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## LOCAL POSITIONING SYSTEM USING ULTRASONIC TRILATERATION METHOD

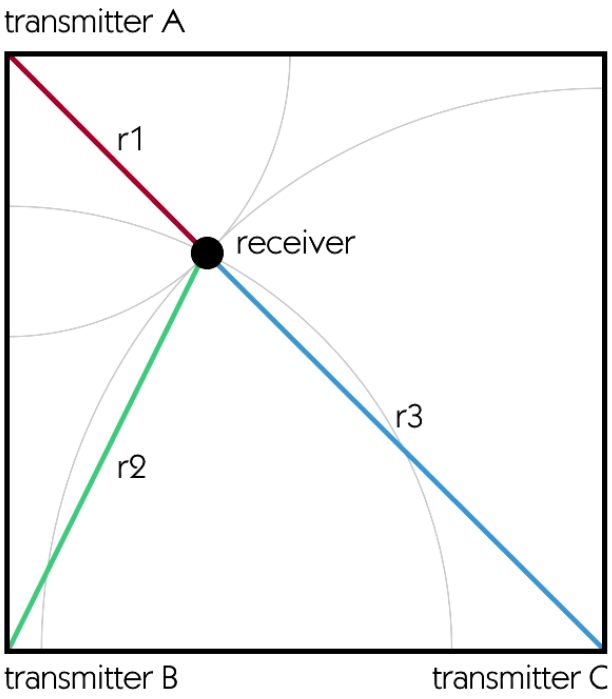
Accurate determination of the objects' location anywhere in the world is an important and urgent task. The development and modernization of the Global Positioning System (GPS) at all its levels occurs daily, but the problem of accurate indoor positioning of moving objects cannot be completely solved using satellite navigation technology. The organization of a productive workflow in the modern world is in dire need of constant accumulation and analysis of a huge amount of data, among which an important role is played by the location of the working staff at any given time.

Many companies and enthusiasts are looking for the most efficient Local Positioning System (LPS). There are a large number of developments of such systems based on various technologies, the main of which are: radar, optical, ultrasonic [1].

Regardless of the scale and technology used, positioning systems operate on a similar principle. Consider the example of GPS: each satellite sends a radio signal to the ground, which contains information about its identifier, the time the signal was sent, and the exact position. The receiver device calculates the distance to the satellite by measuring the time delay from transmitting to receiving the radio signal. Knowing the distance to several satellites with known positions, the receiver calculates its own coordinates [2, 3].

Local positioning follows the same principle, but instead of satellites, a network of transmitters with known coordinates evenly spaced over the area of the premises is used. The main objective of the LPS is to ensure the highest possible accuracy of the location of the object. This is mainly influenced by two things: the way used to transmit the signal from the receiver to the transmitter, and the method of calculating the object's position [2,3].

Since positioning must be done in a small space, and the measurement from the transmitter to the receiver is carried out by the delay of the signal repetition time, it would be logical to say that for greater accuracy of the calculation, the signal speed should be low. Thus, we can conclude that the use of ultrasonic LPS will be the most optimal, since the speed of sound propagation in dry air at a temperature of 20 ° C is only 343 meters per second [1].




There are several basic positioning methods: triangulation, trilateration, signal strength measurement, fingerprint identification. In case of indoor positioning, the trilateration method provides the highest accuracy [2].

Trilateration is a method originally used in geodesy to determine the position of survey markers. From a geometric point of view (Fig. 1), it comes down to finding the intersection point of at least three circles with known coordinates of the centers (transmitters A, B, C). Their radius (r1, r2, r3) is the distance from the center of each circle to the receiver. The use of this method in conjunction with ultrasonic LPS provides positioning accuracy up to 3…5 cm [1, 2].

**Figure 1. Trilateration**

However, despite the highest accuracy, ultrasonic LTS has a number of disadvantages that make their use difficult at this stage. These disadvantages include:

1. lack of a fully functional solution, since the technology is currently in experimental [1, 4];
2. inability to use in rooms where equipment capable of emitting ultrasound is used, since in this case the operation of the LPS will be subject to numerous interferences [1, 4].

Summing up, we can say that the technology of ultrasonic positioning is promising due to its high accuracy and relatively simple mathematical algorithms for calculating the position of an object using the trilateration method. However, at the moment the technology is experimental and under development, so it will take some time before it will be possible to purchase ready-to-install devices.

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