Human Interface Device
3D Pointer

Arzu Karataş, Metehan Göksel Kurtulan, and Göktürk Bilgetürk

{c1411030, c1611412, c1411013}@student.cankaya.edu.tr

Department of Computer Engineering, University of Çankaya

November 7, 2018, version 0.1

Abstract

In this article, we will try to find a 3D position on the computer by using the trilateration methodology used in GPS using Arduino. The main topics we work on are the positioning of the sensors for more accurate results, the programming of the trilateration formula and the processing of the data from the Arduino. When the project is finished, we aim to use in many sectors this device.

Keywords: Trilateration, Positioning, Arduino

1 Introduction

A human interface device (HID) is a method by which a human interacts with an electronic information system either by inputting data or providing output. There are countless Human Interface Devices. All devices supplying an interface between the user and computers are considered HIDs. This tool has some purposes. These are being extensible and strong, being as compact as possible to device informations, allowing the software application to skip unknown data and supporting collections. Data from at least 3 devices must be detected to determine the position in 2 dimensions. At the same time, in order to be able to determine the position (latitude, longitude and altitude) of this object in 3 dimensions, these data should be calculated with a methodology. Trilateration technique should be used for this purpose.

2 What is the Human Interface Device: 3D pointer?

This study aims to determine the object in 3 dimensions by using ultra-sonic sensor and search for suitable sensors for the project. Nowadays, we aim to design a device that can keep up with human and device interaction.

2.1 Trilateration Methodology

In this Section, we describe the formula that we will use in the project. We decide the use trilateration formula. Formula has a simple algorithm and it needs at least 3 parameters to work. Algorithm use the distance between the point. In our case points are sensors. After the sensors are calculated from distances. We try to find direction using intersection between sensors.

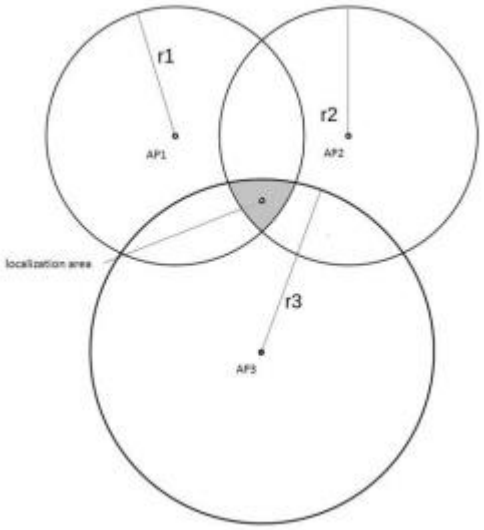

Figure-1

Figure-1 is sample image about what we are do. The main principle is that first sensors calculate the distance between the object and itself. But we have no direction. Then second sensor to do same thing. Then intersection area gives information about the direction. Then second sensor to do same thing. In this way, we can decrease the intersection area for ultimate results. As the number of sensors increases, we can determine a more exact location.

$$d_1^2 = (x-x_1)^2 + (y-y_1)^2$$
$$d_2^2 = (x-x_2)^2 + (y-y_2)^2$$
$$d_3^2 = (x-x_3)^2 + (y-y_3)^2$$

Figure-2

Figure-2 shows the mathematical representation of trilateration formula.

2.2 Sensors

Firstly, we chose to use the HR-SC04 sensor for project. There are two main reasons. First reason is price of sensors. We want to increase the project's cost. Second reason is simple to use sensor.

Figure-3

In the Figure-3, HC-SR04 sensor is a sample to use but as a result of our research we realized view angle is too low than we expect. View angle is about 15 degree that's means we should use approximately 10-12 sensors. If the number of sensors we use increases, it is difficult to synchronizing them and we are looking for wider angle sensors. Then we found JSN-SR04T 2.0 sensor. It has a 75 degree view angle. It is similar to the car distance sensors. Figure-4 is a sample image for JSN—SR04T 2.0.

Figure-4

3 Main findings

Positioning can be made more precise by using the hybrid ie with other sensors and positioning systems. The best way to do this is to use radio waves at these distances and use the WI-FI positioning system. Triangulation and Trilateration are the mathematical functions behind this. Depending on the sensitivity of the transmitter and receiver, the position can be determined with precision at the centimeter level. This requires a good image processing software. The different sensors take the image from different emergencies, the software matches moving objects with patterns and determines the position with centimeter accuracy by calculating over grids on the previously known area.

4 Conclusion

As a conclusion, positioning techniques were first initiated for military studies but with the advancement of technology, nowadays, many areas are used for many purposes. Nowadays, it has become used in scientific and technical studies. The constantly evolving technology can help us to use these techniques in many areas. In the classification of sound waves, sound signals in the range of 20Khz-1Ghz are defined as ultrasonic sound. Our sensor and a lot of ultrasonic sensors produce ultrasonic sound at 40Khz frequency. What is important here is the frequency that determines the height of the sound. The higher the volume, the higher the frequency. Ultrasonic audio signals cannot detect the human ear. This is because all of the sensors are sending ultrasonic audio signals to obtain a certain distance information. We don't know the angle, but we know the distance. Therefore, this distance creates an equal circle in each direction. So we know how far away the sensor is from the center signal that hits the object surface, but we can be anywhere on that ring. In this case, the trilateration method and solution will reach the result.

References

1. Othman, S. N. (2010). Node positioning in zigbee network using trilateration method based on the received signal strength indicator (RSSI). *European Journal of Scientific Research*, *46*(1), 048-061.

2. Bowman, D., Kruijff, E., LaViola Jr, J. J., & Poupyrev, I. P. (2004). *3D User interfaces: theory and practice, CourseSmart eTextbook*. Addison-Wesley.

3. Nishida, Y., Aizawa, H., Hori, T., Hoffman, N. H., Kanade, T., & Kakikura, M. (2003, October). 3D ultrasonic tagging system for observing human activity. In *Intelligent Robots and Systems, 2003.(IROS 2003). Proceedings. 2003 IEEE/RSJ International Conference on* (Vol. 1, pp. 785-791). IEEE.

4. Hazas, M., & Hopper, A. (2006). Broadband ultrasonic location systems for improved indoor positioning. *IEEE Transactions on mobile Computing*, (5), 536-547.

5. Manolakis, D. E. (1996). Efficient solution and performance analysis of 3-D position estimation by trilateration. *IEEE Transactions on Aerospace and Electronic systems*, *32*(4), 1239-1248.