Enhancing the Localization Precision in Aircraft Parking Areas of Airports through Advanced Ray-Tracing Techniques

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Abstract. Parking areas in airports where the aircraft is loaded, refueled and boarded, present a high risk of accidents due to the large number of vehicles and people involved in the handling activity. For airport ground surveillance, different technologies are deployed: Radar, CCTV, GPS and Trilateration systems. All these solutions have important limitations when are using for surveillance in apron and stands areas near the terminal buildings. To solve this problem, we propose new algorithms for localization based on fingerprinting techniques that, using the available WLAN infrastructure and the ray-tracing multipath information provided by newFASANT simulation tool, allow increasing accuracy and safety in outdoor areas of the airports.

1 Introduction

Several surveillance technologies are deployed to achieve the main objective of the airports: to provide a cost-effective and efficient operation to deliver high-quality service to customers while also ensuring their safety. To detect approaching airplanes in flight, primary radar is used, while for ground surveillance, cameras, GPS, surface radar, ADS-B and trilateration systems are deployed. The ultimate goal of these systems is to improve the efficiency and the safety of airport operations. However, in the apron and stand areas near the terminal building, while the risk of accidents increases due to the large number of vehicles and people involved in the handling activity, the current surveillance systems do not
provide adequate target localization. In this work, a new outdoor localization technique based on the signals available from the wireless devices [1] that comprise the Wi-Fi standards is presented. The localization process is done by using the fingerprinting technique [2][3]. In comparison with other techniques, such as angle of arrival (AOA) or time of arrival (TOA) that present several challenges due to multipath effects and non-line-of-sight (N-LOS) [1], the fingerprinting technique is relatively easy to implement. As cost function used inside the new fingerprinting algorithm developed, we use the information about the relative delay between rays provided by the new FASANT simulation tool. The main advantage of using the ray-tracing information is the multipath effects derived from the multiple ray-order reflections and diffractions produced between emitter and receiver [4]. Combining this technique with different similarity metric measures and with an interpolation algorithm the accuracy of the localization is increased.

2 Ground Surveillance in Airports

Apron and aircraft stand areas near the terminal building are not sufficiently protected in terms of surveillance. There are currently three normalized types of radar technologies involved in airport surveillance. The basic radar is the primary surveillance radar (PSR). PSR is a passive system because it only indicates the presence of aircraft without any information about aircraft identification. The secondary surveillance radar (SSR) is a collaborative system because the detection does not depend on the size of the object reflected, but on the response from a transponder on the aircraft. This transponder operates in a combination of transmitter-receiver mode enable of responding to the ground interrogation system to identify the plane. The passive radar is the surface movement radar (SMR). It is used to provide aircraft identification to the controller in low visibility conditions. A new radar technology for surveillance is the microwave sensor (MWS). The millimetric wave sensor (MWS) is collaborative radar that provides good target resolution in apron and stands areas but a high cost.

Conventional radar solutions do not provide coverage in apron and stands areas due to difficulty to discriminate the aircraft false detections and the corresponding to non-aircrafts (cars, trucks, trolleys, stairs). Figure 1 show the coverage provided by means of conventional radar in Madrid-Barajas International Airport. Only runway and taxiways areas (green colour) are covered by radars while apron stands areas are not under radar surveillance (yellow and magenta colors).

Alternatively, surveillance by means of television cameras in outdoor environments is a challenge due to incidence of sunlight on the lens (Fig. 2). Configure the layouts also requires expensive dedicated hardware such as Barco or Jupiter providers. GPS is another solution commonly used for fleet localization near the terminal building in airports. Three are the main problems with GPS: lack of satellite coverage, the different sources of error and the high cost for enhancing precision. Altogether GPS sources of error sums up to an error of ± 15 meters. Corrections mainly reduce ionospheric effects, but also improve orbits and clock errors. The overall error will be reduced to approximately ± 3 - 5 meters. GPS signals can