IR SENSOR DATA VISUALIZATION

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Abstract

This paper deals with possible usage of an infrared sensor (IR) for environment recognition. Firstly this technology can be used as a static device, e.g. for surveillance or secondly as sensor part of a robotic platform. In our case the application is determined for mobile robotic platform, where on the one hand it is going to serve as sensor of collision and on the other hand as equipment for local navigation. In this article the possibilities and restrictions of this sensor are presented. The design of presented result introduces intelligent IR sensor (iIRS), which is implemented by µP ATmega128 in connection with service application. The service application is used as communication with iIRS, verification and visualization of obtained data. The service application is designed in the Matlab environment.

Keywords: Infrared Sensor, Local Navigation, 3D scan, Intelligent sensor

1. Introduction

One of the most important attributes of autonomous robot is its ability to recognize obstacles. This article describes one of the possibilities which is IR distance measuring sensor GP2Y0A700K0F from Sharp Industries. The sensor has measuring distance range from 100 to 550 centimeters and measuring time 16.5ms ± 3.7ms. This sensor is the part of iIRS, which consists of sensor for distance measuring, two servomotors for movement of the sensor in 2 axis and µP ATmega128 as the control.

For these kind of tasks can be used wide range of IR sensors which have different principal usage and they are suitable for different type of results what was said above. The IR sensors are very often used for line follower robots, where on the background is painted a line with different contrast color then rest of environment. One of these types of robots is described in paper [1], where researchers concerned with design and implementation of double line follower robot. Furthermore, Scientist from India used a simple IR sensors logic for object detection in development of robot hand system. [2] In this system, pick and place command key drives the hand from its current position in clockwise continuously 360 degrees and hunts for an object using IR sensor placed in the center position of the palm. However, these two examples are using different principal usage then in our case. The types of IR sensors which are described above are useless in this case, because they cannot measure of distance. Their ability is only to show if there is obstacle or not in required range (logical 1 or 0).

Therefore, just two different type of sensors can be used for research this task. The both are applied for example in micro-mouse robots which are designed for path searching in unknown maze. [3] An old version of a micro-mouse robot has used solution which was quite accurate but it had too long time lag which represented just few measurements per second. Nowadays, the Robots are faster and faster and that mean, that they need many information from sensors. For these reason, the sensors are divided into two categories. The first has rate of measurement in µs, but the accuracy is lesser and the second is more accurate but its disadvantage is smaller rate.

On the other hand, IR sensors are just a one option for getting information about unknown environment. The most used sensor for mapping environment is ultrasonic sensor (SONO) and it was used by Mr. Hoffman in soft computing techniques for the design of mobile robot behavior [4]. Its advantage is good accuracy but the acoustic column is highly wide and it means that a robot has data about an obstacle but it does not have information were the obstacle exactly is. The next possibility for mapping environment is laser sensor or 3D laser sensor, but these sensors are many times more expensive than IR sensors, although they very accurate.

Finally, the IR sensor was chosen for design of intelligent sensor (iIRS) which has to map the environment in 3D like a 3D scanner. The heart of the iIRS is the µP how was said above. The data from iIRS are sent into PC with Matlab environment where the software evaluates and process these date into useful graphs which are shown below. This article describes design of iIRS and its the advantages and disadvantages.

The paper is organized as follows. We first explain the hardware realization and describe communication between iIRS and PC. The experimental results are in section 3 and they show in which environment is appropriate to choose this type of sensor. We finally conclude the paper with a short survey of related work, discussion, and conclusion.

2. The Hardware Realization

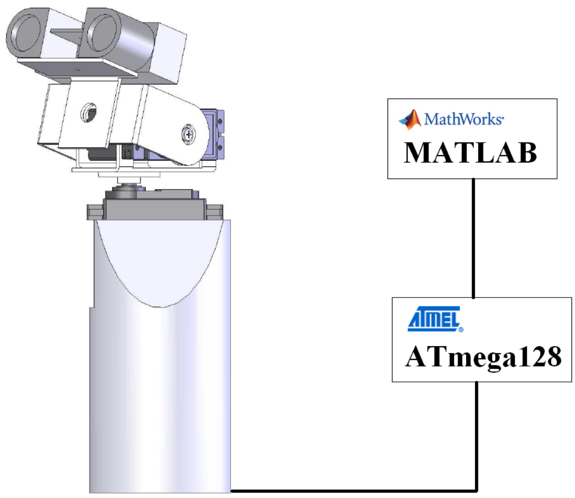

Figure 1: Schema of the iIRS and its connection with ATmega128 and PC

The iIRS is consists of an IR sensor Sharp 2YOA700 which is situated on the top of the measuring tower and the tower is shown in the figure 1. The IR sensor is moved by two HS-322HD servos which move with sensor in horizontal and vertical positions. The horizontal servo can turn the sensor from 0 to 180 degrees and the vertical servo from 0 to 130 degrees. The iIRS is connected with µP ATmega128 which controls both servos and the IR sensor. The data which µP received from iIRS are transmitted into a PC by RS232, where are processed by the Matlab environment.

The µP obtained information from iIRS about distance and angle of rotation which has to be transformed into Cartesian coordinates. The equations of transformation are shown below in (1).

$$x = R.\cos(\alpha).\cos(\beta), y = R.\cos(\alpha).\sin(\beta), z = R.\sin(\alpha) \quad (1)$$

The iIRS can be set three possible states, which are shown in the tab 1. These three states have different work with obtained data in Matlab environment.

Table 1: THREE STATES OF IIRS WHICH USER CAN CHOOSE IN MENU OF MATLAB ENVIRONMENT, WHERE *A* MEANS AZIMUTH AND *E* MEANS ELEVATION.

Type of measurement	Accuracy	Results
IR sensor with low resolution	10°e, 10°a	plot3(), polarplot3D()
IR sensor with medium resolution	2°e, 2°a	plot3()
IR sensor with high resolution	1°e, 1°a	plot3()

The IR sensor sharp continuously measure and sent the voltage signal to A/D convertor of µP ATmega128. When a user send the characteristic which type of measurement want to received for completion of the condition, the µP opens the analog port for receiving data in range from 0 to 1024. Before the µP opens the port, servos are set into initial position which is first position for measurement (usually [0,0]). The received data from A/D convertor are saved in the local variable and they are converted to unit of length (centimeters). The conversion is performed with the equation of linearization which was calculated from documents about sharp IR sensors [5]. The information about distance is sent into PC by RS232 in packet which contains the space between next information of distance for separation one value from others. When the iIRS finishes mapping of an elevation level, µP sent the character ';' and servo for azimuth is turned to next level. Finally, when the iIRS send all data from IR sensor, µP send last character '/n' for termination of communication.

```
clc;
clear all;

s = serial('COM4');
s.BaudRate = 9600;
s.Timeout = 360;
s.InputBufferSize = 512000;

temp = input('Type of measurement: (i
- low resolution, p - medium
resolution, q - high
resolution)','s');

fopen(s);
fprintf(s,temp);
result_L = fscanf(s);
fclose(s);
result_L = str2num(result_L);
```

Figure 2: Example of Matlab script for the IIRS and PC communication

In the Fig. 2 is shown how Matlab environment communicates with µP. At first, in m-script is setting of the serial communication where is set name of port, timeout which means the maximum time limit of communication in seconds and buffer size. Then a user has to choose the type of measurement and the saved value is transmitted into µP which than starts measurement. The data from sensors are saved in the result_L value as a matrix where columns present angle of elevation and rows present angle of azimuth. After receiving all data the serial communication is closed and variable result_L is converted from string to integer and the script can start to work with these values.

3. The Experiments

The experiments were made in one of the room in the Brno University of Technology for testing of the iIRS abilities of mapping unknown environment. The first type of measuring when the sensor measures in size of grid 10 degrees is quick but less accurate and the graph on left side of figure 3 is not as perfect as graph on right side with smaller grids.

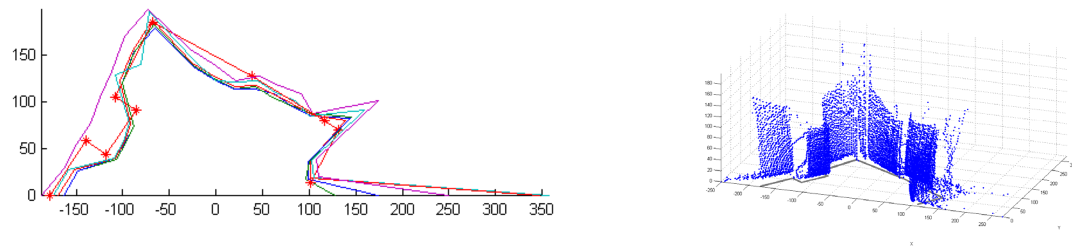

Figure 3: The visualization using iIRS

In the left side of Fig. 3 is shown the ground plan which was made in low resolution. The particular color lines present a different level of elevation measurement and the red color line is specific ground plan of the room. From the picture is evident, that our iIRS can be used for local navigation of autonomous robot. In the right side of Fig. 3 is shown 3D scan of the room with using the high resolution and from the picture is evident, that on left side of wall is some obstacle and the iIRS correctly detected the corner of the room. On the right side of the corner are located the door which are let into the wall only 10 centimeters. The sensor can be affected by the equation of linearization which is chosen by experimental method. For this reason was made some experiments about accuracy of the measurement which are shown in tab 2. One of the experiments was aimed to repeatability of the measurements.

Table 2: NUMEROUSNESS OF THE MEASUREMENT IN 200 CENTIMETERS DISTANCE

Distance in centimeters	191	194	197	198	201	202	204	205
Numerousness	1	6	38	18	23	2	5	7

4. Conclusion

The time of measurement this iIRS and complete mapping of environment is relatively short. This is one of the advantage of this solution. Similar type of sensors are used in local navigation of robot [6],[7]. One of the disadvantages of this sensor is that course of measurement is not linear and a system with this sensor has to linearize this course. The equation of linearization is usually experimental and this is the reason of inaccuracy. Furthermore, the sensor can be sensitive to different surfaces. This sensor is according to manual in range from one meter to five and half meter, but our experience was just to three meters.

On the other hand, the iIRS demonstrated great accuracy and dispersion of values was in ± 7 centimeters what is satisfactory for measuring in these ranges. The next significant advantage is a price of the iIRS, which is many times lesser than usage of iIRS with different type of sensor.

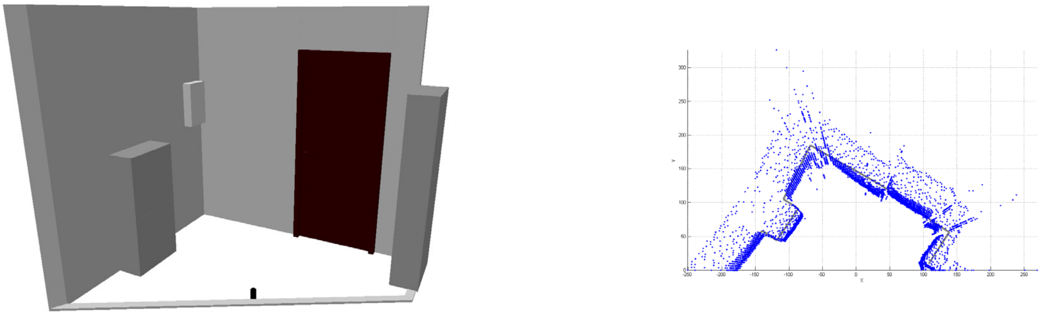

Figure 4: On the right sideof the figure is model of scanning room and on the left side of the figure is result of the scanning

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