

Positioning in indoor environments with low-cost Wi-Fi devices

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The development pace of research associated with location tracking is highly associated with the breakthrough of wireless sensor networks and wireless technologies, being explored in several different areas. A classic example is the Global Positioning System (GPS), in which satellites are used to send signals to receivers on Earth, which, in turn, use these signals to compute navigation information. In order to address the growing interest in the research for position tracking in indoor environments, it is necessary to rely on wireless devices based on Bluetooth technology or Wi-Fi (IEEE 802.11). The objective of this study is to show the development of applications using new Wi-Fi devices (ESP8266) for the estimation of positioning and location in indoor environments. Since this study proposes to use the RF (Radio Frequency) signal of Wi-Fi devices, the choice of the method of lateration, in this case setting up a trilateration, is the most recommended. In order to use lateration techniques [1], at least three reference nodes are needed, hence defining a trilateration. In trilateration, the distances between the reference position and an unknown position can be regarded as a circle radius with a center in each reference position. Therefore, the unknown location is the intersection of the three circles.

The expressions for the calculation of the coordinates can be obtained using the Pythagorean Theorem. By solving the equations (1) for x and y, the coordinates of the unknown position T can be calculated.

$$\begin{aligned}d_1^2 &= (x_1 - x)^2 + (y_1 - y)^2 \\d_2^2 &= (x_2 - x)^2 + (y_2 - y)^2 \\d_2^2 &= (x_2 - x)^2 + (y_2 - y)^2\end{aligned}\quad (1)$$

The location using a trilateration is deeply useful, since the distances (d_1 , d_2 , d_3) can be obtained from the received signal strength (RSS), and the coordinates for the location of all the reference nodes are known and stored beforehand.

The ESP8266 microcontroller has a firmware called NodeMCU. The program, developed using the

LUA language, gathers the values of the signal strength of the transmit power between the ESP8266 and multiple wireless Access Points (AP) in the environment, also sending these data via wireless to a PC that is present on the network (Figure 1). The ESP8266 device can work portably with a battery.

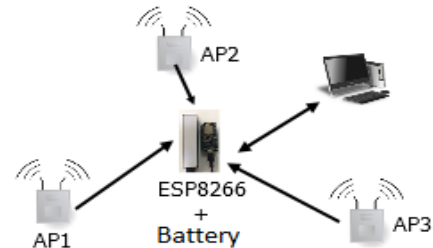


Figure 1. Developed system

The program's screen intended to display the position is shown in Figure 2. The red points refer to the successive positions calculated on a one-minute interval. The variation reached a distance of 1.2 meters from the real point, marked in green.



Figure 2. Screen to positioning the device.

A more accurate characterization of the environment, taking into account adjustments in function of furniture and curtain walls, may help increase the accuracy. However, as a low-cost solution when compared to others, like the RFID (radio frequency identification), already used in some applications, the use of the ESP8266 device is deeply beneficial.

References

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