A Comparative Performance Survey of Obstacle Detection of Mobile Robot using various Sensor Technologies

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Abstract

This paper proposes a novel survey approach to obstacle detection and avoidance using a various sensor technology. We depart from the research of previous researchers who use several sensor technology for obstacle detection and avoidance .In that paper we discuss the frequency ,detection range, pulse width, system bandwidth, range resolution, probability of detection of ultrasonic sensor, image processing system, radar, artificial retina sensor, IR sensor.

Keywords - IR sensor, Radar, Artificial Retina Sensor

Introduction

Detecting and avoiding obstacles is an important problem in mobile robotics. If a robot can be made to avoid coming into contact with objects in the environment, the other higher-level capabilities can safely be incorporated into the system. Yet, despite decades of research and development on the topic, robust and reliable obstacle avoidance remains a delicate problem that is difficult to ensure. The most common sensors for obstacle detection and avoidance have been laser range finders, sonar's, and cameras. Each of these has its own strengths and weaknesses, as seen in Table 1. Laser range finders, while providing a dense, accurate

Depth array, consume large amounts of power and are expensive. A ring of Ultrasonic sonar sensors are more economical, but the resulting depth readings are more coarsely spaced and less accurate. Both approaches suffer from only providing readings within a horizontal plane parallel to the floor. Unlike sonar's and lasers canner, cameras do not directly provide geometrical measurements of an environment, which must instead be inferred from the pixel data (a difficult problem). Due to the close spacing of pixels, a camera captures raw data at a high spatial resolution, but a multi-camera (e.g., stereo) system usually is only able to provide depth estimates for a sparse set of matched pixels. (Akbarally *et al.,* 1995)

Video Based Detection Image Processing System

The image processing system forms the basis of the obstacle detection system. Video images from a forward looking video camera, situated by the rear view mirror are sampled by a real-time image processor in the boot of the car. The image processor consists of a VME rack, a Sun Sparc workstation in overall control, with a Max Video 20 card and i860card providing the processing power. The communications to and from the i860 are handled by transporters. Various user displays are available from the Max Video and i860which can be sent to a liquid crystal display on the dashboard.

Radar Detection Radar System

The Radio Detection and Ranging, its function principle is to broadcast microwaves and analyze the reflected ones by objects. It's possible to obtain from these reflected waves; position and speed of targets. It has typically been used in aircraft industry and also in military applications. In automotive industry, was introduced some years after its use in other industries. Typically has been used by vehicle manufacturers in Adaptive Cruise Control (ACC), even though its use is restricted to luxury cars, because of the cost of this technology. Two frequencies are the main used in automotive applications, 24GHz band and 76-77 GHz band; the first one is used for measurements in short ranges, up to 30 m; the second one is used for measurement of distance above 150 m, and speeds up to 150 km/h. RADAR has a good performance in almost all weather conditions. (Bai and wei, 2010)

Design of Collision Avoidance Radar Sensor

The main advantages of millimeter wave radar are narrow beam width, small-sized antenna and short wave length about millimeters. Due to the narrow beam width, high range resolution is possible, and the effect of mutual interference between systems is decreased and robustness against Electronic Counter Measure (ECM) could be achieved. Small-sized antenna is feasible by short wave length, which has the high directivity and narrow beam width for detecting low-altitude target without multi-path effects. Collision avoidance sensor for UAV is coherent-on-receiver system of pulse radar, which is capable of extracting the range-rate information from the moving target. (Barrick *et al.,* 1970) Also, system is relatively simple and its cost is low compared with coherent system. Designed radar parameters for collision avoidance are presented in Table 1.

Table 1: Typical Radar Sensor Model.

Frequency	**35 GHz**
Detection Range	6.4 km
PRF	5 KHz / 15 KHz
Pulse Width	33 ns
System Bandwidth	30 MHz
Range Resolution	5m
Peack Power	3 Kw
Scan Coverage	180 deg (+90~-90) in Az 100 deg (+20~-80) in El
Scan Rate	150 deg/sec
Antenna Beam Width	2.5 deg
Antenna Gain	37 dB
RCS	2~30 dBsm
Prob. of False Alram	10e-6
Prob. of Detection	90%

Artificial Retina Sensor

Osaka University in Japan is applied to PRVII (P0STECH Road Vehicle11) for real time collision detection and avoidance in high speed navigation. ARF consists of a linear ccd sensor and dove prism rotating in front of the camera lens. Since ARS provides polar domain images directly from the scene, size and projection in variance in polar coordinate system can be utilize directly. Thus we only have to apply an edged detection and a template matching method to the horizontal direction. Then an optical-flow of moving objects is estimated to obtain 3Ddistance and time-to-impact information from obstacles.

To verify the validity of our proposed technique 'real images are taken using an ARS mounted on PRV I1 and analyzed. (Thorpe, 2009).

IR Laser

An infrared laser is used for large distance measurement, the infrared light beam is reflected by the target, then this reflected light is received in sensors allocated next to the laser; the received signal is processed in order to get the distance. These sensors are typically used in industrial process automation, also object detection and people counting. In present paper are considered only sensors based on refractive effect, because those based on reflective effects requires a special tape or a reflector allocated on the target, these characteristics makes them not proper for automotive braking systems. (Ulke *et al.,* 1994).

Ultrasonic Sensor

Ultrasonic sensors emit a sound pulse that reflects off of objects entering the wave field. The reflected sound, or “echo” is then received by the sensor. Detection of the sound generates an output signal for use by an actuator, controller, or computer. The output signal can be analog or digital. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. Systems typically use a transducer which generates sound waves in the ultrasonic range, above 18,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed. Ultrasonic signal is propagated from a sender to an obstacle and, after being reflected, back to a receiver. This is enough to compute the distance of path. In this way the form of the data obtained from sonar's is very simple. Unfortunately this type of information is not easy to interpret. . The wide emitted beam causes that they suffer from a very pure resolution. This type of beam smears the location of the object reflecting an echo and produces arcs when a rotational scan of the environment is performed. Ultrasonic sensors emit a sound pulse that reflects off of objects entering the wave field. The reflected sound, or “echo” is then received by the sensor. Detection of the sound generates an output signal for use by an actuator, controller, or computer. The output signal can be analog or digital.

Ultrasonic sensing technologies based the principle that sound has a relatively constant velocity. The time for an ultrasonic sensor's beam to strike the target and return is directly proportional to the distance to the object. The sensing range of an ultrasonic sensor is the area between the minimum and the maximum sensing limits.

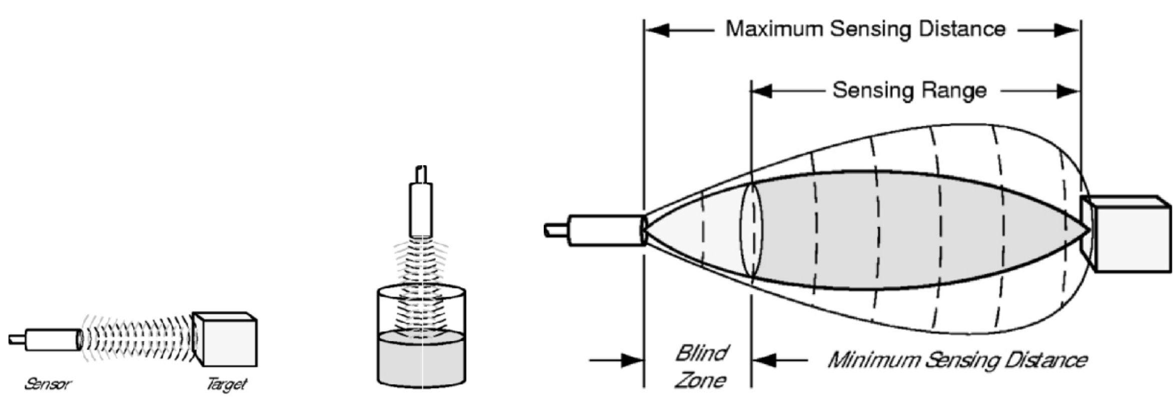

Figure 1: Ultrasonic and sensing data.

Conclusion

We conclude that collision detection and avoidance of ultrasonic is better when compare to all other sensor technology.

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