

УДК 621.391

Denys Romaniuk¹, Anastasiia Lebedieva-Dychko², Galina Shilo³, Andrii Pysarskyi⁴, Stanislav Shaptala⁵

¹ student of PT-516

² Head of LLC SIS-IT

³ Doctor of Technical Sciences, Docent, Zaporizhzhia Polytechnic National University

⁴ Senior Lecturer, Zaporizhzhia Polytechnic National University

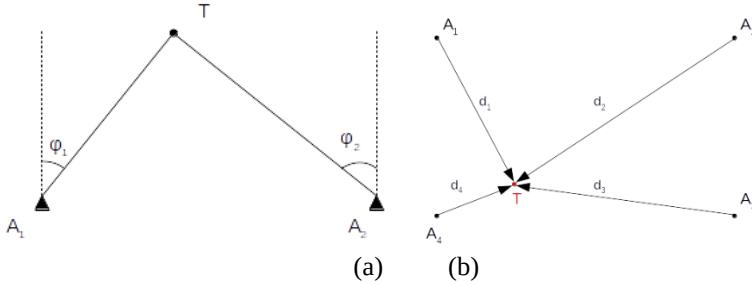
⁵ Postgraduate Student, Zaporizhzhia Polytechnic National University

INDOOR AND OUTDOOR POSITIONING TECHNOLOGY AT THE INDUSTRIAL ENTERPRISES

Modern positioning systems are often based on radio position technologies. These technologies usually use Wi-Fi or Bluetooth.

The angle of arrival concept uses the angle of arrival of signals from multiple anchors. Then using a triangulation method, a tracker's location is estimated, as shown in Fig. 1a.

The angle of arrival is determined by an antennas array, which measures the time difference of arrival. Some applications use an array of directed antennas as well. Such systems only need two measuring devices for two-dimensional positioning and three for three-dimensional. They also need large and complex hardware and are susceptible to multipath interference, that is when the signal reflects from multiple surfaces. Thus, this method is not ideal for indoor applications. Tests show that this approach may achieve an accuracy of up to 1 meter [1].



(a) – angle of arrival concept; (b) – trilateration principle.

Figure 1—Positioning principles, A_i are the anchor points with known position, T is the tracking device.

The time of flight (or time of arrival) concept is based on the amount of time it takes a signal to travel from a transmitter to a receiver. The value is measured and used to calculate the distance to an anchor. Measurements from at least three anchors are required to solve the problem in two-dimensional space and four for three-dimensional. And then, using known anchors' positions and the trilateration method, a tracker's location is estimated. Time of flight systems require a complicated time synchronization mechanism and also suffer from multipath interference, although various techniques exist to mitigate these issues. Decawave has coupled this concept with Ultrawideband technology for minimum interference with other radio devices and was able to reach a reported accuracy of several centimeters [2-3].

The relative signal strength concept is based on measuring the power level of the received signal. The value is then transformed into the distance to a signal emitter using inverse-square law or logarithmic distance path loss model. Similar to the time of flight concept, the trilateration method would give us an estimate of the tracker's position. Most of the consumer-grade devices like mobile phones and Wi-Fi or Bluetooth development boards like ESP32 provide a way to measure the relative signal strength. This makes them a perfect fit for implementing this concept. Implementation of this concept based on these wireless technologies may achieve an accuracy of up to 2 meters. This approach is one of the most cost-effective. However, Wi-Fi signal strength is extremely noisy and highly dependent on the antenna configuration. Any obstacles significantly decrease the accuracy of this method. Hence, various noise reduction and redundancy methods, as well as antenna configuration optimization and inertial movements compensation, must be used to deliver stable operation [4].

As shown in the paragraphs above, the time of flight and relative signal strength concepts seem to offer the most cost-effective solutions in the applications of indoor positioning and have to be further studied and improved.

REFERENCES

1. S. Wielandt, J. Goemaere and L. De Strycker, "Multipath-assisted angle of arrival indoor positioning system in the 2.4 GHz and 5 GHz band," 2016 International Conference on Indoor Positioning and Indoor Navigation (IPIN), Alcalá de Henares, 2016, pp. 1-6.
2. P. Dabove, V. Di Pietra, M. Piras, A. A. Jabbar and S. A. Kazim, "Indoor positioning using Ultra-wide band (UWB) technologies: Positioning accuracies and sensors' performances," 2018 IEEE/ION Position, Location and Navigation Symposium (PLANS), Monterey, CA, 2018, pp. 175-184.
3. A. R. Jiménez Ruiz and F. Seco Granja, "Comparing Ubisense, BeSpoon, and DecaWave UWB Location Systems: Indoor Performance Analysis," in IEEE Transactions on Instrumentation and Measurement, vol. 66, no. 8, pp. 2106-2117, Aug. 2017.
4. Li, Guoquan & Geng, Enxu & Ye, Zhouyang & Xu, Yongjun & Lin, Jinzhao & Pang, Yu. (2018). Indoor Positioning Algorithm Based on the Improved RSSI Distance Model. Sensors. 18. 2820.