Popular Science Summary

Currently, there is a great interest in location-based applications. These applications are used in industry, academia, and society. Not only has the demand for location systems grown, but these services also need to be very accurate in their estimates and be able to function well in different scenarios. These scenarios can be outdoor, indoor, or a combination of them. Most current location technologies have optimal performance in a specific scenario, such as GPS, which is typically a very reliable and accurate radio navigation system in outdoor scenarios, however, the use of GPS in indoor scenarios is affected by the loss of visibility of the devices with the satellites and the loss of signal due to obstacles such as walls or floor levels. On the other hand, there are solutions for indoor locations which include technologies such as Bluetooth, Wi-Fi, and RFID among others. These technologies can be found in almost all current mobile devices. Among these technologies, Bluetooth stands out due to its low energy consumption and the feature Direction Finding that is included in Bluetooth 5.1. This feature allows the equipment to determine the direction of a signal through different methods such as Angle of Arrival (AoA). The use of this characteristic allows the development of accurate indoor location applications based on Bluetooth.

Although the different technologies mentioned above have good performance in specific environments, the use of position-based applications is not restricted to a single scenario, so it is necessary to have a system that can give an accurate location regardless of where the user is. A hybrid Positioning System (HPS) is presented as an alternative to cover this need. HPSs make use of two or more technologies to obtain a more accurate position estimate. In this work, the possibility of using GPS and Bluetooth direction finding based on AoA as components of a HPS is studied, for which different methods are investigated and tested to combine the position estimates given by the components of the HPS and thus, obtain a better estimate of the final position in indoor-outdoor scenarios.