RANGING SENSORS FOR OBTAINING VISION INFORMATION: SUCCESSES AND SHORTCOMINGS

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ABSTRACT

This paper describes an investigation of the feasibility of using low-cost, off-the-self ranging sensors for obtaining vision information. A polaroid ultrasonic ranging system was obtained and the sensor was mounted so that its direction could be controlled by an IBM XT PC-compatible. Then an interface board was designed and software was written to allow communication between the sensor, the positioning system and the computer. In addition, software was written to gather distance and angle measurements, and to analyze the data obtained. This ranging system worked well for obtaining distances to objects, however, its resolution for measuring angles was not as good. Thus, it was concluded that the system described would be applicable where details about an object's shape are known or not important, and the distances to the objects are of prime importance.

KEYWORDS: ultrasonic ranging, vision, robotics

INTRODUCTION

To realize the full potential of a robot system, one must have an effective vision system. In fact, it can often be concluded that vision systems are bottlenecks in effective robot system. Features of elaborate vision systems are high cost and physical encumbrances. With these observations as motivation, a project was initiated to investigate the feasibility of using low-cost, off-the-shelf ranging sensors for obtaining vision information.

A Polaroid ultrasonic ranging system was obtained, a positioning system was developed, and an IBM XT PC-compatible was made available. An interface board was designed to enable the ultrasonic ranging system and the positioning system to communicate with the PC. These constituted the main components of the hardware.

Next, software was written to position the sensor, gather distance measurements, and analyze the data in order to obtain information about objects of interest.

Overall, the ultrasonic ranging unit worked very well for obtaining distances to objects. It did not work as well when attempting to obtain detailed shapes of objects because the ultrasonic beam is not sharp enough to obtain high resolution of angular positions. Thus, the sensor could be useful where high angular position resolution is not required. This could include applications where details about an object's shape are already known and distances to it are of prime importance, or where the application is such that detailed shape information is not critical.

HARDWARE DESCRIPTION

The heart of the hardware is the Polaroid Ultrasonic Ranging System. This system is comprised of an electrostatic transducer similar to that used in the Polaroid SX-70 camera, the ultrasonic transceiver board, and the Experimental Demonstration Board (EDB). The first three components combine to form a sonar system capable of detecting the presence and distance of objects within a 0.27 m (0.9 ft) to 10.7 m (35 ft) range.

The electrostatic transducer acts as both a speaker (in the transmit mode) and a microphone (in the receive mode). In operation, a burst of 56 pulses (transmitted at 49.1 kHz) is emitted toward the target and the resulting echo is detected. The total distance travelled can then be calculated by multiplying the elapsed time between transmission and detection by the speed of sound.

The ultrasonic transceiver board controls the operating mode (transmit/receive) of the transducer. It is comprised of three sections: the digital section, the power interface section, and the analog section. The digital section generates the burst of ultrasonic pulses transmitted by the transducer and the power interface section initiates the transmission of the pulses from the transducer. When the return echo from the target is received by the transducer, it is amplified by the analog section. This amplified signal is finally sent to the digital section to produce the echo received signal.

The Experimental Demonstration Board (EDB) contains the circuitry required to convert the transmit/receive time interval into a distance value and display it on a three digit LED display.

The sensor positioning system is comprised of the sensor set into a pointer fixture and mounted atop a stepper motor. In order to determine the angular position of the sensor at any moment in time, a protractor was fastened onto a small platform. The shaft of the stepper motor was inserted through the platform and the sensor/pointer fixture was attached to the protruding shaft. The angular position of the sensor can be determined by observing the position of the pointer on the protractor. This provides one dimensional information only, but it could be extended to two dimensions