Land Surveying Robot

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doi: https://doi.org/10.21467/proceedings.160.32

ABSTRACT

A land survey is a detailed study or observation of a land, in detail it analyses the data's in supporting of planning, designing and land surveying is also used to find out the property boundaries. This information's are collected through continuous observations, field measuring or research of legal instruments. This paper discusses about land surveying using a robot. Here a robot is a used to calculate the area of land which is divided into subplots. In current scenario for calculating the area of the land the surveyor has to use different instruments to obtain the land measurements. We are designing these robots keeping in mind the current complexities in land surveying techniques. This robot will help in reducing the carrying of different tools for land surveying. The robot can be operated easily and consume less time for the calculating the area of a given plot. With the help of a camera module the navigation of the robot can be easily made. The proposed system can be give accurate value of area of particular land and can be easily implemented and operated. The information of the land survey can be obtained with the help of IoT.

Keywords: Land surveying, Robot, IoT

1 Introduction

Nowadays the development of robotics in today's world is changing and advancing rapidly, with the help of new emerging technologies all the times. Robotics is a new emerging branch of technology that it is dealing with the designing of robots and it parts, building, and operating the functions of robots. A robot is a specified machine that is capable of carrying out all the complex activities automatically, especially with the help of artificial intelligence. Many industries are now deploying robots to help them in automating their process, increase the efficiency of their works and to reduce the time consumption of the particular processes to be conducted.

For example, in the manufacturing robots are being used to assembling of the particular products, performing the quality control checking of the robots and even packaging of finished products etc. Another area in the development of robotics is in use of drones. Drones are unmanned aerial vehicles used to control remotely or can operated using GPS technology. Drones are being used in variety of applications, including land surveying, delivering packages, even monitoring wildlife populations etc....Advance in artificial intelligence are also driving the development of robotics. Artificial intelligence allows robots to learn from their behaviours [1, 2].

This means that the Land surveying is the practice of measuring and mapping the physical features and boundaries of land. It involves using a variety of techniques, such as using specialized equipment to measure distances and angles, creating maps and drawings, and analysing data to determine property boundaries, elevations, and other characteristics of the land.

Land surveyors play a critical role in many industries, including real estate, construction, engineering, and government. They are responsible for ensuring that land development projects are planned and executed accurately and safely, and that land use and ownership rights are properly established and respected. Some of the tasks that a land surveyor may perform include: Measuring and mapping land boundaries, determining the location, size, and shape of buildings and

Proceedings DOI: 10.21467/proceedings.160; Series: AIJR Proceedings; ISSN: 2582-3922; ISBN: 978-81-965621-9-9

other structures, identifying topographic features, such as hills, valleys, and waterways, analysing data to determine elevation and slope, conducting research to identify historical land use and ownership patterns, preparing reports and maps to document survey findings.

To become a land surveyor, one typically needs to have a degree in surveying or a related field, as well as be licensed or certified by the relevant state or local authority. The skills and knowledge required for land surveying include a strong understanding of math, geometry, and physics, as well as proficiency with specialized surveying equipment and software.

In current scenario of land surveying, the surveying is more time consuming and for this the surveyor has to use different tools for survey the land. We are designing a system keeping in mind the current complexities related to the land surveying. The proposed system is an integration of land surveying and robotics [3-5]. The system gives more accurate value for the measured land more and the proposed system consumes less time for surveying the land. The result of the land surveying can be obtained very easily. The output obtained from the system is more accurate and uses only less amount of time. We can give more future enhancement to the proposed system and can be used for various purposes including military, agricultural and technological operations. The proposed system can be navigated with help of camera in it and can give some future advancement to be used in the surveying of mines etc.

2 Literature Review

This paper deals with the land surveying with the help of a robot which measures the plane we want to survey. From the proposed system we can accurately measure the entire land without using large amount measuring instruments.

This study analyses the early robotics technologies and ancient land surveying methods. In olden times land surveying back ago thousands of years, with the findings of land surveying activities found in classical times civilizations such as Egypt, Mesopotamia, and including China. One of the earliest recorded land surveys was the Survey of conducted in the 3rd millennium BC. This survey was used to determine land boundaries and calculate taxes based on the amount of land owned.

In ancient China, land surveying was also important for the allocation of land and taxes. The Chinese used a device called a groma, which was a cross-shaped instrument used to align sight lines and measure angles. In Europe, land surveying became more advanced during the medieval period, with the development of theodolites and other measuring instruments. These tools were used for mapping and dividing land for ownership and taxation purposes.

Early robotics technology dates back to ancient times when inventors and philosophers explored the concept of automatons mechanical devices capable of performing human-like tasks. One of the earliest known examples of early robotics technology is the mechanism, a complex mechanical calculator that was discovered in the Antikythera shipwreck off the coast of Greece in 1901. It was believed to have been built in primitive Greece around 100BC and it was used to foretell astronomical positions and eclipses. In the Middle Ages, automata were developed as toys and entertainment. Some were powered by water or wind, and others were designed to perform simple tasks like writing or drawing.

The Industrial Revolution in the 18th and 19th centuries saw the development of automated machines for manufacturing, such as the Jacquard loom and the Spinning Jenny. These machines used punched cards or other mechanical means to automate repetitive tasks. In the 20th century, the development of electronics and computing led to the creation of modern robotics. In 1956, the first industrial robot, Unmated, was developed by George Devol and Joseph Engel Berger. Unmated was used in the automotive industry for tasks like welding and painting.

Today, robotics technology continues to advance rapidly, with robots being used in a wide range of industries, including manufacturing, healthcare, and transportation. The proposed system is an integration of robotics and land surveying. In olden era, the land surveying of robot was held with of many measuring instruments. For surveying a particular land surveyor has to use different instruments and materials. After all the surveyor has to collect all the measurements and calculate the particular land area the area calculated after this will be not proper there should have some errors in

this and is more time causing. So, keeping in mind these complexities in land surveying we are developing the proposed system.

A land surveying robot is a specialized robot that designed to collect precise spatial data and measurements on the ground [6, 7]. It is an automated system that uses advanced sensors and imaging technologies to accurately survey the land, map terrain features, and collect data on soil composition and topography [8,9]. These robots are equipped with advanced navigation system that allow them to move autonomously across terrains, avoid obstacles [10]. They are programmed to perform wide range of applications and surveying tasks, from the basic distance, measurement to detailed topographic mapping and can be advanced methods for 3D mapping and modelling technologies. Land surveying robots are used in diversity of industries, as well as construction mining agriculture and environmental impact analysis. They are increasingly popular due to their ability to provide fast, accurate, and reliable data that can be used to improve efficiency, safety, and decision-making in a wide range of applications. This robot can reduce the current complexities in land surveying methods.

3 Components

3.1 Arduino Mega Microcontroller

It is a popular microcontroller board which is based upon ATmega2560 microcontroller. It is designed for use in projects that demand a large number of interfaces, including robotics and automation projects. An Arduino Mega board has 54 digital input and output pins, 16 analog inputs and 4 COM ports. It also has a larger memory size and more I/O pins than the standard Arduino Uno board, making it more suitable for complex projects.

The Arduino Mega board is adaptable with most Arduino shields and libraries, facilitate to add an increased functionality to the Arduino board. Further, the board can be programming using with the help of Arduino IDE which is an adaptable software platform for scripting and sync code to the board. Across-the-board, the Arduino Mega microcontroller is a powerful and versatile board that is widely used in various projects due to its extensive I/O capabilities and compatibility with the Arduino platform.

3.2 IR Sensor

An infrared sensor is a device that catch infrared radiation in the environment. Perhaps, it can be used in a diversity of applications, including distinct temperature sensing, motion detecting also distances sensing. In remote temperature sensing, the sensor detects the infrared radiation emitted by an object to determine its temperature. In motion detection, the sensor detects changes in the infrared radiation in its field of view to detect movement. In proximity sensing, the sensor detects the presence of an object based on its reflection of infrared rays.

IR sensors may be passive or active. Passive IR sensors detect the infrared radiations eliminated by objects in their own particular surrounding, while active IR sensors eliminates their own infrared radiation and detects it reflection of objects.

IR sensor can be found in wide range of products including security systems, home appliances, medical device, and automobiles.

3.3 Ultrasonic Sensor

An ultrasonic sensor is a device that uses sound waves with frequencies higher than 20 kHz to distinguish the appearance of objects or measure distances. Ultrasonic sensors work by emitting high-frequency sound waves and measuring the time it takes for the waves to comes back after striking an object. The sensor then calculates the distance to the object based on the time it took for the waves to journey and from the object. Ultrasonic sensors can be applicable in a diversity of purposes, such as in robotics, automated manufacturing, and parking sensors. For example, in robotics, ultrasonic sensors can be used to detect obstacles and avoid collisions. In automated manufacturing, ultrasonic sensors can be used to measure the thickness of materials or to detect the presence of defects. In parking

Proceedings DOI: 10.21467/proceedings.160
ISBN: 978-81-965621-9-9

Series: AIJR Proceedings
ISSN: 2582-3922

sensors, ultrasonic sensors can be used to detect the distance between a vehicle and an obstacle and alert the driver if they are getting too close. Ultrasonic sensors can be either analog or digital.

Analog sensors provide a continuous measurement of distance, while digital sensors provide discrete measurements in steps. Some ultrasonic sensors also have the ability to detect multiple objects and can provide measurements of the distance to each object separately. Overall, ultrasonic sensors are an effective and widely used technology for detecting the presence of objects and measuring distances in a wide range of applications.

3.4 Camera

A camera can be a useful tool for a land surveying robot, as it can provide visual information about the environment and help the robot to identify and locate features of interest. When selecting a camera for a land surveying robot, there are several factors to consider, including;

Resolution: The camera should have a high enough resolution to capture clear and detailed, images of the environment. Higher resolution cameras will produce clearer images but may also require more processing power.

Field of View: The camera field of view should be wide enough to capture the entire area of interest. A wide-angle lens may be useful for capturing larger areas, while a telephoto lens may be useful for capturing smaller features in greater detail.

Image Stabilization: The camera should have some form of image stabilization to reduce blur caused by camera movement or vibration, which can be common in outdoor environments.

Durability: The camera should be able to withstand the environmental conditions that the robot will be operating in. This may include exposure to dust, water, and such extreme temperatures.

Compatibility: The camera should be compatible with the robot and control system and software, and the images captured should be easy to integrate into the surveying data. In addition to these factors, it may also be useful to consider features such as low light sensitivity, auto-focus, and the ability to capture images in different spectral ranges, such as infrared or UV, depending on the specific requirements of the surveying task.

3.5 Servomotor

A servomotor is an electro-mechanical device, it is mainly used to manage the place, speed also rapidity of an operating system. It can be a type of rotary actuator typically used in industrial applicability, including robotics automation, and constructing. A servomotor usually consists of a DC motor, a set of gears, a control circuit, and a feedback mechanism. A feedback mechanism is used to monitor the motor shaft position and supply feedback to the control circuit. The control circuit differentiate the feedback signal with the desired reference signal and adjusts the motor accordingly to achieve the needed position, rapidity, or acceleration.

It is often used in different purposes where accurate control of position, speed or torque is needed. It is commonly found in robotics, CNC machines, aerospace and defence equipment, and medical devices. They are also used in hobby applications, viz.

Remote control cars, planes, and boats. Servomotors are available in a variety of sizes and configurations to suit different applications. They can be powered by AC or DC power sources, and can be controlled using a variety of signals, including analog, digital, and pulse-width modulation (PWM).

3.6 Motor Driver

A motor driver is an electronic circuit or device that is used to control the speed and direction of a motor. It provides the necessary electrical signals and power to the motor to drive it at the desired speed and in the desired direction.

Motor drivers can be found in a wide range of applications, including robotics, industrial automation, automotive systems, and consumer electronics. They are essential components in any system that uses a motor, as they help ensure that the motor operates safely and efficiently.

3.7 IoT Module

An IoT (Internet of Things) module is a device that allows devices to connect to the internet and exchange data with other devices or systems. These modules are typically small, low-power devices that can be embedded into a wide range of devices and machines to enable them to communicate and exchange data with other devices over the internet. IoT modules usually consist of a microcontroller, wireless communication components (such as Wi-Fi, Bluetooth, or cellular connectivity), and various sensors or actuators that enable the device to collect data, process it, and interact with the environment.

IoT modules are used in a wide range of operations, including home automation, industrial monitorization systems, healthcare devices, also transportation systems. They provide the foundation for the creation of IoT ecosystems, which can enable organizations to gather and analyse large amounts of data from various sources, leading to improved efficiency, reduced costs, and new business opportunities.

4 System Description

The proposed system is built to conduct the purpose of land surveying with the help of a robot and reduce the current complexities related to the land surveying techniques. The proposed system consists of following components:

- Arduino Mega microcontroller
- IR Sensor
- Ultrasonic Sensor
- Servomotor
- Motor Driver
- 4 Wheel Motor Driver
- Camera
- IoT Module
- Mobile/PC

The land surveying robot is a robotic device that is designed to perform land surveying tasks autonomously. The robot is equipped with several sensors and devices, including IR sensors, ultrasonic sensors, a camera, a motor driver, a 4-wheel motor driver, an IoT module, and a mobile device.

The IR sensor is used to detect obstacles that are within the robot range. It sends out infrared signals, and when the signal bounces back from an obstacle, the sensor detects the obstacle and sends a signal to the robot control system to adjust its course.

The ultrasonic sensor is used to estimate distances between robot along with other objects in its environment. It sends out ultrasonic waves, which bounce back from the object and are detected by the sensor. The sensor then calculates the distance to the object and sends a signal to the control system to adjust the robot's path.

The camera is used to capture images of the robot's surroundings. These images can be used to create a map of the area being surveyed or to identify specific features of interest.

The motor driver and 4-wheel motor driver are applied to control the action of the robot. A motor driver controls the speed and direction of the robot's movement, while the 4-wheel motor driver allows for precise control of the robot's movement and direction.

The IoT module is used to connect the robot to the internet and to other devices. It allows the robot to transmit data about its location and other surveying data to a remote server or to a mobile device.

Proceedings DOI: 10.21467/proceedings.160
ISBN: 978-81-965621-9-9

Series: AIJR Proceedings
ISSN: 2582-3922

The mobile device is used to control the robot remotely and to receive data from the robot. It can be used to set the robots surveying path, to adjust its speed and direction, and to receive data from the robot's sensors.

Overall, the land surveying robot is a highly advanced device that combines a range of sensors and devices to perform autonomous land surveying tasks. It offers a high degree of precision and accuracy, and it can be controlled remotely, making it ideal for use in a wide range of applications.

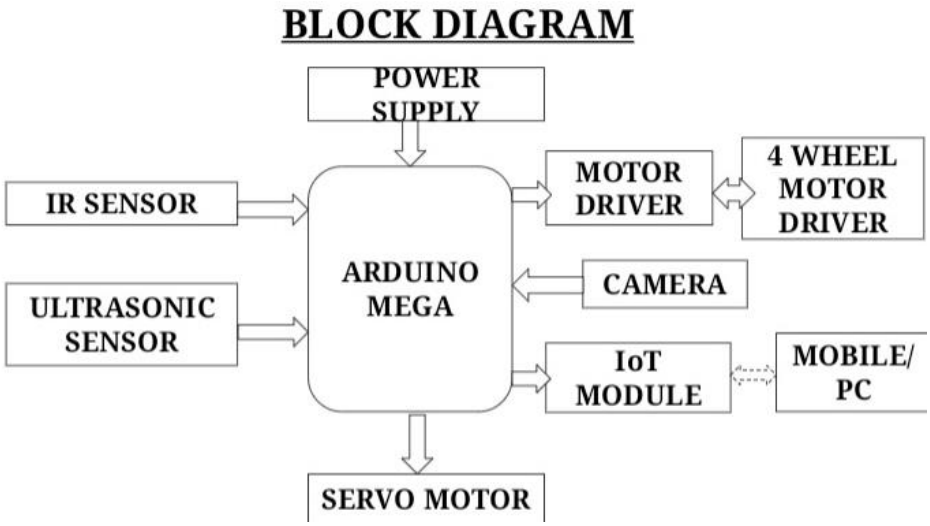

Figure 1: *Block diagram of proposed system*

Figure 1 is to develop a device which helps us to conduct a land survey with reduced human intervention. The ESP8266 Microcontroller acts as the command unit which controls all the components for the proper functioning of the device. The Battery source, connected to the microcontroller, provides the energy required to operate the ultrasonic sensor to measure the distance and also to facilitate the movement of the device. The L293 N motor driver monitors the function of the servomotor attached to the sensors and the DC motors connected to the wheels for motion. The device is externally controlled using a mobile application and the terrain surveillance can be done by using the WiFi camera.

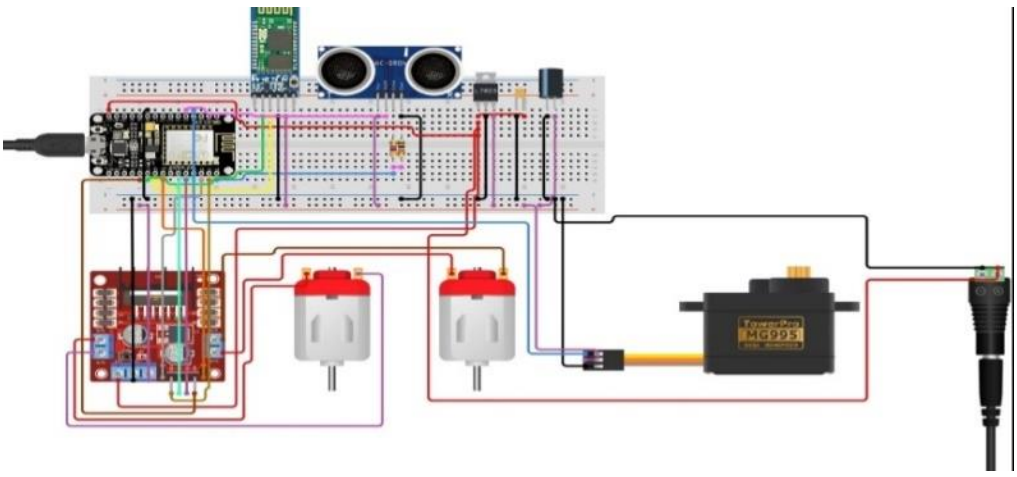

Figure 2: *Circuit of the proposed system*

Figure 2 is the land surveying robot which is a robotic device that is designed to perform land surveying tasks autonomously. The robot is equipped with several sensors and devices, including IR sensors, ultrasonic sensors, a camera, a motor driver, a 4-wheel motor driver, an IoT module, and a mobile device.

The ultrasonic sensor is used to estimate distances between robot along with other objects in its environment. It sends out ultrasonic waves, which bounce back from the object and are detected by the sensor. The sensor then calculates the distance to the object and sends a signal to the control system to adjust the robot's path. The camera is used to capture images of the robot's surroundings. These images can be used to create a map of the area being surveyed or to identify specific features of interest.

The motor driver and 4-wheel motor driver are applied to control the action of the robot. A motor driver controls the speed and direction of the robot's movement, while the 4-wheel motor driver allows for precise control of the robot's movement and direction. The IoT module is used to connect the robot to the internet and to other devices. It allows the robot to transmit data about its location and other surveying data to a remote server or to a mobile device. The mobile device is used to control the robot remotely and to receive data from the robot. It can be used to set the robots surveying path, to adjust its speed and direction, and to receive data from the robot's sensors. The buck convertor is used to convert the main supply voltage, which is the battery source, which is of 12V, down to lower voltages of 5,3.3 or 1.8V for powering up the components of the system, which have different voltage specifications.

5 Limitations

Land surveying robots are highly advanced machines designed to collect accurate and precise data for mapping and surveying purposes. However, like any other technology, they have certain limitations that can impact their performance and accuracy. Here are some of the limitations of land surveying robots:

Limited terrain adaptability: Land surveying robots are designed to operate on relatively flat terrain, and they may not be suitable for use in steep or rough terrain. They can struggle with uneven surfaces, such as hills or rocky outcrops, which can cause inaccurate measurements.

Weather limitations: Land surveying robots are highly sensitive to weather conditions such as rain, snow, or fog, which can affect their sensors, rendering them less accurate or unusable. Moreover, they may not be able to operate in extreme temperatures, as these can damage the robot's internal components.

Limited battery life: Land surveying robots are powered by batteries that can only last for a limited time. This means that they may not be suitable for large-scale projects that require long hours of continuous operation without recharging.

Dependence on satellite signals: Land surveying robots rely on GPS and other satellite signals to determine their location and orientation. However, in areas with poor satellite coverage, such as dense forests or urban canyons, they may not be able to function correctly.

High cost: Land surveying robots are expensive pieces of equipment, which can make them inaccessible to small businesses and individuals who cannot afford the high cost of purchase or rental.

In summary, while land surveying robots offer many benefits, they also have certain limitations that can impact their performance and accuracy, and users should be aware of these limitations when using them.

6 Conclusion

In conclusion, land surveying robots offer several advantages over traditional surveying methods. These robots are capable of performing accurate measurements and data collection in challenging terrains, dangerous environments, and inaccessible areas, without risking human safety. Additionally, they can cover large areas in a shorter time frame, which can significantly increase the efficiency and productivity of surveying projects.

Moreover, land surveying robots are equipped with advanced technologies such as LiDAR, GNSS, and photogrammetry, which enable them to collect high-quality data that can be used to create detailed maps, 3D models, and digital elevation models. This data can be further analysed using various software tools to extract valuable insights and make informed decisions. While land surveying robots offer many benefits, they also come with some limitations.

Proceedings DOI: 10.21467/proceedings.160
ISBN: 978-81-965621-9-9

Series: AIJR Proceedings
ISSN: 2582-3922

For example, they can be expensive to purchase as well as maintain, and they require trained personnel to operate and interpret the collected data. Additionally, they may not be suitable for certain types of surveying projects, such as those that require a high level of precision or involve complex legal boundaries. Overall, land surveying robots are a promising automation that can revolutionize the surveying industry by providing accurate, efficient and safe collection methods.

7 Future Scope

The future scope of land survey robots is expected to be significant as technology continues to advance. These robots are designed to automate the process of collecting data about land, this robot can be used for a diversity of objectives such as mapping, architecture planning, and natural resource management. One potential area of growth for land survey robots is in the construction industry. As construction projects become more complex, accurate and efficient data collection becomes increasingly important. Land survey robots can be used to collect data on construction sites quickly and accurately, helping to reduce errors and improve project timelines.

Another area of growth for land survey robots is in the field of agriculture. As farmers look for ways to increase productivity and reduce costs, they are turning to precision agriculture techniques that rely on accurate data about soil conditions, crop health, and other factors.

Land survey robots can be used to collect this data in a more efficient and cost-effective manner than traditional methods. In addition to these specific applications, the continued development of artificial intelligence and machine learning technologies is likely to expand the capabilities of land survey robots. As these technologies become more advanced, land survey robots will be able to analyse and interpret data in real-time, making them even more valuable for a wide range of applications. Overall, the future of land survey robots is likely to be bright, as they continue to offer an efficient and accurate means of collecting data about land that can be put upon extensive diversity of implementation across various industries.

8 Publisher's Note

AIJR remains neutral with regard to jurisdictional claims in institutional affiliations.

How to Cite

Saji *et al.* (2023). Land Surveying Robot. *AIJR Proceedings*, 256-263. https://doi.org/10.21467/proceedings.160.32

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