Bayesian Filter to accurately track airport moving objects

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Moving from human based operations to machine-based systems is a global trend

Introduction

Existing systems for the monitoring of surface movements

Higher level of A-SMGCS

Acoustic detection can help to avoid collisions

Target location and tracking proposed method

simulation

Congestion in airports complicates surveillance, and lead to delays caused by worriment

Ground surface movement present a variety of scenarios with conflicting objectives: security requirements/ operating pressure

Most incidents and accidents are humain related
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Reducing direct human involvement in airport ground movement is a safety benefit

The complete ground traffic automation system remains a subject of controversy

UAVs and UGVs are predicted to play an important role in air transport, however, no safeguards exist to facilitate the safe operation
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Cooperative targets are equipped with a transponder that communicates its precise location to the surveillance system.

Non-cooperative targets do not communicate with the surveillance system.

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ADS-B system the aircrafts automatically broadcast their flight information to the other ADS-B capable systems

MLAT system consists of a set of antennas installed in the operational area that broadcast query signals to the airspace

No detection of unequipped vehicles/aircraft
non-cooperative technologies systems

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SMR based on the transmission of radio frequency signals that are echoed by moving objects/No Identification

Magnetic Sensing allows detecting the passage of ferromagnetic objects/ Cost

Image-based tracking system designed to use cameras in order to detect moving objects / Occlusion, misdetections
Considered as the most promising way to achieve the necessary shift

It is difficult to provide a reliable coverage in all the airport areas without increasing costly ground infrastructure
potential hazards for manned or unmanned aircraft.

Wide list of possible applications for UAVs on airports

non-cooperative system must be established to facilitate the detection

acoustic sensing may be used to serve such a purpose in Aerodrome Traffic Zone
If noise is the first warning sign of danger, then acoustic detection can help to avoid collisions.

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Introduce a system able to act as a “gap filler” for the airport zones that traditional sensors fail to reliably cover.

Recent years have witnessed the deployments of wireless sensor networks for many critical applications.
Locating methods in sensor networks can be classified into geometrical or statistical location.

Random components such as environment characteristics, position of sensors and the behavior of a target, therefore we tend to analyze the problem from a more statistic point of view.

Method to Determine the trajectory of a moving object by applying a Bayesian filter to the measurements taken by the sensors.
Based on Energy: the sensor that has received a greater amount of energy will be elected as leader. The main advantages of this type of selection are its simplicity.

Tracking Based on Information: this selection of the leader is only based on information currently available.
\[ z = \frac{a}{\| x - \xi \|} + W \]

- **z**: sensor measure
- **a**: amplitude of the sound source
- **x**: target position
- **X**: sensor position
- **W**: gaussian noise

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The estimator by using the minimum mean square error

\[
\hat{x}^{(t)} = E\left[ x^{(t)} \mid z^{(t)} \right] = \int x^{(t)} p\left( x^{(t)} \mid z^{(t)} \right) dx^{(t)}
\]

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Figure 1. Tracking of two parallel paths
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Figure 2. Tracking of two diverging paths
Conclusion

• The simulations have shown that the proposed tracking algorithm can provide trajectory estimation without significant losses.

• acoustic sensing may, in fact, be a viable technology to establish a non-cooperative system.

• However, results regarding the ability of the system to localize and track detected targets are still required before any definitive conclusions can be made.
Be careful out there!

Questions