Self-contained Infrastructure-less Tracking of Assets

Daniel Lissner, Santanu Guha

WISe MANet Labs, University of Memphis

Abstract: We present **“Auto-Track”**, a self contained infrastructure-less tracking system. The need to protect high value items and expensive assets against theft has ushered in the development of numerous tracking systems in recent years. These tracking systems are either dependent on GPS or some citywide infrastructure like cell phone towers to provide them with the item location. Tracking in these systems is primary based on frequent item location updates and hence loss of GPS connectivity or GPRS signals renders such systems inoperable. Such loss of signals can be accidental or intentional. Travelling through urban canyons or no coverage areas often result in loss of GPS connectivity or the cellular network. On the other hand intentional signal losses are mostly attributed to modern day burglars who often put stolen items in bags wrapped with aluminum foil, or boxes coated with electromagnetic shielding dyes to create a Faraday Cage. The Faraday cage blocks the item location update mechanism jeopardizing the entire tracking process. Another weakness of the existing tracking systems is the limited active life span which is about a week without recharging. Law enforcement agencies often prioritize cases of assault and homicide over burglaries making the one week life time of existing tracking units insufficient to recover stolen items. The “Auto-Track” system takes into consideration a strong adversarial model and addresses both the issues stated above. Auto-Track consists of two modules namely the tag node which acts as the tracking unit and the base station. Tracking is accomplished using a combination of inertial sensing and map matching using Hidden Markov Models. Assuming that the stolen item is driven in a car, our inertial sensors consisting of a 3 axis accelerometer and a 3 axis gyroscope approximates distances travelled on a road segment and the turning angles respectively. To eliminate the integration drift bias we have modeled the measurement and process noises as Gaussian and applied Kalman Filtering on the raw sensor values. The filtered estimates are then transferred to the base station using GPRS, where they are fed to a Hidden Markov Model which converts the estimates to probable roads traveled in the city map. Finally we use the Viterbi algorithm to obtain the actual route taken. Since the tracking is based on inertial sensors, electromagnetic shielding doesn’t affect the system. When the GPRS radio is blocked, the system simply stores the distance and turns estimates in its local memory. At the final destination when the asset is removed from the shield the GPRS radio gets a location fix and transfers the stored inertial estimates to the base station along with the approximate location. The entire track is then retrospectively calculated at the base station yielding even the burglar’s hideout spots during commute which may be potential rendezvous points for the crime nexus. Since the Auto-Track system doesn’t rely on power hungry GPS or frequent radio message exchanges with any deployed infrastructure significant amount of energy is saved prolonging the lifetime of the tracking unit for a successful asset recovery.