DESIGN OF QIBLAT DIRECTION USING HMc 5883L SENSOR

Sudirman Lubis[1]
Wawan Septiawan Damanik[2]
Munawar Alfansury Siregar[3]

Faculty Of Mechanical Engineering Studies, University of Muhammadiyah Sumatera Utara , Indonesia,
E-mail: sudirmanlubis@umsu.ac.id

Abstract: *The level of accuracy of a measuring instrument is expected to be better because it is expected to provide information that can be used as a reference and benchmark in research and application in people's lives. The use of a compass measuring instrument in determining the direction of the wind and the location of the Earth's magnitude varies from year to year, such as analog and digital compasses. Both offer good readings in the same way that utilizing magnetic north and south poles as reference points. The HMC 5883L sensor is a measuring instrument that is able to detect the cardinal directions in the same way analog and digital compasses work. By using Arduino Uno as a microcontroller as a central control that is able to convert the information received from the HMC 5883L sensor into a form of data that is easy to understand. The HMC 5883L sensor is applied as a companion to the reading results of the RHI compass at the OIF Muhammadiyah University of North Sumatra to get a more accurate Qibla direction by comparing the readings of the two. The results of the HMC 5883L compass sensor readings will be visualized in the form of a pointer, a wind direction lamp and the reading will be changed in the form of a number. All data that is changed in the form of work is the result of orders from Arduino Uno received from the HMC 58883L sensor. A total of eight LED lights are used as a wind vane and are connected to the data obtained from the sensor.*

Keywords: *HMc5883L Sensor, Qibla Direction*

Introduction

Earth has two magnetic poles located at the north and south. Earth's magnetic field or also called geomagnetic field is a magnetic field that reaches from the inside of the earth to a certain extent until the magnetic field meets the solar wind [1]. The magnitude of the Earth's magnet varies greatly from 25 to 65 microteces or about 0.25 to 0.65 gauss[1,2]. In 1635, Gellibrand in London reported that the earth's magnetic field is unstable and changes its declination every year and continues to experience the movement of the Earth's core fluids [3,4]. Within five years BMKG (Klimatoligi and Geophysics Meteorological Agency) observes changes in variation maps and maps the changes in order to obtain the latest and correct map of variations in the earth's megnet. [5]. Changes in the earth's magnetic map affect the direction of the wind that is intended when using a compass or google map application when searching for locations either manually or using the internet network[6]. Accuracy in tracing the location and direction is needed, especially in finding a direction such as finding the direction of the Qibla for some Muslim communities, especially in Indonesia. The tools that are often used manually in finding the Qibla direction such as the Analog compass are still not accurate because they can only show the direction with a pointer without providing information on the whereabouts and degrees of the position to look for [7]. Muhammadiyah University of North Sumatra has a Falak Science Observatory which has tools

that can be used to see the arrival of the new moon at the beginning of the month of Ramadan by using a telescope and has a Qibla direction tool called Kompas RHI. The RHI compass works the same as the analog compass works manually and has the disadvantage of being very sensitive to metal objects and electronic equipment[7]. A more accurate compass is needed to compare and strengthen the results of a more precise Qibla direction and this can use digital sensors that can be operated using the Arduino Uno Micro controller. The sensor in question is a three-axis HMC 5883L type. The three-axis HMC 5883L is a very simple magnetoresistive sensor, very sensitive to the rotation and direction of the sensor, which uses the earth's magnetic field as a reference[8,9,10]. After reading a lot that the capabilities of the HMC 5883L sensor can be used as a substitute for an arduino-based compass, it is hoped that the HMC 5883L compass sensor can be a companion tool in determining the cardinal directions and the Qibla direction of the RHI analog compass used so far by the UMSU OIF (Falak Science Ovservatorium).

Literature Review

The increasing development of technology is very helpful for humans in completing daily work such as digital system compass technology or compass used in ships and aircraft. In recent years the use of analog compasses has decreased due to the emergence of digital-based compasses. Accuracy levels are increasingly expensive and sought after, leading to the creation of compass technology that is more accurate than previous analog compasses. The use of the HMC5883L sensor has been widely used by previous researchers from both the academic and industrial fields as a tool to determine the direction of the wind such as a compass. In 2016 TW Wisjhnuadji and Sesar Sugandi performed auto tracking and satellite finder for parabolic antennas using HMC 5883L compass and Android based Bluetooth HC05. The goal is to make it easier to work in determining the signal direction and satellite position with a Bluetooth HC05 based on an android smartphone. The controller used is a cost-effective, low-power chip. Chip capable of communicating with various sensors in realtime. The Leadless Chip Carrier (LCC) is composed of high resolution magnetic resistant sensors with automatic demagnitation. From testing this tool, the accuracy and fast response time of this adroid-based control system is produced [11].

Compass

A compass is a navigation tool for determining the direction of a magnetic pointer arrow that is free to accurately align itself with the earth's magnetic field. Compass provides a reference for certain directions, so it is very helpful in the field of navigation. The cardinal directions that it shows are north, south, east, and west. When used together with a clock and exa, the compass will be more accurate in showing the direction[12].

Arduino

Arduino UNO is a microcontroller board based on the ATmega328. The Arduino UNO has 14 digital input / output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz Crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Arduino UNO contains everything you need to support the microcontroller, easily connect it to a computer with a USB cable or supply it with an AC to DC adapter or use a battery to start it up [13].

Sensor HMc 5883L

HMC 5883L is a sensor that is used to show the cardinal directions, or it is also known as a digital compass. This sensor uses the main component in the form of IC HMC5883L which is a 3 axis digital compass IC which has an interface in the form of 2 I2C pins. HMC5883L has a high-resolution magneto-resistive sensor HMC118X series, plus ASIC with amplification content, automatic degaussing strap driver, offset cancellation and a 12 bit ADC that allows compass accuracy of 1 to 2 degrees. This module is commonly used for automatic navigation systems, mobile phones, netbooks and personal navigation devices. This module has 5 pins, including VCC, Gnd, SDA, SCL, and DRDY [14]. There are three magnetoresistive elements used by the HMC5883L sensor, one of which is that it can change the resistance propesional with the strength of the magnetic field along its axis. It should be noted that the way this sensor works is by using the earth's magnetic field as a reference for the magnetic field points on the north and south sides. An important point to note is that the sensitivity of each individual magnetoresistive element is a component that is parallel between the magnetic field and the element's axis.

The three elements in the sensor package are oriented such that each one is orthogonal to the other two. In other words, the respective X, Y and Z axes are unidirectional. Thus, when the sensor package is exposed to a magnetic field, the strength and direction of the field in three-dimensional space can be determined from the resistance exhibited by the three elements. HMC5883L presents the magnetic field sensitivity as a vector to all three axes marked with 16-bits (one for each axis). It also automatically compensates for any internal dependence on offset and angle effects on individual elements. The HMC5883L sensor is a magnetic sensor whose components are wrapped in fiber material and packed in a 3.0 x 3.0 x 0.9 mm surface mount with a 16 pin leadless chip carrier (LCC). This sensor uses Honeywell's anisotropic magneto-resistive (AMR) technology, regarding the precision of this sensor is very sensitive by using 2 earth magnets as a reference.

How the 5883L HMC Sensor Works

Like other conventional sensors, namely analog sensors, this sensor also relies on the earth's magnet as a reference point for the south pole and north pole. This magnetic field develops throughout the earth's surface so that it can be used to assist in pointing the cardinal directions. The magnetometer uses the magnetic field, but does not attract the tiny needle inside. Inside the magnetometer there are three magnetoresistive sensors on three axes. This explains that the effect of the magnetic field on this sensor regulates the flow of current through the sensor by applying a scale (milli-gauss). The Honeywell HMC5883L is a surface-mount, multi-chip module designed for low magnetic field sensing with a digital interface for applications such as compassing and magnetometry. The HMC5883L includes a high-resolution HMC118X series magneto-resistive sensor and ASIC amplification. This HMC5883L makes use of Anisotropic. Honeywell Magnetic Sensors are one of the most sensitive and reliable low field sensors in the industry. This solid-state sensor construction with extremely low cross-axis sensitivity is designed to measure both the direction and magnitude of the Earth's magnetic field, from milli-gauss to 8 gauss. Honeywell's magnetoresistive (AMR) technology provides an advantage over other magnetic sensor technologies. This anisotropic, directional sensor has precision in the axes of sensitivity and linearity.

This HMC5883L sensor is a sensor that is very sensitive to the rotation and direction of the sensor, because this sensor uses a magnetic field as a reference for its detection / a module used to show digital cardinal directions, or also called a digital compass. This module uses the main component in the form of IC HMC5883L which is a 3 axis digital compass IC which has an interface in the form of 2 I2C pins. A sensor that has a response to rotation or rotation, so this sensor will have a different value when it is facing a different position, for example if this sensor

faces north to south, the results when the position faces north will be different from when the sensor is facing. facing south position, that is how the HMC5883L compass sensor works[14]. In addition to the HMC 5883L sensor, the MPU 6050 sensor also has the same working principle, namely measuring the acceleration of an object or moving object. The MPU 6050 sensor is one of the MEMS Metion Tracking sensor products produced by the Invensense company. MPU 6050 is an IC which consists of an accelerometer and a digital gyroscope, each of which has 3 axis orientation. Both the accelerometer and the gryscope in the MPU 6050 have 16 bit digital outputs that can be accessed via the IC or SPL interface. For each channel it is possible to capture x, y, and z channels at one time. This sensor uses the 12C-bus to communicate with Arduino.

Liquid Crystal Display (LCD)

The LCD can receive two signals, the first is a data signal and the second is a control signal. This signal is captured from the RS pin status. Data can be read by LCD by pulling the highest R / W pin. After pin E flashes, the data is transmitted to the front screen of the LCD. LCD (liquid Crystal Display) is an electronic component that is used to display a character, be it a number, letter or certain character, so that the display can be seen visually. The use of LCD as a display is widely used because the power required by the LCD is relatively small (micro order wstt), although this module is limited by external / internal light sources, temperature and life span.

Method

At the time of assembling the components that require high accuracy and persistence. Adjustment of test result data with Arduino uno by creating a program in the form of a program language that can be read by Arduino uno to apply the data obtained from the HMC 5883L sensor. The solution to the problem with the installation process can be done after the equipment and materials mentioned above are complete and available. After the installation process, the sensor that has been installed will not run without a program that has been made on the HMC 5883L sensor.

Resultand Discussion

After testing, the results obtained will be discussed in order to get conclusions and answer the research objectives mentioned in the previous first chapter. According to information obtained from OIF UMSU, the direction of the angle of inclination from the Qibla until today is 293^{o} to the northwest. In relevant literature and research it has been stated that the workings of the digital compass sensor and analog compass are very dependent on the presence of the earth's magnet. If the earth's magnet shifts, the compass reading will also change. In Figure 1, the results of the reading of the Qibla direction using the HMC 5883L sensor at a tilt angle from north to northwest 293^{o} are shown on the LCD screen and the LED lights are lit.

Volume 2 Nomor 1 Tahun 2021
e-ISSN: 2722-7618

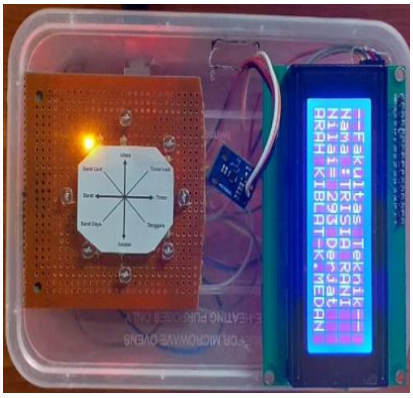

Figure 1. The result of the compass reading for the degree of tilt direction of the Qibla 293^0

On the same arc line, a degree line of the slope of the Qibla direction is drawn at the taqwa mosque in the Muhammadiyah University of North Sumatra which has been measured the slope of the Qibla direction by the OIF UMSU team to equalize the starting point of measurement so that the difference in degrees of inclination from the HMC 5883L sensor is found in finding the tilt angle of the Qibla .

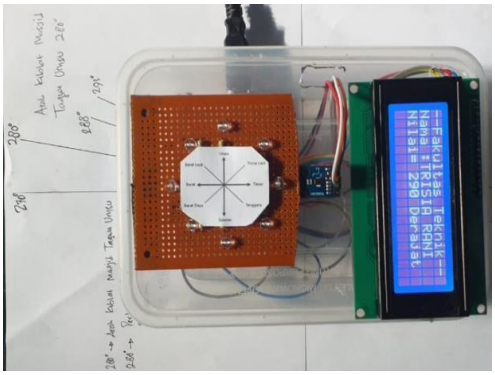

Figure 2.Look for the qibla direction guide line at taqwa mosques in the neighborhood USU with the HMc 588L sensor

When compared with the results of the RHI compass readings listed on the Taqwa mosque on the campus of the Muhammadiyah University of North Sumatra, it can be concluded that the results of the compass reading of HMC 5883L are close to the Qibla direction shown from the RHI compass readings. Comparison of the slope of the reading of the Qibla direction of the RHI sensor and the HMC 5883L sensor can be seen in Figure 3 below.

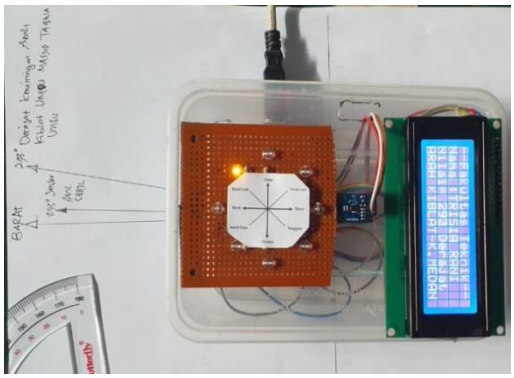

Figure 3.Readings of the RHI compass and the HMc 5883L sensor

From Figure 3 above, you can see the difference in the degree of slope of the HMC 5883L compass sensor reading with the Qibla direction at the UMSU taqwa mosque. The degree of slope of the reading is a difference of 7^o from the Qibla direction at the UMSU taqwa mosque. Indonesia is at 290^o to 295o the slope of the Qibla direction to the northwest, while the difference in the Qibla direction from the HMC 5883L compass sensor is only 2^o from a safe distance, so the HMC 5883L sensor can still be used as a companion to the RHI compass in reading the Qibla direction..

Conclusion

After obtaining the results from the discussion in the previous chapter 4, it can be concluded the effectiveness of the HMC 5883L sensor in order to answer the research objectives that have been previously mentioned.

1. The reading ability of the HMC 5883L sensor is quite good due to the difference in the readings of the tilt angle of the Qibla direction which is still in the safe category, namely 7^o while the safe distance range for the slope of the Qibla direction in Indonesia is 5^o .
2. The reading of the HMC 5883L sensor is very easy to understand because the language displayed on the LCD screen can be replaced with everyday language that we use.
3. Comparison of the results of measuring the degree of Qibla direction is not so far and worthy of being used as a companion to the RHI compass sensor which is on the OIF UMSU.

References

Adiwijaya, W. (2016). "Penunjuk Arah Kiblat Berbasis Arduino Nano Dengan Menggunakan Sensor Kompas Hmc5883l." *sekripsi*.

Adriansyah, A. and O. Hidyatama. (2013). "Mechanism and technique of friction control by applying electric voltage. (II) Effects of applied voltage on friction." *J. Teknol. Elektro, Univ. Mercu*, vol. 4, no. 4, pp. 100–112.

Arifin, H. P. Jauhari & Leni Natalia Zulita. (2016). "Perancangan Murottal Otomatis Menggunakan Mikrokontroller Arduino Mega 2560," *J. Media Infotama Vol.*, vol. 12, no. 1, pp. 89–98.

B. Li, W. Lai, C. Yang, and S. Zheng. (2016). "Design of Electronic Compass," no. Mmebc, pp. 1240–1243.

Buffett, N. Knezek and B. (2018). "Influence of magnetic field configuration on magnetohydrodynamic waves in Earth's core," *Phys. Earth Planet. Inter.* vol. 277. no. January. pp. 1–9.

Diana D. and J. Al Rasyid. (2017). "Implementasi Sensor Compas HMC5883L Terhadap Gerak Robot Micromouse dengan Menggunakan Algoritma PID.," vol. 6, no. 2. pp. 120–124.

Faudin, Agus. (2019). "Tutorial Arduino mengakses module accelerometer & Gyroscope MPU6050," *Nyebarilmu.Com*, no. January.

Finlay, C. C. et.al. (2010). "Short timescale core dynamics: Theory and observations." *Space Sci. Rev.* vol. 155. no. 1–4, pp. 177–218.

Hakim, L. et.al. (2017). "Prototype Robot Untuk Menentukan Arah Kiblat Dengan Cotg B = Cotgbsina - Cos A Cotg C Sinc." *Sekripsi*. pp. 1–8.

F. Meteran, D. Cara, and F. M. Sekrup, "Fungsi Kompas Jenis Kompas Bagian-Bagian Kompas," pp. 1–2.

Https://id.wikipedia.org/wiki/Kompas#cite_note-Li_Shu-hua, "Diakses 22 April 2019," 2019. .

Https://hurahura.wordpress.com/2016/03/06/sejarah-kompas-si-penunjuk-arah/, "Kompas," *di akses 23 Mei 2019*, 2016.

http://www.mandalamaya.com/pengertian-gps-cara-kerja-gps-dan-fungsi-gps/, "Pengertian GPS Cara Kerja GPS Dan Fungsi GPS," *diakses 12 Januari*, 2015.

AL-Ihsan, A. A. (2018). "Akurasi Arah Kiblat Masjid-Masjid Di Kecamatan Sampung Kabupaten Ponorogo." *Sekripsi*. no. akurasi kiblat. pp. 1–88.

K. Pembesar *et al.*, "Cara Menggunakan Kompas," pp. 4–6.

Maus ,S. et al. (2010). "The US/UK World Magnetic Model for 2015-2020."

Novianta, M. A. and E. Setyaningsih, (2017). "Alat Monitoring Kecepatan Dan Arah Angin Berbasis Arduino Uno Sebagai Pendukung Mitigasi Bencana Dengan Informasi Sms Gateway," *Semin. Nas. Inov. Dan Apl. Teknol. Di Ind.*, vol. ISSN 2085-, pp. 1–9.

Nowicki, R. S. Michał and Maciej Kachniarz. (2017). "Temperature error of Hall-effect and magnetoresistive commercial magnetometers." *Arch. Electr. Eng.*, vol. 66. no. 3. pp. 625–630.

Putra R. A. and A. T. Sutanto. "Perancangan Dan Pembuatan Magnetometer Digital Dengan Sensor Magnet Hmc5883l Berbasis Web," *ISSN 0852-002 X,PPI KIM KE-42*, pp. 405–422.

Putra, R. U. et.al. (1995). "Studi Analisis Perbaikan Stabilitas Tegangan Melalui Penjadwalan Ulang Generator."

Roberts, G. A. G. & P. H. (1995). "A three domensional self consisten computer simulation of a geomagnetic field reversal.." *Nature*, p. 6.

Roberts, G. A. G. and P. H. (1996). "Rotation and Magnetism of Earth's Inner Core." *Science (80-.).* vol. 274, no. December.

Rohmanu, A. and D. Widiyanto. (2018). "Sistem Sensor Jarak Aman Pada Mobil Berbasis Mikrokontroller Arduino Atmega328," *J. Inform. SIMANTIK*, vol. 3, no. 1, pp. 7–14.

Saputra, D. T. 92016). "Aplikasi Sensor Ultrasonik Hc-Sr04 Pada Sistem Kendali Valve Sebagai Penyalur Air Dengan Akses Control Rfid Berbasis Arduino Uno."

Saputra, H. A. (2012). "Laporan Akhir ini disusun sebagai salah satu syarat menyelesaikan Komputer. pendidikan Diploma III pada Jurusan Teknik." pp. 3–18.

S. Sugandi, S. et. Al. (2016). U. B. Luhur, P. Utara, and K. Lama, "Auto Tracking Dan Satellite Finder Untuk Antena Parabola Dengan Menggunakan Kompas Hmc5883l Dan Bluetooth Hc05 Berbasis Android." *Komputer, F. T. Informasi*. vol. 13, no. 2, pp. 1–8.

Sulila, M. S. and M. A. Riyadi. (2017). "Perancangan Sistem Kontrol Navigasi Bearing Pada Quadcopter Dengan Metode Pid (Proportional , Integral , Derivative) Self Tuning Pso (Particle Swarm Optimization) Metode," vol. 6, no. 3, pp. 1–10.

Taufikurrahman, M. and H. Aprilianto. (2018) "Penerapan Sistem Navigasi Sensor Kompas Pada Robot Beroda." vol. ISSN: 2089. no. 2. pp. 1–10.

Wenden, A. L. (1981). "Perkembangan Kompas." vol. 3. no. September. p. 1899.