Journal of Soft Computing and Artificial Intelligence
JSCAI, 1(1): pp:40-46 (2020), www.dergipark.org.tr/en/pub/jscai
JSCAI
ISSN: 2717-8226
Received: June 2 2020 Accepted: June 8 2020

Recommendation of a New Device for Calculation of Non-Planning Areas

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ABSTRACT Area calculation is frequently used in engineering areas as well as especially in the construction sector. It is used in the effectiveness and efficiency research of companies, in the design and management of work areas and warehouses. In the marketing sector, it is used to deliver independent areas. The success of the delivery process is measured by customer satisfaction. In engineering services, area calculation is frequently used during the design phase. The designs of logistics storage areas and residential independent areas can be exemplified in the design of independent area. It is very important to calculate the right area when making these designs. Large area calculation devices are used in geographical area calculations and the appearance of historical monuments of restoration works. Laser scanners, drones and drones are used in the app. It is not appropriate to use these devices in small areas, such as specified areas. It is more suitable to use devices that measure single-axis length in the account of independent areas of industrial and residential structures. The simple area account is multiplied by data from two axis measurements. Individual measurement and calculation errors occur in manual measurements. Mistakes made in the production process cause serious economic problems. At the same time, companies suffer from prestige losses. A system is needed to eliminate these errors. For this reason, the idea of designing a device that can measure and calculate with a multi-axis measurement has emerged. Measuring, mapping and calculating planar and non-planar independent areas can be made with the developed device. Thus, practical and accurate calculation and mapping can be done at low cost. The laser distance sensor connected to the microcontroller is made with the help of a stepper motor and an area account with 360° scanning of the area. 20 different areas were calculated both by making a single-axis measurement and with the help of the device. These calculations were compared with single-axis measurements made with the help of civil engineers and error rates were obtained. As a result of the study, it was observed that the device made measurements with an average error of 3.64%. The lowest error rate was 1.50%, while the highest error rate was 6.04%. It is thought that better results will be achieved by using different equipment and methods in the design of the device. It is believed that it has the potential to pave the way for work to be done in many areas.

KEYWORDS: Laser Distance Measurement, Area Calculation, Non-Planar Areas, Construction.

1. INTRODUCTION

The laser scanning system, which appeared in architectural and restoration works in the 20th century, is often used today. It is applied in the determination of cultural heritage, in the determination of damage measurements, in documenting restoration works, measuring large-scale structures, geological surveys and land measurements. There are many projects and scientific studies using laser scanning system in our country. The method works as recording the return data of the distance sensors after each shot and mapping all data as punctuation. Istanbul Technical University School of Foreign Languages study [1], Tozman Cave [2], Harput Castle Bath [3] etc. such as this method was used. Thus, the desired map is

created from the points obtained. In order to clearly create the appearance of the structure, it is necessary to map from different points. An integrated look is achieved with the maps assembled. Another purpose of laser scanner systems is to demonstrate the defining properties of geometric shapes and areas. It is simple and easy to measure and calculate two-dimensional systems that produce three-dimensional mapping.

In the construction sector, the delivery process follows the production process. There is a contract between the employer and the contractor to create works. There are disagreements about the gross and net square meters of independent areas planned to be delivered under this work contract. The parties also have a sales contract for these independent areas. The cost of independent areas is multiplied by gross measurement values and unit prices. If it is determined that the net area committed by the employer is not carried out, a refund request is made. Studies on the accuracy of this request are limited. Single-axis distance meters are used in the delivery of independent areas. In particular, technical personnel such as engineers and architects are helped by the employer. However, disagreements occur due to individual measurement and calculation errors.

In the logistics sector, it is actively used in the execution of storage activities. In addition, the removal of net areas of logistics warehouses is an important topic in planning. It is important to detect empty areas when filling storage areas with different types of products. As in many sectors, individual single-axis measurements are technical errors. As a result of these errors, economically permanent damage sparked by serious return costs. It is seen how efficient and effective individual single-axis measurements are on a sectoral basis. Efficiency and effectiveness need to be increased, technological development must be captured and margins of error should be reduced. The need to calculate and map measurements of planar and non-planar independent areas has emerged.

2. LITERATURE

There are many areas scanning and calculation devices in the literature. With laser scanner and UAV, planar and non-planar terrain can be scanned and area edify. The study, "Researching Earth Laser Scanners and Location Accuracy", describes how three-dimensional information transfer is used in engineering and architectural studies. It is explained how it is used in relief and restoration works in the preservation of historical and cultural heritage. The laser scanner uses the cloud system as a working principle. A mapping system is created by identifying and transferring the data obtained from the scan as an object. Thus, an architecturally immense base is created [4]. In the study called "Basesal Laser Scanner Systems Used in Engineering Applications", accuracy and reliability tests of laser scanners used as measurement technology in all areas were carried out. It has been revealed how the laser scanner works. Then the coordinates obtained from laser scanners were converted to the desired coordinate system. Positive and negative results were discussed [5]. In the study called "Scanning Non-Planar Areas with UAV", it was thoroughly investigated to create a mapping system by scanning large areas

for different purposes. The study, which usually includes a purpose for the military and defense industries, has an important place in the literature to explain the transfer of large areas to the cloud system. Area scanning is carried out through Unmanned Aerial Vehicles. Thus, large areas are scanned for a short time and the map is created [6].

3. PURPOSE AND JUSTIFICATION

It is aimed to make a practical calculation using the automation system for the low cost and accurate calculation of building independent areas. When considering the cost option, different quality single-axis measuring devices are introduced in production by different companies. The aim of this study is to design a device that can calculate by measuring the two axes at the same time. Area measuring devices are mostly used for scanning and mapping large terrain. In addition, they are used in the process of removing the architecture and restoration works. These studies are carried out on large areas. Single-axis planar measuring instruments used in the application cannot make a clear measurement. Area measuring devices cannot be used in closed structures and small sizes. Personal measurement and calculation errors occur in single-axis measuring devices. The main purpose of this study is to create a device that can perform both two-axis measurements and calculate area as a result of measurement in order to pass all these glitches and errors. In experimental studies, measurements will be made with the device that is created. The numerical values of the selected venues in architectural projects, the results of a single-axis measurement and the results obtained from the device will be examined comparatively.

4. DEVICE DESIGN

4.1 EQUIPMENTS

Arduino UNO control card was decided to be used due to easy programming and economic timing of the device when planning the prototype. A stepper with a gearbox was used to ensure a 360° rotation. In order to measure distance, the laser distance sensor is preferred because it can measure point. The following are the features of the components mentioned:

- LIDAR-Lite v3 is a distance sensor developed by Garmin for spot measurement up to 40 meters. The drone is used for 2D/3D scanning in automation systems such as robots. Simple output pins are quite easy to use thanks to the Arduino library with I2C and PWM features. [7].
- Connections can be easily connected to rotating systems thanks to the rotary connector named "Flange Slip Ring - Rotary Connector 22mm Diameter 12 - 240V 2A Adafruit". It allows you to make connections that provide 360 degree smooth rotation thanks to the electromechanical mechanism that finds it inside. Up to 12 cables can be connected. Tested for rotation up to 300 RPM, each cable can carry 240V 2A DC or 240V AC. It comes with 12 15 cm cables [8].
- 28BYJ-48 engine; Operating voltage is 5V, step angle 5.625°, internal resistance is 130 Ohm, 100 Hz frequency and a gearbox unipolar step pert. It is often used in simple and mid-level automation projects. A stepper motor driver with four LED and four control pins is used to

control the stepper engine. It is possible to use it with many microcontrollers so that it is possible [9].

- Arduino UNO control card is used to read data from the laser sensor and control the stepper motor. Arduino UNO contains a TTmega328 microcontroller running at 16 Mhz. The card has a operating voltage 5V and has 14 digital input-output pins and six analog input pins [10].

4.2 PROTOTYPES AND FEATURES

The above-mentioned equipment is assembled and developed codes are installed on the control card. It is tested and prepared for measurement as a result of calibration operations.

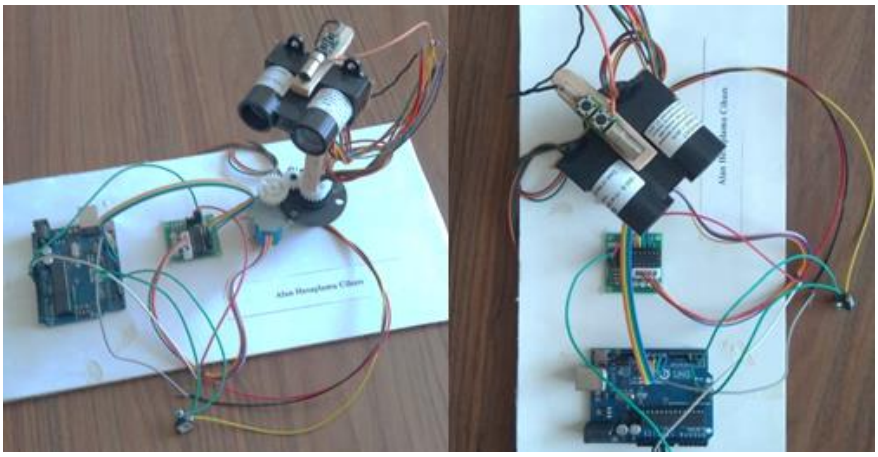

Figure 1. Produced Area Calculation Device Prototype

The prototype shown in Figure 1 has a Lidar Lite v3 sensor that rotates 360 degrees thanks to a flanged connector on the stepper motor. With 455 step motions of the stepper motor, the lidar sensor is provided for a lap. Thus, measurements were performed with angle accuracy of 360/455=0.8 degrees. With each distance measurement, the two sides with an angle of 0.8 degrees were formed by known triangles. The sum of the areas of these triangles is the total area. In addition, the data obtained using an interface developed on the Visual Studio 2017 platform was analyzed and the shape of the area contained in it was carried out.

5. FINDINGS

First of all, the area was accounted for with the help of existing single-axis devices. Measurements were made with the device that was then created, area map was drawn and area calculation was made. By comparing the data obtained, the error rate of the device in the calculation was determined. As a result of the calculations, the device was found to have measurements with an average error of 3.64%, including the lowest error rate of 1.5% and the highest 6.04% in the calculation of non-planar areas. Shown in Table 1. The measurements made by the prototype developed in Figure 2 show the maps created by the interface program.

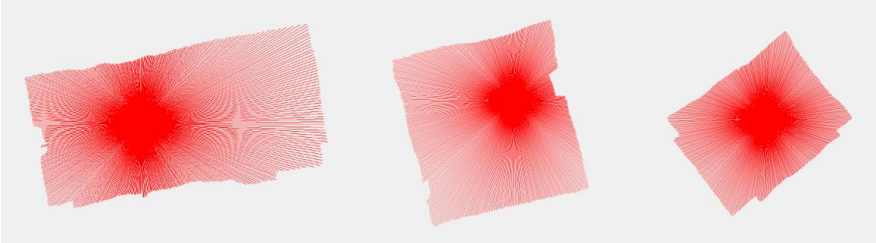

Figure 2. Maps created with interface

Table 1. Comparing Single-Axis Measurement and Device Measurements

Queue	Independent Area	Single-Axis Measurement	Measurement with device	Error Quantity	Error Rate
1	Room 1	10,83	10,32	0,51	4,71%
2	Room 2	11,17	10,94	0,23	2,06%
3	Room 3	10	9,73	0,27	2,70%
4	Room 4	28,86	27,39	1,47	5,09%
5	Room 5	17,32	17,11	0,21	1,21%
6	Room 6	20,26	19,76	0,5	2,47%
7	Housing-1	11,92	11,29	0,63	5,29%
8	Housing-2	8,76	8,62	0,14	1,60%
9	Housing-3	6,76	6,46	0,3	4,44%
10	Housing-4	12,56	12,35	0,21	1,67%
11	Housing-5	22,45	21,32	1,13	5,03%
12	Housing-6	20,21	19,04	1,17	5,79%
13	Housing-7	9,78	9,48	0,3	3,07%
14	Housing-8	13,58	12,96	0,62	4,57%
15	Housing-9	5,86	5,73	0,13	2,22%
16	Housing-10	18,47	17,54	0,93	5,04%
17	Housing-11	12,93	12,28	0,65	5,03%
18	Housing-12	8,65	8,24	0,41	4,74%
19	Housing-13	7,12	6,98	0,14	1,97%
20	Housing-14	6,46	6,19	0,27	4,18%
				Average Error Percentage:	%3,64

The data shows that the device makes fewer errors in smaller areas. In large areas, increasing error rate has been found to be effective in exceeding the correct measuring capacity of the distance sensor. Due to exceeding distance capacity, the error rate increases in area calculation. Therefore, sensors that are more featured should be selected depending on the size of the area to be measured.

6. DISCUSSION AND RESULT

The need for area calculation is frequently seen in the areas of construction, logistics and defense industry. Every move that increases the efficiency of work and production in these sectors creates a benefit to the national economy. We need to be able to create a product that meets the need, is economical, quality and captures the technology of the age. Many systems are used in the application for area scanning and calculation. Although the targeted area scanning and area calculation can be done with existing laser scanners and UAV, the calculation of the structure-independent internal areas is not useful and economical with existing systems. Internationally produced devices for area calculation do not fully meet the current need and cause high costs.

It is aimed to produce an original technology that will contribute to the economy of the country by creating a more economical, desired quality area measurement and calculation device than foreign devices. In this developed system, it is aimed to calculate the structure independent internal areas correctly by considering the quality-cost balance. The current technology is very costly due to its high foreign exchange values. The components to be used to create this device are foreign capital. However, it is possible to sell at a higher price than the costs of the equipment that makes up the device with the added value that occurs by achieving the desired targets. With the system created, all units needed in the public or private sector area account will be able to make area calculations without the need for technical personnel. The current ongoing length measurement equipment will eliminate individual measurement errors and eliminate job and cost loss.

Due to its specialization in the public sector, a budget is created using the "Direct Procurement" method for measurement and calculation. The subject of expertise is created by an external report. However, this need will be met with the developed device. Checks will be carried out without the need for additional confirmation, eliminating a serious financial burden on the public. In terms of private sector construction, logistics and defense industry, production efficiency will be increased by making more use of less cost. In the construction sector, disputes will be avoided, especially in the delivery of finished independent areas. Warehouse planning in the logistics area will be opened to easy construction. The device appeals to all sectors that interact indirectly with the aforementioned sectors and sectors. This creates a serious area.

As a result of the area measurements, a result of the targeted result was revealed. The error rate increases in the calculation of areas above capacity due to the selection of the distance sensor in accordance with the specified budget. With increasing budget and the use of more equipped materials, a more efficient and effective device design will hope.

Acknowledgments: A brief summary of this study was presented at the International Conference on Material Science and Technology in 2019. We would like to thank Kırşehir Ahi Evran University Scientific Research Projects Coordinator for the support given to the study.

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