36:37
3	0	2021-06-14 11:15:04
4	0	2021-06-15 10:09:26
5	0	2021-06-15 11:06:18
6	0	2021-06-16 09:09:27
7	0	2021-06-16 10:21:40
8	0	2021-06-16 11:17:16
9	0	2021-06-17 09:46:39
10	0	2021-06-17 11:10:17
11	0	2021-06-18 09:52:28
12	0	2021-06-18 10:30:29

Fig. 6. Stop Table in Database

III. RESULTS AND DISCUSSION

Data logger made using ESP8266, 220-volt relay and 5 Volt power supply assembled in a box. The power supply is connected to a 220-volt power source cable and the relay coil is connected to the electric motor contactor on the lathe. Figure 7 shows the data logger design that has been created.

Fig. 7. Developed Data Logger

The data logger trial was carried out in a mechanical workshop, Mechanical Engineering Department, Universitas Negeri Malang. The trial was carried out for 5 days to obtain data on the workload of the lathe. The data logger is installed on the lathe box panel as shown in Figure 8 and the Raspberry Pi and the Wi-Fi modem is placed in the box as shown in Figure 9. The server is placed in the same workshop room.

Fig. 8. Installation 0f Data Logger in Panel Box

Fig. 9. Raspberry Pi as Server and Connect via Wi-Fi Modem

Recorded data can be viewed through phpMyAdmin and a simple web interface. The recorded data can be downloaded into an excel file so that it can be processed to see how much workload has been taken by the lathe. From the experimental data for 5 days, the average workload of the lathe machine every day is obtained as shown in Table 1.

TABLE I. DATA LOGGER OF LATHE 1

No	Start Time	Stop Time	Duration
1	6/18/2021 10:14:44	6/18/2021 10:30:29	0:15:45
2	6/18/2021 8:42:47	6/18/2021 9:52:28	1:09:41
3	6/17/2021 10:02:28	6/17/2021 11:10:17	1:07:49
4	6/17/2021 9:09:22	6/17/2021 9:46:39	0:37:17
5	6/16/2021 10:48:28	6/16/2021 11:17:16	0:28:48
6	6/16/2021 9:29:24	6/16/2021 10:21:40	0:52:16
7	6/16/2021 8:43:14	6/16/2021 9:09:27	0:26:13
8	6/15/2021 10:33:40	6/15/2021 11:06:18	0:32:38
9	6/15/2021 9:05:16	6/15/2021 10:09:26	1:04:10
10	6/14/2021 10:08:27	6/14/2021 11:19:34	1:11:07
11	6/14/2021 9:22:42	6/14/2021 9:36:37	0:13:55
12	6/14/2021 8:32:55	6/14/2021 9:06:55	0:34:00

The purpose of developing a data logger is to record the workload of a lathe machine automatically and precisely. By recording workloads automatically and with precision, machine maintenance activities can be scheduled precisely because the service life of components can be easily known. The use of data loggers has the advantage of large storage capacity, can obtain data at a relatively high speed and can perform further analysis of the stored data [14].

From the test results, it can be concluded that the development of a data logger that is used to record the work load of a lathe can work well, can work automatically and has recording data that can be used as a basis for scheduling machine maintenance. The exported data in excel form can also be processed in the form of graphs such as Figure 10 to see a comparison of the workload of the lathe every day. Recorded data can also be processed to calculate the total workload that has been taken by the lathe.

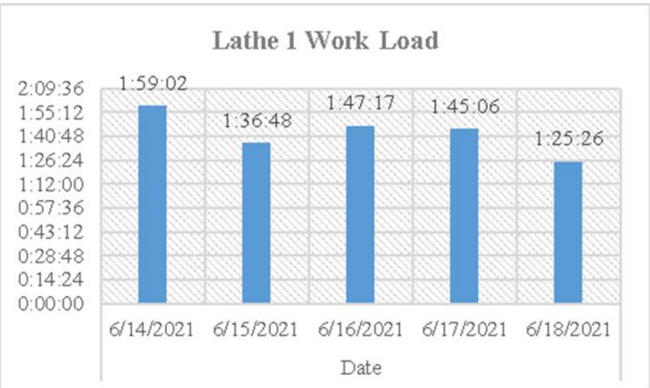


Fig. 10. Average Daily Workload Of Lathe

IV. CONCLUSION

Automatic recording of lathe workload has many advantages when compared to manual recording. The development of a data logger using the ESP8266 has advantages, namely low manufacturing costs, can be connected via a Wi-Fi network, has a large storage capacity, can record data quickly and accurately and data in digital form so that it can be analyzed further. By using ESP8266, the data storage can be centralized to the server so that the recorded data can be viewed in real time.

By using a data logger, the preventive maintenance scheduling process can be carried out easily according to the workload that has been taken by the machine. With a systematic scheduled machine maintenance system, the lathe will always be ready to be used in practical activities, besides that damage to the machine can be minimized.

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