DRAFT POSITIONING SERVICE ROBOTS USING ULTRASOUND

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Abstract

Management of service and mobile robots gets lots of changes in recent years. From little solutions of scanning near space around robots, it has developed to complex solutions calculating the trajectory of the robot. The most common solutions are camera systems now. Their expansion allows acceptable price for costumer and wide application. The disadvantage this systems is the difficulty in the light conditions. For navigation solution in the event of a reduction of lighting is advisable to use ultrasound sensor.

Key words: ultrasound, draft positioning of mobile service robots

PROLOG

It is very necessary to provide a camera system with cameras with high light transmission for operations in workspace with bad light conditions. Such cameras are often very expensive. For solutions where we have to have more that one camera incorporation expenses is very expensive. If we need low start costs in workspace where is bad light conditions, we can use ultrasound sensors. Ultrasound sensors are alternative solution for positioning mobile servis robots. Benefit of ultrasound sensor is that it does not need light for work. This sensor is not dependent on the level of light captured area and a view of the start price is a relatively low-cost solution.

PRINCIPLED PROPOSE SOLUTIONS

Design a solution based on the principle of sensing distances using sound. Basic data for distance measurement by ultrasound is the speed of sound in air. This value is reported for a tab with dry air 25 ° C, 346.3 ms⁻¹. The signal is sent from the transmitter whose position is known and is captured receiver for mobile service robots. The basic formula for this measurement is a formula (1) for computing the orbit of known physics.

\[ s = \frac{v}{t} \]  

(1)

\( s \) – path
\( v \) – speed of sound
\( t \) – time until catch signal by robot

The formula for calculating the track (1) is derived from the basic formula for calculating the speed. Using this formula, we can determine the path that passed between the sound transmitter and receiver. Thanks to the known quantities which are speed of sound and the measured time period between outgoing and incoming signal we can calculate the distance of the robot from the receiver.

PROPOSE SOLUTIONS

For scanning the robot are two possible solutions location of the sensors. The first option is the location at an angle (Fig. 1) allows for a larger coverage area with a lower number of sensors. The disadvantages are shooting in areas barriers, where capturing for objects in the room is not possible. Another significant disadvantage is less effective sensing area.

To remedy shortcomings in the angle scanning is appropriate to use capturing from the ceiling (Fig. 2).

Fig. 1 Angle scanning area [2]

Fig. 2 Proposal scanning robot
This enables accurate capturing a recalculation of the robot in space. If sufficient height of scanner setting there is minimal "blind" area, an area which is not sensed by sensor. There are needed more sensors than angle scanning, but they are cheap.

For a order to detect the ultrasonic transducers are selected HC-SR04 (Fig. 3). Sensor HC-SR04 been selected for their dimensions and sensing distance, which is up to 40 meters.

For the small size (Fig. 4) and light weight it is able to be placed on the lighter construction. An example would be the coffered ceiling.

When designing grid sensors need to be considered the probing angle indicated by the manufacturer (Fig. 5).

Fig. 3 Ultrasound sensor HC-SR04 [1]

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Fig. 4 Dimensions of HC-SR04 [1]

When designing grid sensors need to be considered the probing angle indicated by the manufacturer (Fig. 5).

Fig. 5 Angle of scanning of sensor HC-SR04 [1]

For the calculation of the conical scanning which is based on the formula (2).

\[ r = \tan \left( \frac{\alpha}{2} \right) \times l \]  
(2)

\( r \) – radius sensing cone  
\( \alpha \) – angle of the transmitted signal  
\( l \) – sensor height from floor

This formula is based on Figure 6. Where the bending section sensing cone. As the formula (2) to see, only the radius \( R \) of the cone depends in proportion to height of the scan. So it can say that the ceiling of the room is higher team is capture area detected by one sensor is larger.

Fig. 6 Wiring scanning cone

ANALYSIS SOLUTIONS

When capturing using one sensor there is a problem ambiguous position of the robot. It can measure the distance to the sensor but this distance is only a radius of the circle on which the robot is located (Fig. 7).
For more clearly capturing in space it is preferable to capturing using sensors tidy in regular lattice.

It allows better cover for the scanned area. For accurate positioning of the robot is one sensor however insufficient. The main problem is the ambiguity of the position of the robot. For more accurate positioning of the robot is therefore necessary to use more of these sensors. When using two sensors, the problem is not resolved. This problem manifest themselves in that the two sensors for detecting the two positions and receive thus the position of the robot is not unique as shown figure 8.

For clear determination of the position thus it is necessary to capture the robot while three sensors to ensure accurate positioning of the robot in space (Fig. 9). A third sensor is positioned in such a way that the sensing cone overlap by more than half of the sector by the transducer sensor 1 while the sensor 2.

REFERENCES


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