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A REVIEW ON ROBOT SURVEILLANCE USING VL53L0X SENSOR AND MECANUM WHEELS

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Abstract: A machine that can do locomotive tasks is referred to as a mobile robot. Mobile robots cover a wide range of large-scale manufacturing and commercial sectors. Robotic manipulators are now mounted on a movable platform rather than being fixed to a manufacturing line. Flexibility has greatly improved because it is now possible to move around and carry out necessary tasks whenever it is most efficient. As robotic technology develops, robots are able to do tasks that are getting more complicated. Robotic workers can be programmed to perform even the riskiest tasks, never get tired, and don't need to be paid. This project's objective was to integrate several current technologies and hardware controllers into a system that could carry out security-related duties. A crucial element of the safety and security system, video surveillance is fully integrated. Video surveillance is precise, timely, and allows for the sharing of the data gathered. Along with network and image processing developments, the video supervision technique has evolved recently. In recent years, the cost of hard discs has decreased due to greater capacity. The system for video surveillance has been improved and modernized.

Keywords - Mecanum wheels, Time of flight sensor, Autonomous, LiDAR, Robotics.

I. INTRODUCTION

Robots have a better throughput of data collecting since they can operate continuously, more cheaply, and for longer periods of time than individuals. LiDAR sensors are among the most popular sensor systems in robotic platforms because they can offer accurate distance measurements without making touch.[1]

Robotics, industry, and logistics have all made use of omnidirectional wheels. A rigorous examination and analysis of the available literature on this type of wheel revealed that systems based on Mecanum wheels have omnidirectional capabilities, but systems based on conventional wheels do not. [2]

The power of the mecanum wheel makes the car extremely controllable, which can be useful for a variety of internal and external systems. As a result, omnidirectional robotic vehicles have many advantages over conventional vehicles in terms of mobility and congestion. [3]

Vehicle robots have become common in automated manufacturing in recent years. However, it appears that in order to employ such vehicle robots at workplaces with alleys, difficult technological challenges must be overcome. In contrast, mecanum wheels are sometimes added to vehicles to improve their omnidirectional capabilities.[4]

II. MECANUM WHEELS

The Mecanum wheel was developed and patented by Bengt Ilon, an engineer with the Swedish company Mecanum AB, in 1975. It has previously been known to place separately drivable rolls or the like along the opposing sides of the vehicle to drive it. These rolls are propelled to spin with the help of the vehicle's driving assembly, and each roll has an outside flange that is spirally positioned around the roll in the longitudinal direction of the roll in order to achieve the necessary grip on the base. These vehicles are particularly well adapted for driving on a yieldable surface, such ice or snow, where the flanges may cut and gain traction.[5]

On the other hand, driving on a firm base increases the chance that the flanges may slip on the base's surface without grabbing onto it. It causes a loss of the necessary course stability and steering ability when driving. Furthermore, the flanges may be subject to exceptionally high wear if the base's surface is rough.[6]

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2.1. Mecanum Wheels construction

Mobile platforms that are omnidirectional may move fast in any direction and from any position. As a result, a mathematical model of the platform is required, especially if the platform is to be used as an independent vehicle. The mathematical model will be used to achieve full control of a sophisticated mobile robot, such as an office service robot. Omnidirectional mobile systems have enhanced performance in crowded spaces including offices, warehouses, hospitals, and manufacturing workshops, among others.[8]

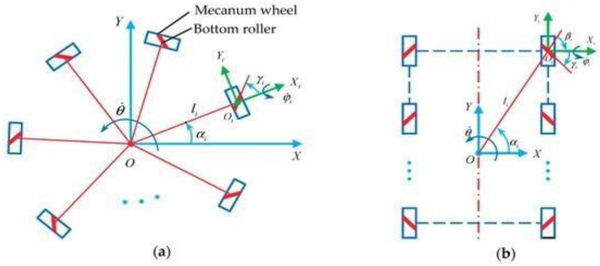

Fig. 2.1: Mecanum wheels directions and force.

According to research findings, the robot should be able to freely navigate in small and medium-sized spaces. Our robots employ mecanum wheels to satisfy this need.Small navigation, user safety, and robot control simplicity have all been taken into mind throughout the construction of robots. The prototype of the sophisticated robot was evaluated in an actual manufacturing environment. The effectiveness of this omnidirectional driving system has been tested. A second version of the robot was constructed in accordance with the findings of the experiments. The second version includes stronger body structure, better lifting mechanism, and improved mecanum wheels. We anticipate that highly developed robots will help injured industry employees.[9]

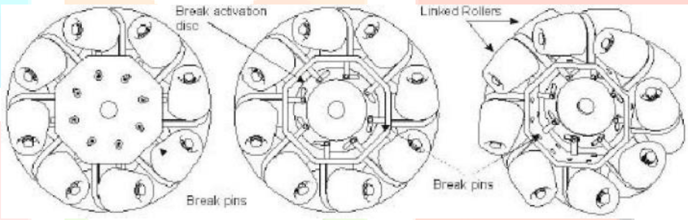

Fig. 2.2:Mecanum wheels wireframe.

Its forum must function within the well-known pre-existing restrictions of its respective site since each is designed for a certain set of duties. Depending on the type of wheels utilized, the robot system can be constructed as either a holonomic or non-holonomic system. In this study, ordinary wheels, omnidirectional universal wheels, Mecanum wheels, caster wheels, and conventional steering wheels are some examples of portable robot wheels that we evaluate and analyze for their good design applications. [10]

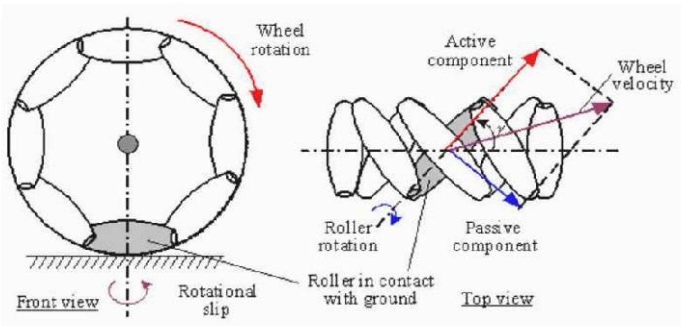

Fig. 2.3: Mecanum wheel Cross-section.

In recent years, an omni-directional motor system using Mecanum wheels has been developed and used in wheelchairs. It should be widely used as a type of intelligent wheelchair-powered robot or in-vehicle car robots for its efficient use. This paper introduces how to adjust the situation during position control and standing with multiple sample times. The control system is based on unique kinematics, which is below the holonomic limits. The idea of a proposed remedy that includes symptomatic correction and preventive remediation is borrowed from medical science.[11]

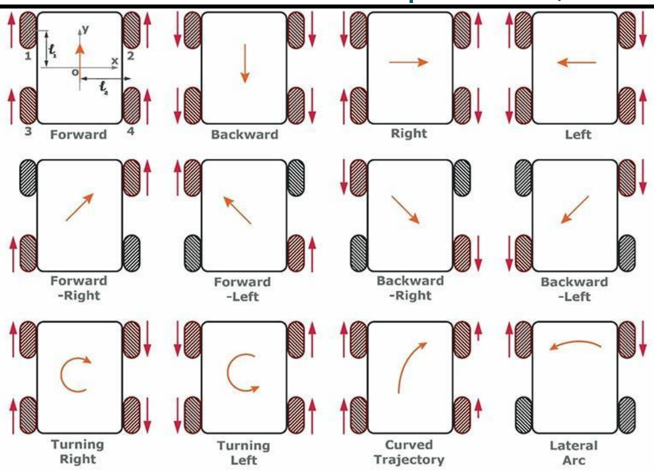

Fig. 2.4:Mecanum wheel directions.

In research and instruction, omnidirectional mobile robots are now used. Omnidirectional movement is possible because to the robot's unique Mecanum wheels. General information about Mecanum omni-directional wheels, details on the mechanical design of wheels and robots, and explanations of the robot's kinematic and dynamic models and control system. [12]

Mecanum wheels provide omnidirectional control over cars and robots that standard wheels do not have. Because such tires are omnidirectional, the vehicle is highly maneuverable, which can be very useful for a variety of internal and external systems. However, present Mecanum tyre designs perform badly on uneven ground and can only be used on a level, solid surface. This paper describes the benefits and drawbacks of two modified Mecanum wheel designs that are focused at curved areas in comparison to traditional Mecanum wheels. It is simpler to drive in difficult terrain and soft terrain, such as impenetrable sand, with other types of wheels when using the wheels suggested below, which are highly helpful in overcoming difficulties of up to 75% of the entire wheel load.This paper also introduces control elements to be taken into account while directing robots or autonomous vehicles utilizing the suggested wheels.[13]

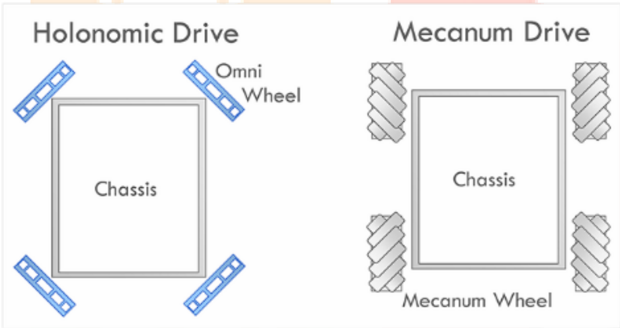

Fig. 2.5:Mecanum wheel robot top view.

Unlike a vehicle with conventional four-wheel drive, a vehicle with omnidirectional wheels can travel without changing the body's direction, in all directions. However, the majority of omnidirectional vehicles are only meant to be used on flat terrain. In this study, we suggest the "Spiral Mecanum Wheel," a revolutionary omnidirectional wheel that enables the car to ascend stairs. This new wheel has numerous small, positioned adjacent to the rolling beams, little rollers, and spherical beams. The spiral edge rolls to close the step from the top when an automobile on these rolling Mecanum Wheels advances in the usual manner. We put a Spiral Mecanum Wheel through tests and demonstrated its excellent performance. About 83 percent of a wheel diameter was climbed by the Spiral Mecanum Wheel. in normal motion in a research utilizing a single wheel as a result. When traveling and in normal mode, an automobile with a spiral mecanum wheel rides on a step that is roughly 37 percent and 59 percent of the wheel's diameter, respectively.[14]

Mecanum wheels' self-rotating wheels enable them to rapidly propel an automobile in any direction. The mecanum wheel has inescapable barriers, such as direct and horizontal vibrations because of the constant contact between the rollers and the ground, because it is constructed of harps and rollers. We built a prototype and ran tests to precisely measure the vibration as part of our investigation into the mecanum wheel's dynamic characteristics.

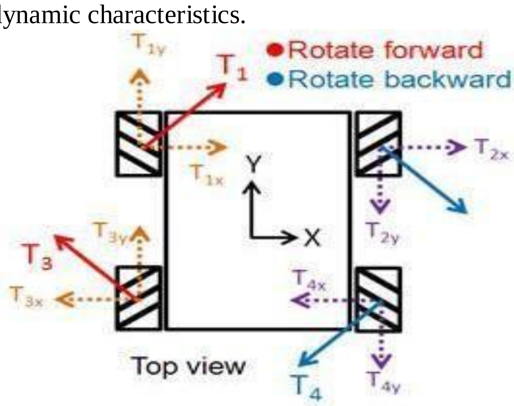

Fig. 2.6:Mecanum wheel robot directional forces top view.

The direct acceleration was found to be asymmetric in relation to the average number of signals; the vibration signals show very different positions. The dynamic simulations performed by RecurDyn confirm this asymmetric action. In order to investigate the effects of roll-down on direct vehicle vibrations, peak-to-peak values, RMS migration, and acceleration were calculated. We used a spring to raise the mecanum wheel to reduce vibration. It was also discovered that the absence of a spring resulted in a significant decrease in direct acceleration. We also discovered a precise geometric design that minimizes direct vibration of the mecanum wheel by taking into account the equal strength of the mecanum wheel in several different filet radios.[15]

III. APPLICATION THAT ARE USEFUL IN DIFFERENT SECTORS

3.1 Military Applications

Numerous outdoor applications, including search and rescue missions, military operations, planetary explorations, and mine operations, can make use of and benefit greatly from the maneuverability provided by omnidirectional vehicles. When a robot needs to be highly maneuverable, such as when NASA is exploring dangerous environments, this wheel is frequently used. The Omni Bot project's goal is to create a mobile base for hazardous duty that will serve as a cutting-edge test bed for developing new technologies for remotely managed operations in risky environments. Additionally, several automated umbilical technologies for autonomous mobile vehicles will be tested on this base.

The transient nature of the military installations, constructions and material culture is commonly used to describe them. In the specific instance of the marching camp, this scenario is easily prone to becoming excessive. The employment of remote sensing techniques for their detection and investigation has proven crucial because these sites are essentially undetectable in the contemporary landscape.

On the Fort Lewis Military Reservation, three-dimensional forest structure data is essential for a number of ecosystem management goals, such as habitat evaluation, ecological restoration, fire management, and commercial wood harvest. In order to track vegetation response to various management strategies, the Forestry Program at Fort Lewis, in particular, needs measures of shrub, understory, and overstory canopy cover. In three-dimensional (3-D) space, forests are organized as complex systems. The understory light regime, microclimate, and habitat structure are primarily determined by the 3-D structural organization of forest canopies. One of the more significant factors determining the spatial organization of a forest stand in the Pacific Northwest is the vertical distribution of canopy features. According to the findings, field-based estimates and LIDAR-based cover estimates for overstory and understory are typically connected. For any forest type, there does not seem to be a substantial correlation between LIDAR and field-based estimates of shrub cover.

Fig. 3.1: Smart robot with mecanum wheels

3.2 Industrial Applications

Many applications, including ADAS (advanced driver assistance systems), industrial automation, and robots, depend on the ability to avoid collisions. To protect humans and valuable assets in industrial automation context, some places should have been off-limits to autonomous vehicles. These zones can be isolated by mapping (using GPS, for example) or by using beacons to mark a no-entry zone.

These beacons are easily detected by the LiDAR, but other shiny surfaces, such as worker safety jackets, cause false positives. Here, we propose a strategy to reduce false positive detection from the LiDAR that involve showing the beacons in the camera vision using a deep learning technique and showing the detection with a neural network-learned projection from camera to the LiDAR space Mecanum wheels have long been employed in robotics, business, and logistics. It was discovered that systems based on Mecanum wheels retain omnidirectional capabilities, whereas systems based on conventional wheels do not by thoroughly studying and analyzing the current literature on this type of wheels. Particularly, these qualities greatly increase the vehicle's maneuverability, which might be quite beneficial in a variety of interior and outdoor applications.

Fig. 3.2: Industrial robot with mecanum wheels

They are capable of carrying out specific tasks with ease in crowded surroundings that are predicted to contain static impediments, dynamic obstacles, or small spaces. Such settings are typically seen in factories, warehouses, hospitals, etc. Consequently, there is a need to develop these types of robotic platforms to meet the needs of numerous industries, including: industrial, medical, naval, military and last but not least, the educational sphere.

Numerous research has recently concentrated on tracking emission sources and analyzing the primary and secondary generation of pollutants in Brazil's major cities. Two related studies were done to measure the PM2.5 and black carbon concentrations in six major Brazilian cities and to determine their correlation with negative health impacts and an elevated mortality risk. examined the relationship between air quality and the impacts of short-lived climate pollutants connected.

IV. VL53L0X SENSOR

The Internet of Things (IoT) has received a lot of recent attention. The goal of the Internet of Things is to increase the advantages of having an internet connection by connecting more things, including technological gadgets. Sensors that are always active and well-connected to local and international networks can be implanted into these things. These items have been created to offer details about the environment they are in. As an illustration, consider the devices that use an internet network to monitor environmental hygiene conditions [21].

Robotics is a field that is quickly evolving, and a lot of work is now being done to create radiation-tolerant autonomous robots for use in the nuclear sector. They are especially necessary for nuclear decommissioning duties like remote handling and inspection. Robots often move about and access locations where there is a risk of physical injury, chemical pollution, and radiation harm. Referrals are provided for some common radiation settings.

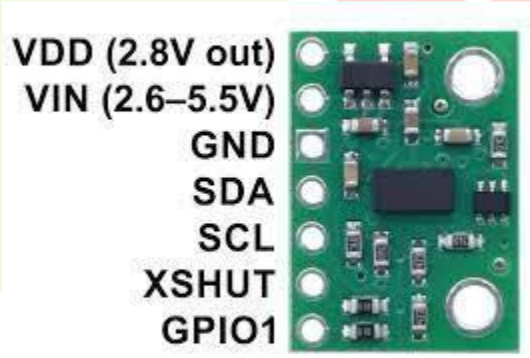

Fig. 4.1: VL53L0x sensor

The 4.4 x 2.4 x 1.0 mm LiDAR module employs time-of-flight measurements of infrared laser pulses for ranging and can provide precise results up to 2 meters distant regardless of the target's color and surface. Figure 3 reveals the Vertical Cavity Surface-Emitting Laser (VCSEL) at 940 nm, Single Photon Avalanche Diode (SPAD) array, on-board memory, and microcontroller inside the module. The essential output, which is communicated over an I2 C bus, is the distance measurement. For just 640 rupees, all of this technology is supplied.

A cutting-edge Time-of-Flight (ToF) laser ranging sensor, the VL53L1X (Figure 3), expands the ST Flight Senser product line. It is the quickest small ToF sensor available, with a rapid ranging frequency of up to 50 Hz and proper ranging up to 4 m. The SPAD is a receiving array, 940 nm invisible Class1 laser emitter, physical with infrared filters, and optics are all integrated into a small, reflowable device to provide the optimum ranging performance in a variety of ambient lighting circumstances with a variety of cover window choices. The VL53L1X, in contrast to typical IR sensors, employs ST's most recent generation of ToF technology, enabling determination of absolute distance regardless of target color and reflectance. Additionally, the size of ROI on the receiving array may be programmed, allowing the sensor and FoV to be narrowed. Table 1 contains the technical details of the usage sensor. [23]

Table 4.1: Technical Specification of VL53L0x

Working Voltage	2.6-5.5V DC
Working Current	10mA up to 40mA
Working Frequency 1-Short: up to ~130 cm 2-Medium: up to ~300 cm in the dark 3-Long: up to 400 cm in the dark	1-50 Hz max sampling rate (most immune to interference from ambient light) 2- 30 Hz max sampling rate 3- 30 Hz max sampling rate
Output format (I^2C)	16-bit distance reading (in millimeters)
Distance measuring range	Up to 2m with a minimum range of 4cm
Weight without header pins	0.5 g
Dimension	13*18*2mm

Using a specially designed laser-based range module, the robot with VL53l0x can move over two-dimensional surfaces and conduct interior environment sensing. For the purpose of creating an occupancy grid map, log-odd occupancy and an inverse sensor model are used. We demonstrate that the robot can do mapping in a contained environment using the established approach. We also demonstrate how many of these robots may be upgraded to carry out multi-robot mapping. This is the initial stage in the creation of a multi-robot system employing an embedded system architecture for mapping interior spaces [24].

V. CONCLUSION

AThis essay gives a general overview of the Mecanum wheels and some of its practical applications. This type of wheel's key advantage is its omnidirectional nature, which allows for remarkable agility and movement in crowded areas.. Additionally, some study done on Mecanum wheel mobile robots to enhance the wheel design is mentioned. both it has, outdoor applications, such as rescue and search missions, military operations, planetary explorations, and mine operations, as well as indoor applications, like the transportation of some small goods, powered robotic wheelchairs or shopping carts, can make use of and benefit greatly from the maneuverability offered by omnidirectional vehicles. The VL53L0X LiDAR module demonstrates that there is reason to believe that radiation-tolerant robotics systems may be created utilizing off-the-shelf components

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