Design of Real Time Anemometer Based on Wind Speed and Direction

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Abstract- Data acquisition of wind speed and wind direction are needed to get the data potential of wind power. The aim of this research is to generate a device of wind speed and wind direction with the real time condition. With this device, we will obtain an analysis about the potential of wind power electrical generation around the Puger beach, Jember, Indonesia. In this study and discussion, the main part is made in three hardware that is to measure wind speed, wind direction and to show real time data. The device which is used to measure wind speed using hall effect sensor as a transducer. With using of the active magnet that spins will be created pwm that will be read by sensor to get the wind speed. As for the shows wind direction, we use a compass sensor CMPS 03 is a digital sensor that outputs in the form of digital bits so that be able to show wind direction from 0° to 360°. The magnitude of angle will be used in analyzing the direction of the wind. Then the real time clock (RTC) will be used to directly to determine the time and date of recording data.

Key words : Anemometer, Hall Effect, Compass, RTC

I. INTRODUCTION

Wind is moving air due to the difference in air pressure in the direction of wind flow from a high pressure to a lower pressure or from areas which have a low temperature to a high temperature region.

Anemometer is a device used to measure the wind speed that is widely used in the fields of metrology and Geophysics or station weather forecasts. The wind speed was measured by the cup anemometer has three wind catcher cup and rotates in the direction of the wind catcher. The effect of the rotor's geometry on the cup anemometer transfer function has been investigated experimentally and analytically. The analysis of the anemometer's output signal as a way of monitoring the anemometer status is revealed as a promising procedure for detecting anomalies [1]. The anemometer very helpful in thorough research about the movement of wind and wind characteristics. Therefore, the development of anemometer is very important in knowing wind potential which is exist in certain areas.

Wind power electric generation is the renewable electric energy utilizing wind as a driving force. Therefore we need to conduct a research on the wind potential and wind direction in order to know the exact wind farm to build wind power.

Therefore, the researchers want to know more focus of the existing wind potential in the coastal areas. In the reference [2] the device created just based on wind speed and direction, whereas in this paper we equip with a device of time to indicate the time and date when the data recording experiments. So with the help of a hall effect sensor, a compass sensor and a RTC device, we can measure of the wind speed, wind direction and time eventually expected will be helpful in the research process.

The sensor used is a sensor that does not require an encoder with many holes, but only uses active magnet which has side of north and south. With the changes in the magnetic motion through hall effect sensor, then the sensor will send a pulse that will be converted into speed. While the use of the compass sensor is used to determine angle or areas will always be passed by the wind and the RTC is used to determine the real time and date when the actual data recording.

All the data of wind speed, wind direction, real time and date will be stored in a micro SD memory combined with data storage module. The data stored aims to find out all the speed and wind direction when the tool is not used in a long period of time, then will store the data again when the next addition. By using arduino uno control system so that more compact design can be created for these tools. Moreover, we use LCD that can display data of wind speed and direction while at the sites.

II. BASIC THEORY

D. Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328 with 14 pins have digital inputs/outputs. Among them is 6 PWM output pins, 6 analog inputs, a crystal oscillator of 16 MHz. Arduino UNO contains all needed to support the microcontroller, easy to connect it to a computer with a USB cable or supply it by an AC to DC adapter. ATmega328 has 32 KB to 0.5 KB used for the bootloader. ATmega328 also has 2 KB of SRAM and 1 KB EEPROM. Figure 1 below shows an Arduino UNO [3]:

Figure 1. Arduino UNO

With the help of this arduino all the data will be processed and controlled to obtain data of wind speed, wind direction and real time in accordance with a state of the research that has been determined. Pins are used to obtain performance sensors are pin A4 and A5 are used for compass sensor. Pin 2 is used for hall effect sensor.

E. SENSOR HALL EFFECT

Hall effect sensors are used to detect magnetic fields and position and displacement of objects. The effect is based on the interaction between moving electric carriers and an external magnetic field. In metals, these carriers are electrons. When an electron moves through a magnetic field, a sideways force acts upon it [4]. This sensor is designed to detect magnetic objects with position changes. The change over in the magnetic field that continuously causes the pulse frequency can be determined. This type of sensor is used to measure speed. Hall effect sensor can also be used to detect the proximity, the presence of magnetic objects using a critical distance. Figure 2 below shows hall effect sensor which is placed near a magnetic field.

Figure 2. Position of Hall Effect Sensor

Hall effect sensors will be used to provide pulse is converted to be frequency in order to detect the speed corresponding to the real state of the rotating object. By giving count pulse then there will be a change to the speed frequency.

F. SENSOR KOMPAS CMPS03

CMPS03 compass sensor is a sensor that can determine the angle position. This sensor is designed specifically for the field of robotics with the aim as a navigator that is used for the movement of the robot [5]. This sensor is produced by Devantech uses two magnetic field sensors artificial KMZ51 Philips which sensitive enough to detect the Earth's magnetic field, where the installation of two sensor intersecting. In the compass module has been installed a series of state of the signal and the microcontroller, so that the data can be accessed easily. CMPS03 requires a working voltage of 5 volts with a current consumption of 15 mA. There are two ways to access generated data of these sensors by using a PWM signal or using the I2C protocol. The following figure 3 is a compass CMPS03 uses I2C communication and figure 4 is CMPS03 sensor mounted on the tail flipper of anemometer.

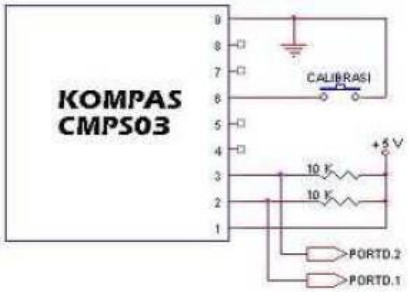

Figure 3. CMPS03 Sensor

Figure 4. CMPS03 sensor mounted on the tail flipper of anemometer

PWM signal by 16-bit timer of the processor on the compass module that produces a resolution of 1 µs. So it is recommended by the manufacturer for detecting the PWM signal with the timer which the resolution is lower than that produced by the compass. To pin I2C, SDA and SCL connected to the supply 5 VDC through pull up resistor, because the SDA and SCL does not have the pull up. I2C communication protocol is the same as that used in Serial EEPROM production of Atmel 24CXX and Serial of RTC (Real Time Clock) production of Dallas Semiconductor RTC1307, so the SDA and SCL lines can be used simultaneously. The reading of this compass sensor connected with arduino microcontroller.

G. REAL TIME CLOCK DAN DATA LOGGER

RTC is used to indicate the data based on the time and date actually and follow when the data is retrieved. The data obtained are wind speed and direction will be recorded on a data logger and stored on the memory card. From experiments in a full day of data collection obtained large data storage capacity is used about 250 kB. Figure 5 shows a figure of series RTC and RTC components are mounted on the anemometer. While Figure 6 is komponendata logger that serves as a data recording.

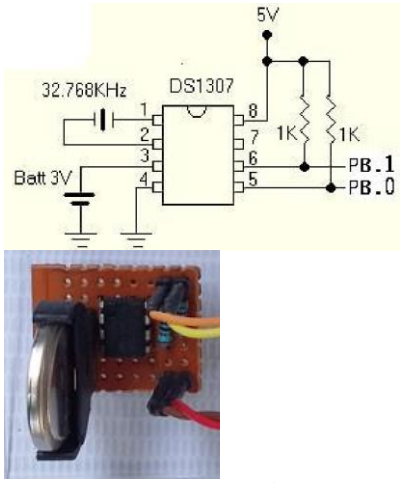

Figure 5. Figure of RTC series and RTC components

Figure 6. Data Logger

III. METHODE

The research was conducted by making listing program on arduino software using the C ++ language. The program that created is started by the wind speed program, compass program CMPS03 and RTC program. The program that was created is loaded in the ATmega328 microcontroller.

Sensors mounted on the mechanical design of the anemometer. Speed sensors placed on the propeller system of the cup anemometer that can read the magnetic field pulse that has been attached to the propeller. With different mounting point between the speed sensor and its compass, sensor will allow for stability without any wind disturbance caused by crash with wind catcher cup. Anemometer design that is designed as in figure 7 and trial anemometer with real time data retrieval is done as in Figure 8.

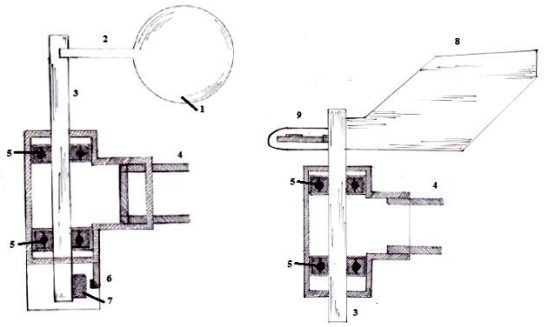

Figure 7. Design of Anemometer

Figure 8. Anemometer Experiment

From figure 8 above can be explained that the wind catcher cup design with 10 x 7 cm for height and width. As for the wind direction flipper with a size of 10 x 15 cm for height and width. While the sensor is placed in the number position of 6 and 4. Number 6 is mounted hall effect sensor to measure wind speed. While number 4 for compass sensor CMPS03.

IV. RESULTS AND DISCUSSION

The experiments were carried out on the beach Puger in one day started at 21:24:17 to 21:24:31. Data obtained from the test results as shown in Table 1 below:

TABLE I
EXPERIMENT OF ANEMOMETER
BASED ON REAL TIME OF WIND SPEED AND DIRECTIONS

Time	Date	Speed	Degree
21:24:17	27/06/2015	1.26	320
21:24:19	27/06/2015	1.26	329
21:24:21	27/06/2015	1.26	326
21:24:23	27/06/2015	1.26	326
21:24:25	27/06/2015	1.26	326
21:24:31	27/06/2015	1.26	325

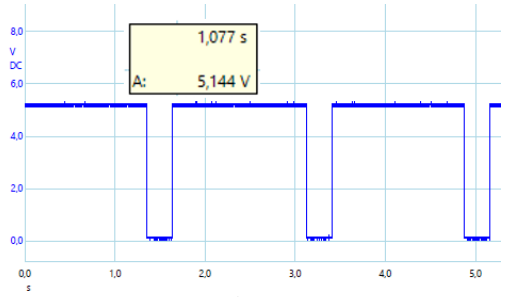

Figure 9. Graph of Hall Sensor Voltage

Equation of calculation results from the rotation speed of the rotor magnet into units of m/s are:

$$v = (\pi \times 2 \times r_{rotor} \times rpm)/3600$$

Speeds equation above is used to determine the results of the data speed actually. From the experimental results obtained in Table 1 wind speeds found in column 3 of 1.26 m/s. At this speed indicated on sensor Hall voltage value of 5.14 V as in Figure 9. Device of anemometer made this already follows the real-time data with the data condition wind speed, wind direction, time and date data retrieval.

For data obtained from the trial on June 9, 2015 is shown by the following table 2:

TABLE II
TRIAL DATA OF WIND SPEED AND DIRECTION AT JUNE 9, 2015

Time	Speed	Direction	Time	Speed	Direction
1	6,3	272	13	5,04	240
2	5,04	260	14	2,51	272
3	3,77	255	15	3,77	280
4	3,77	239	16	2,51	292
5	5,04	280	17	2,51	260
6	3,77	292	18	5,04	255
7	2,51	260	19	3,77	250
8	2,51	255	20	6,3	276
9	2,51	250	21	7,56	210
10	3,77	276	22	6,3	208
11	3,77	272	23	5,04	290
12	5,04	266	24	7,56	208

Wind speed data in Table 2 show average speed of 4.4 m / s with graphic of wind rose map at an average angle of 259° as in Figure 10 below:

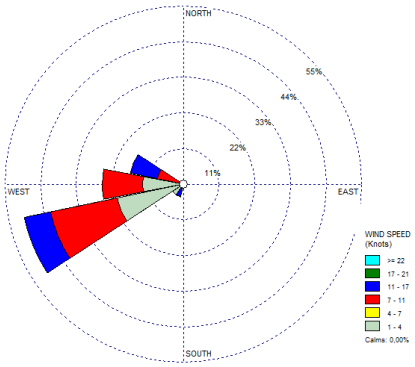

Figure 10. Graph of wind direction angle

V. CONCLUSIONS

From the results of tests performed it was concluded that the speed sensor in the form of an electronic circuit that consists of a hall effect sensor generates a frequency that is proportional to the speed of the wind catcher cup mechanical and wind speed measurements an average of 4.4 m/s and the average angle of 259° were carried out around the Puger beach, Jember, Indonesia.

ACKNOWLEDGMENT

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