Indoors localization system with the use of WiFi and other network standards

Abstract. In this paper there is information about the methods of determining the localization inside the buildings and a description of the experiment program to measuring the distance from the AP.

Limitations of localization methods

The unlimited localization of persons inside the buildings has the take the risks. The main is the limited confidence of traced and controlled persons to the current available systems of localization. One of the actual available methods to prevent identification is a special application developed by Apple. This program is based on a pseudo-random address amended on the network card before logging in to a Wi-Fi network. This method seems to exclude unauthorized localization and tracking systems. However, the same manufacturer (Apple Inc.) offers the anti anti tracking and localization application that is able to predict the next pseudo-random address. Currently available commercial systems use Wi-Fi network to determine person’s location, however, the accuracy and popularity due to the specialized equipment is limited. IndoorAtlas system uses signal strength triangulation to determine the position of the tracing person at the nearest transmitter to the area in which the person is located. (IndoorAtlas, 2014) The other presented systems show different methods of the indoor localization. Systems based on the GPS receiver’s modification require huge power antennas thus their usefulness is significantly limited. Localization systems based on wireless signal require a permanent connection to the network. Finally systems employing gyroscope and accelerometer allow determining the current position with a small accuracy. In a conclusion the appropriate development of the hybrid system that will employ all above presented systems should give the highest accuracy in localization using the most economical efficiency.
Description of the method of determining the localization

The experiment relied to create a connection between the access point (AP) and the device with built-in network that supports Wi-Fi. In this case, testing was conducted in two smartphones. One has been applied as AP (transmitter) and the other (smartphone Samsung GT-S7580 equipped with the appropriate software) has been applied to determine the distance (receiver). It has been placed in a known distance from the access point inside the building.

Fig 2. Screen of the program on the phone designating the distance to the AP

\[ P = 20 \log_{10}(d) + 20 \log_{10}(f) - 27.55 \]

\[ -20 \log_{10}(f) + P + 27.55 = 20 \log_{10}(d) \]

\[ \frac{1}{20}(-20 \log_{10}(f) + P + 27.55) = \frac{20 \log_{10}(d)}{20} \]

\[ \log_{10}(d) = \frac{1}{20}(-20 \log_{10}(f) + P + 27.55) \]

\[ d = 10^{\left(\frac{1}{20}(-20 \log_{10}(f) + P + 27.55)\right)} \]

\[ d = \frac{P - 551}{400} \]

\[ d = \frac{20P - 551}{400} \]

Fig. 3. Dependence between the power P and the distance signal which is received

The installed software has been written to calculate the distance from access point, based on the signal strength that determines the distance from the access point (AP).

Experimental measurements of a distance was carried out on 3 levels 0.0 m, 0.5 m and 1.5 m height relative to the position of the access point (AP). The measurements were performed inside the building at a distance from AP 0 to 10 m at intervals of 0.5 m.

Fig. 4. Accuracy depending on the height at which the measurement was conducted

Conclusions

Analyzing the measurements obtained from the program can be determined that the best results are achieved at the height level of 0.5 m. The best result close to the real measurements contains in the range from 0 to 4 m. The biggest deviation from reality contains in the range of 9 m to 10 m. Such results follow from the way of radio waves propagation.

By this experiment one determines the approximate accuracy of the user's position within 5 m from the device. To increase the accuracy of determining the localization should increase the power of the device and increase the count to minimum 3 AP to use triangulation method determining the localization of the signal in a 3-dimensional space.

REFERENCES

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