Obstacle detection and avoidance of Robotic metallic Debris collector

Introduction

On a worksite, debris naturally coalesces on the ground. Nails get dropped. Bins of bolts and nuts get toppled. Scrap metal falls from cutting the board. People around are just one misstep away from a tetanus nightmare. A metallic debris collector can easily collect this dangerous debris and clean up a work area nicely. Making this robot to work perfactly, it requires a highly efficient sensor to detect any obstacle in the routing area. IR sensor and ultrasonic sensor are most used sensors for robot obstacle detection mechanism. This technical review briefly summaries some commercially available sensors designed for obstacle detection, explain algorithm of detection, and provide methods of implementation for ideal operation.

Application of different type of sensor in robotics

Since all type of sensors are widely available in market it is easy to find sensors to perform specific task for any robot. Most commonly used sensors for obstacle detection are: IR, Ultrasonic(sonar), and LIDAR. Infrared obstacle sensors work in accordance with the infrared reflection principle to detect obstacle [6]. The Sharp GP2Y0A02YK0F Infrared sensor measure distance in the 6 to 60-inch (20-150cm) range using a reflection beam of Infrared light. It cost only $14 - $20 from spark fun and can provide consistent reading which are less influenced by surface reflectivity and environment temperature [1]. OSOYOO 10PCS IR obstacle avoidance sensor is popular for it's easy to use with Arduino microcontroller which cost about $10 on amazon. Ultrasonic sensors are used to detect objects and measure distance [1,2]. The HC-SR04 ultrasonic sensor offers excellent non-contract range detection with high accuracy and stable readings in an easy to use package. It has a range from 2cm to 400cm or I inch to 13 feet. It is also cheap (cost about $8 on amazon). Lidar sensor is popular for its speed. It calculates the distance based on the speed of light. The Vu8 LiDAR sensor from LeddartTech is a complete solid-state LiDAR which provides highly accurate multi-target detection over eight independent segments. It cost about $475. Another LiDAR is Adafruit VL53L0X time of flight distance sensor. It can detect obstacle about 50mm to 1200mm and cost only $15 [1,2].

Technology of different sensor and tradeoffs

Infrared sensors work on the principal of reflected light waves. Infrared light reflected from objects or sent from an infrared remote beacon [6]. The reflected light is detected and then an estimate of distance is calculated between sensor and object. Infrared sensor does not work in dark environments [1,]. So, if a robot must be operational at night time or extreme weather it is

not a good choice. But it can provide consistent reading and is less influenced by surface reflectivity, operating time and temperature [5]. It very good for short distance calculation. Ultrasonic work on the principle of reflected sound waves [6]. It sends out a high frequency sound pulse and then times how long it takes for the echo of the sound to reflect. It uses the speed of sound along with the time difference between sending and receiving the sound to determine the distance of an object. Ultrasonic is not affected by light, dust, smoke, mist, vapor or lint. It is perfect choice for outdoor use and the price is also within reach. It is not as good as Infrared to detect the edge of an area, but it is more reliable [3]. A lidar sensor calculate distance and detects objects by measuring the time which it takes for a short laser pulse to travel from the sensor to an object and back, calculating the distance from the known speed of light. It can pulse at 20kHz which allows for measurement of up to 1.3 million of data points per second. It is highly used for long distance measurement and in commercial cars [4]. It is also expensive but most accurate and fast. Combination of infrared and ultrasonic is a good choice for a metallic robot to avoid any obstacle.

Algorithm and implementation

The combination of infrared and ultrasonic sensor will be used in case the robot has to work outdoor or a dark room. To detect any obstacle both infrared sensors and ultrasonic sensor will be used and then there's data will be collected to make calculation. The calculated value will be converted into centimeters [4]. The reading value will be compared with a threshold value within a range. If any of the sensor's value is within the range (2cm – 40cm) the robot then the obstacle detection decision will be made, and the avoidance algorithm will be triggered. The obstacle avoidance will use the obstacle detection value to control the robot movement. If the obstacle is within range the robot will stop for few seconds and then change direction depending on the routing algorithm and keep moving and doing the same obstacle detection procedure [3,4]. If none of the sensor's calculated value is within the range of collision, then the robot will keep moving [5].

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