International Journal of Application on Sciences, Technology and Engineering (IJASTE)
Volume 1, Issue 4, 2023. ISSN:2987-2499

DESIGN OF AUTOMATIC ELECTRIC DRILLS TO DETECT AND ADJUST DEPTH AND ERGONOMIC LIDAR AND GYROSCOPE BASED

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Enter : 25-09-2023, revision: 22-10-2023, accepted for publication : 06-12-2023

ABSTRACT

A drilling machine is a tool that moves by rotating a cutting tool used to make a hole in a plane. Usually, electric drills come with attachments that can be used to drill more accurately and precisely. One of the drill attachments are LiDAR and gyroscope attachments, LiDAR attachment allows drill users to adjust depths and the range of the drill to a plane and gyroscope to adjust the incline or tilt. Developing such attachments will reduce space for storage and time to attach a support unit to the drill, it helps users to automatically turn the drills off when it reaches the length that users desire and adjust the incline or the tilt of the drill. The methods used in developing the automatic drill are analysis and research regarding the parts that will be used on the automatic drill. As well as doing some simulation and experimentation to make sure the integrated parts works as planned. The results of our analysis and research from analyzing the most suitable part to be integrated to the automatic drill design is a digital prototype design in the form of a 3D model design. In conclusion, the integration of LiDAR and gyroscope sensors has significant potential to revolutionize the drilling industry by combining precision, safety, ease of use and efficiency, making it a valuable tool for a wide range of applications and has the potential to be a game changer in the market.
Keywords: *Drill, LiDAR, Gyroscope, Automatic, Revolutionize*

1. PREFACE

Introduction

A drilling machine is a tool that moves by rotating a cutting tool used to make a hole in a plane, such as iron, wood, and other materials [1]. In use, drilling machines have various sizes of drill bits, namely 6.5 mm, 10 mm, 13 mm, 16 mm, 23 mm, and 32 mm and can use a screwdriver bit in their use. The drilling machine has supporting equipment that can be used, such as a water level to measure the slope, a measuring tape to measure the depth of drilling, and other

equipment. Along with the times, equipment such as drilling machines have developed in everyday life, ranging from design changes such as a hand drill that is shaped like a gun and can be held in one hand to an electric drill that charges using a charger.
A hand drill is a machine tool that functions like a drill in general, but the use of this machine uses electricity or battery power which is usually distinguished from an electric drill that has a cable and an electric drill that doesn't use a cable or wireless [2]. Generally, electric drills do not use supporting equipment such as a level pass or measuring tape when drilling because the drill design is designed to be as minimal as possible so that it is easy to store and use. This results in inaccurate depths and skewed holes when using a power drill. Using a waterpass or measuring tape makes it difficult to operate because it takes more time and the placement of a waterpass, measuring tape and electric drill reduces efficiency and effectiveness.
For this reason, the design of an electric drill that can measure depth is carried out with the aim of making it easier for drill users to find out the depth of drilling which is carried out automatically according to the desired depth setting.

Problem Formulation

The problem formulation for designing automatic electric drills to detect and adjust depth and ergonomics are: How to integrate LiDAR and gyroscope sensors in a power drill system to obtain accurate data about depth and slope? And how to ensure the reliability and accuracy of a plane depth and slope measurement results?

2. RESEARCH METHOD

The object of this research is about designing an electric drill that utilizes LiDAR for the range measurement and gyroscope for adjusting the drill at the desired plane. The vibration when drilling could potentially be dangerous to the operator and reducing the accuracy when drilling. The measuring stick usually used to measure the depth is replaced with LiDAR and the waterpass that used to measure the angle or the angle of a plane is replaced with a gyroscope. In designing an automatic electric drill design system for measuring depth and slope based on lidar and gyroscope, some literature reviews are needed as follows:

LiDAR

LiDAR (Light Detection and Ranging) is a distance measurement technology using a sensor which is obtained by calculating the travel time of a light from the sensor which is reflected back to the sensor. LiDAR produces data in the form of three-dimensional data where the data has a high level of accuracy. The basic principle of the LIDAR sensor is, the sensor emits a laser beam towards the object then reflected back towards the sensor, the reflected light then captured and analyzed by the detector. Change the composition of the light received from a target is determined as an object. The LiDAR in this design will use the Time of Flight (ToF) principle. The ToF LIDAR works by emitting a laser beam towards the object and then the reflection of the light will be received by the receiver [3].

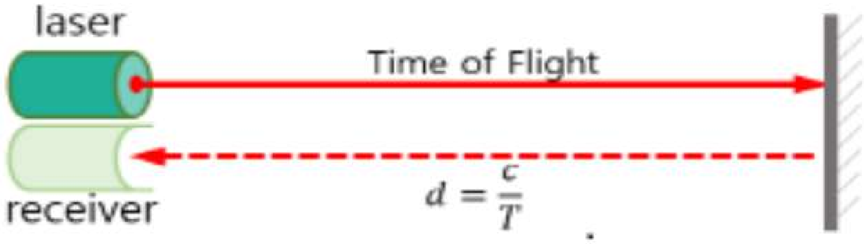

Figure 1. The Working Principle of Time of Flight (ToF) LiDAR
Image Source: [3]

The LiDAR that is planned to use in this design is VL53L0X LiDAR. The VL53L0X LiDAR sensor is a laser distance sensor that uses the Time of Flight principle to measure the distance to objects. The laser beam is released from the Laser Transmitter which is on the sensor. The emitted light reflects off the surface of the object whose distance is measured.

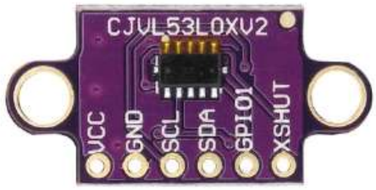

Figure 2. VL53L0X LiDAR
Image Source: www.esphome.io

Microcontroller

A microcontroller, also known as a microcontroller, is a microcomputer chip which is physically in the form of an IC (Integrated Circuit) which is usually contained in a small system that can be used for controlling a system. Microcontroller that is used in this design is the Arduino Nano. Each of the 14 digital pins on the Arduino Nano can be used as an input or output, using the pinMode(), digitalWrite(), and functions digitalRead(). Arduino Nano has 8 pins as analog input, labeled A0 through A7, each of which provides 10 bit resolution [4].

Figure 3. Microcontroller Arduino Nano
Image Source: [4]

Relays

Relay is a switch that operates by using electricity. A relay is an electronic component that functions to disconnect or connect electricity flow indirectly [5]. The main component contained in the relay is the electromagnetic coil, which is a coil of copper wire which has no magnetic properties but can be converted into a magnet with the help of an electric signal. The relay that is planned to use in this design is 5V Relays. The 5V relay in this design aims to control the motor on the electric drill. The relay used has an input voltage of 5V with 3 main pins in the form of Normally Open (NO), Normally Closed (NC), and Common (COM). The NO pin is a pin that is always open in a normal position. The NC pin is a pin that is always closed in a normal position. The COM pin is a pin that is connected to an electric current.

Figure 4. 5V Relays
Image Source: (Hudan, 2019)

Organic Light-Emitting Diodes

Organic Light Emitting Diodes (OLED) are photonic devices consisting of a cathode as the negative side, an anode as the positive side, and an emissive layer of organic material which can produce light when a current is applied [6]. The electric field present in the electrodes affects how OLED works. If there is an electric field at the electrode, the work function of the cathode will decrease, this allows electrons to move from the cathode to the conduction band in the organic layer which then produces a hole in the valence band. The OLED that is planned to use in this design is the OLED SH1106. The OLED SH1106 has a screen dimension of 1.3 inches with a resolution of 128 x 64 pixels. OLED SH1106 works at 5V and uses an I2C interface with 2 address options. The SH1106 OLED can display text or images in bitmap format with a refresh rate of 30 frames per second.

Figure 5. OLED SH1106
Image Source: electropeak.com

Gyroscope

Gyroscopes are used to measure linear acceleration and angular velocity of a device. This component calculates the cycle rate of an object on a certain axis: 1-axis, 2-axis, 3-axis. Coriolis acceleration is determined to help determine the cycle rate of the three axes. The navigation system commonly used in four-wheeled vehicles uses the relative position recorded by three different synchronous satellites. The gyroscope that is planned to use in this design is the gyroscope and accelerometer sensor MPU6050. The gyroscope and accelerometer sensor MPU6050 is a sensor module that has 6 motion tracking axes that combines 3 gyroscope axes, 3 accelerometer axes, and DMP or Digital Motion Processor. This position value is obtained from MEMS (Microelectromechanical systems). using capacitive sensors as attitude readers. The resulting capacitive values will be processed through amplification, signal conditioning, and demodulation to obtain The electrical quantity is voltage. The amount of analog voltage obtained will be processed via 16-bit Analog-to-Digital (ADC) on each gyroscope and accelerometer axis so that a digital signal is obtained from the sensor reading [7].

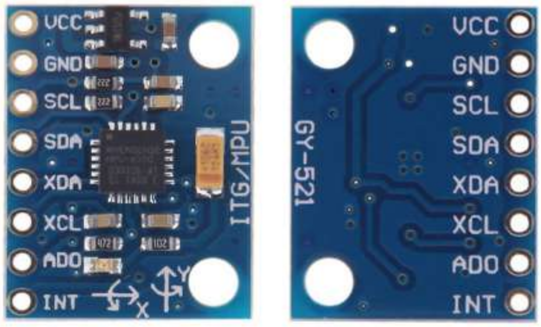

Figure 6. Gyroscope and Accelerometer MPU6050
Image Source:nn-digital.com

Printed Circuit Boards
Printed Circuit Board or often known by the abbreviation PCB is a board that can be used for connecting electrical components with soldering. PCB has multiple layers and laminations into one [8]. PCB has its standard structure and composition namely the base layer, copper, solder mask, and silkscreen. The PCB that is planned to use in this design is the PCB prototyping. The PCB prototyping is used to connect all existing components. The PCB prototyping has holes that have been coated with copper with the appropriate distance to the electronic components to be soldered.

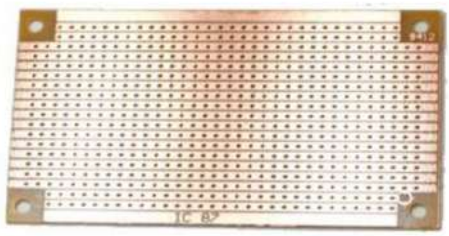

Figure 7. PCB Prototyping
Image Source: www.talkingelectronics.com

Push Button
The push button is a switch that is used to connect or turn off the electric current in the electrical circuit that is connected to the push button [9]. Push buttons can be connected to a microcontroller as input for various types of circuits used by users.

Figure 8. Push Button
Image Source: protolab.in

3. RESULT AND DISCUSSION

The design of cordless electric drill is equipped with LiDAR sensors to detect the measurement, gyroscope sensors to detect the slope or the tilt of the drill and OLED to display the measurement that we adjust and the tilt of the device to a plane or a surface. The design system flowchart is shown in figure 7.

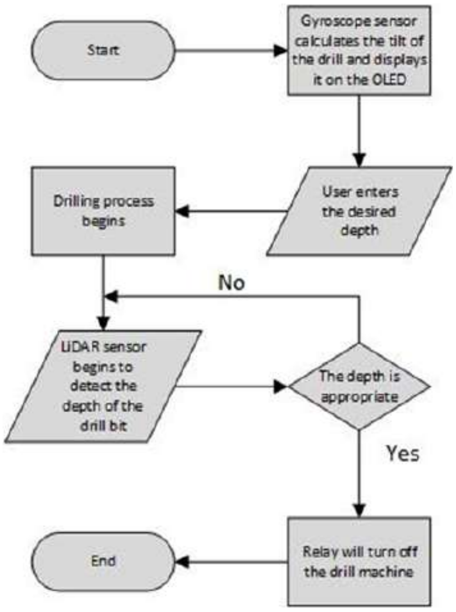

Figure 9. System Flow Diagram

The drill has the ability to measure the depth of the drill bit by calculating the drill distance before it is turned on and after it is turned on. Before the drill is turned on, the User determines the desired depth of the drill bit and the gyroscope sensor will calculate the inclination of the drill against the plane to be drilled on the x axis and y axis and displays the results on the OLED screen in the form of an image in the form of the coordinate position of the drill bit in the x axis and y axis. When the user starts the drilling process, the LiDAR sensor will start calculating the depth of the drill bit to a predetermined point and the drill will automatically turn off. The electric motor on the drill is controlled by a relay connected to the lidar sensor via a microcontroller device. The block design diagram of the drill is shown in figure 8.

Figure 10. System Block Diagram

The method used for the system is by making the prototype tool at the development stage. This method was chosen because it is able to develop basic tools quickly without having to determine all the tool requirements at the beginning. The steps are carried out only until the testing of the system. This is because the output target is a prototype tool. The development diagram is shown in figure 9.

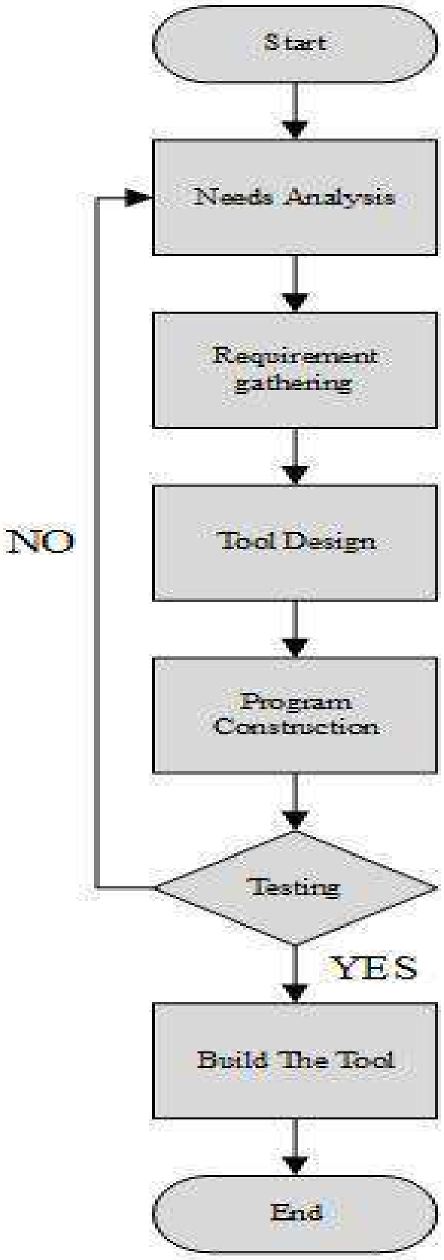

FIgure 11. Diagram of Tool Development Implementation Stages

The implementation phase begins with a needs analysis. In this process, a review of existing literature and related applications is carried out. Collection of needs is carried out based on the results of analyzes that have been done before. Collection of needs includes data collection and supporting components. Requirements that have been collected are then processed to be forwarded to the next stage. The materials needed in making the system are The VL53L0X LiDAR Sensor, Gyroscope and Accelerometer Sensor MPU6050, 5V relay, OLED SSD1306, and PCB. Most of the parts mentioned above are located at the side of the drill body and covered by custom made body parts. The tool is designed using Fusion 360 and Easy EDA by paying attention to the minimalist shape and size of the electric drill design that is made with a system easy to understand and use. The body design of the device is shown at Figure 10.

Figure 12. 3D model of the automatic electric drill

LiDAR sensors can be used to measure the distance of an object. This can be proved through research that has been carried out previously by [10]. Based on the paper that was proposed by [10], there are measurements of object distances using LiDAR sensors in closed rooms. The illustration of the LiDAR tool testing location can be seen in figure 11 and the result of the measurements in table 1.

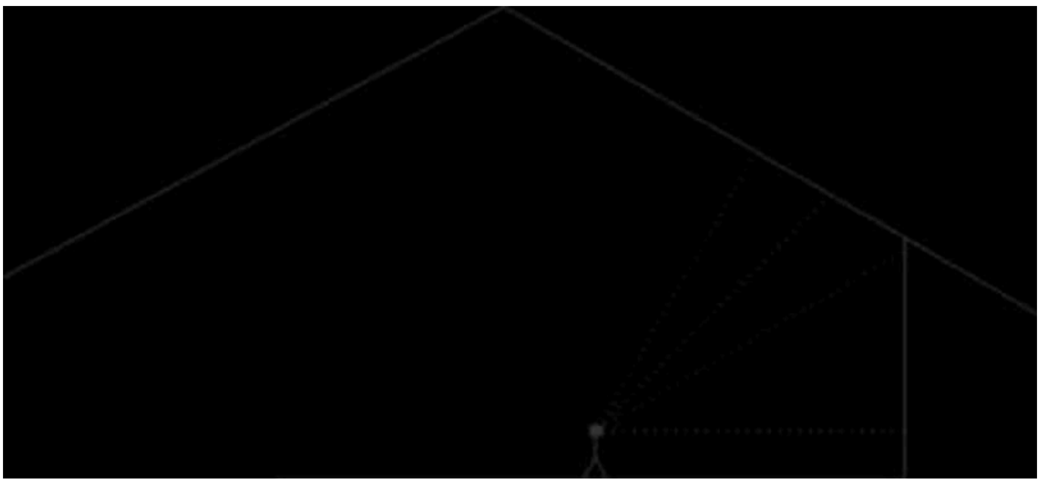

Figure 13. Illustration of the LiDAR tool testing location
Image Source: (Baiquni, 2021)

Table 1. LiDAR test measurement results

Table Source: (Baiquni, 2021)

No	Object Distance (m)	Side B (m)	Angle (degrees)	Front Side C (m)	Side B (*m*)
1	5	5.17	30.6	2.940	6.010
2	5	5.17	30.6	2.939	6.010
3	5	5.14	31.7	3.050	6.040
4	5	3.69	60.2	6.440	7.410
5	5	3.69	60.2	6.440	7.410
6	5	3.7	58.0	6.280	7.330
7	5	5.13	46	5.250	7.430
8	5	5.20	46.1	5.284	7.500
9	5	5.13	46.3	5.250	7.430
10	10	8.76	30.1	4.960	10.130
11	10	8.76	30,1	4.960	10.130
12	10	8.71	30	4.910	10.060
13	10	7.09	45.6	7.120	10.130
14	10	7.07	45.6	7.096	10.100
15	10	7.08	45	6.958	10.010
16	10	4.99	60.5	8.820	10.130
17	10	4.99	60.5	8.817	10.130
18	10	4.82	61.6	8.910	10.130
19	12	7.06	29	3.840	8.100
20	12	7.03	30	3.940	8.120
21	12	7.03	30	3.940	8.120

4. CONCLUSIONS AND RECOMMENDATIONS

From the research of Design Of Automatic Electric Drills To Detect And Adjust Depth And Ergonomic Lidar And Gyroscope Based, it can be concluded that the reading of data from the LiDAR sensor and gyroscope is almost accurate for measuring the distance and angle it points to, and the accuracy of the data reading can be enhanced with a drill system programmed by Arduino with an automatic calibration system when turned on to ensure measurement accuracy. The design of an automated electric drill with depth sensing and setting capabilities, combining Lidar and gyroscope based ergonomic features, with LiDAR and gyroscope sensors has significant potential to revolutionize the drilling industry by combining precision, safety, ease of use and efficiency, making it a valuable tool for a wide range of applications and has the potential to be a game changer in the market.

Acknowledgement

We would like to express our gratitude to all individuals and organizations who contributed to the successful completion of this research especially to our advisor, Lina Gozali S.T., M.M., Ph.D., whose guidance, expertise and patience were invaluable throughout the research process. The constructive feedback and unwavering commitment greatly enriched the quality of this

work. We are also deeply thankful to Tarumanagara University for providing the necessary resources, access and laboratory facilities. Also we would like to extend our appreciation to the researchers whose prior work and contributions have significantly informed and enriched our own research. Finally, we would like to express our gratitude to our families for their unwavering support, patience and understanding through the long hours dedicated to this project.
In conclusion, we acknowledge with gratitude all those who have contributed to this research, directly or indirectly. Your support has been instrumental in making this work a reality.

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