TARGET TRACKING BY USING SEISMIC SENSORS

PROJECT PROPOSAL

GROUP NAME: BG_S3

SPONSOR: ASELSAN

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PROBLEM DESCRIPTION

In this project, we intend to provide an approach to the problem of motion tracking, which has a wide range of military applications. The study of this problem is based on signal processing and analysis, which suits our way to solve the problem of position determination over a field using by means of wireless sensor networks. Seismic sensors provide a reliable sensing solution to the problem of real time object tracking by analyzing the waves the source signal object generates while it moves over the ground.

OUR SOLUTION APPROACH

The aim of the system we are going to develop is to provide the route of a moving object within an area using previously deployed geophone seismic sensors. The system will be composed of:

- a wireless geophone seismic sensor network,
- seismic detection and target tracking algorithms implemented and embedded into these sensors,
- a Sensor System Simulator implemented and integrated with the real sensor network.

A geophone is an entity in contact with the ground surface which transduces its movements into electrical signals and sends them to a card[1]. The geophones provided will be supplied with a processor card with the wireless communication unit integrated and a programmer.

The seismic detection algorithm on real sensors will be provided as a pseudo code algorithm from the sponsor company, ASELSAN. The aim of this algorithm will be sending an alarm signal to the control center using wireless communication once the detection is performed.

The target tracking algorithm development is the core part of our system. A model to track a maneuvering target in accelerating motion will be proposed to describe various target motion patterns. To implement this model, improved versions of Kalman filter will be used to estimate the state of the moving object.

The Sensor System Simulator will be GIS based. GIS (Geographic Information System) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographically referenced data[2]. The simulator will accept sensor position values, target route (waypoints), calculate the route of the target using the sensor inputs and the implemented target tracking algorithm and finally evaluate the performance of the algorithm with the original route.

MARKET RESEARCH

There are a lot of publications about target tracking with wireless sensor network[3][4]. But we could only find one product available in the market for tracking moving objects with seismic sensor network.

The producer company is Alpha Tech Inc.[5] . Alpha Tech also published an article about how the company used Kalman Filter algorithm for predicting path information[6] .

Our case is very similar to Alpha Tech's. But even though our software's algorithm will be based on Kalman Filter, we will use pre-processing techniques on data before using Kalman Filter. The simulation of the target tracking is another difference between our and Alpha Tech's product.

DETAILED PROJECT DESCRIPTION

In this project, a path tracking system for a target moving in a field covered with distributed seismic sensors will be implemented. The system will work for a single moving target as a first step. In later phases, the system will be extended for multiple moving targets.

The intruder detection algorithm for seismic sensors will be implemented. The algorithm will be provided by the sponsor, Aselsan.

The path tracking algorithm for a single moving target will be designed and implemented. For the path tracking algorithm, Kalman filtering will be used. The algorithm will be embedded in all the seismic sensors in the area.

A simulation environment for testing the algorithm will be developed. The simulation will be used both as a test and a simulation environment. The simulation environment will be given the real route of the target and the seismic measurements as inputs. It will then calculate a route by using the path tracking algorithm. Finally, it will check the similarity of the real route and the route generated by the algorithm. The algorithm will be extended for supporting multiple moving targets simultaneously. The system will not identify the different types of moving objects.

Seismic sensors and measurements from seismic sensors will be used as hardware parts of the system. The seismic sensors have the capability of communicating wirelessly among each other.

Java will be used as the main software technology throughout the project. For the connection and programming interface of the seismic sensors, java libraries provided by Aselsan will be used. The

path tracking algorithm will be embedded in all of the seismic sensors in the system. The simulation environment will be implemented by using java libraries of NASA, provided by Aselsan.

Due to the uncertainty an unpredictability of real-world objects' motion, the tracking algorithm will need to be extended to adapt to changes of velocities and directions of the moving target. Moreover, the energy consumption of the tracking algorithm has to be considered because of the inherent limitations of wireless sensors. Recognition of the type of the moving target and tracking of multiple targets are the tentative extensions of our target tracking algorithm.

At the end of the project, the end product will be software that can be used to predict and simulate the path of a moving object by processing the data coming from seismic sensors.

The tracking algorithm of the software will be tested by comparing the real path and predicted path. The testers using GPS devices will move randomly between specially placed seismic sensors and the path obtained from testers' GPS devices will be considered as real path. The difference between the path obtained from GPS devices and the algorithm will be presented as a criteria of success of our algorithm.

If the project is successfully completed, it will be used by Turkish Company ASELSAN[7] . Possible scenarios for the usage of this product are border control, battle field surveillance, traffic flow measuring, or animal monitoring, etc.

PROJECT WORK PLAN

The work plan of the project is described below in the form of a Gantt chart.

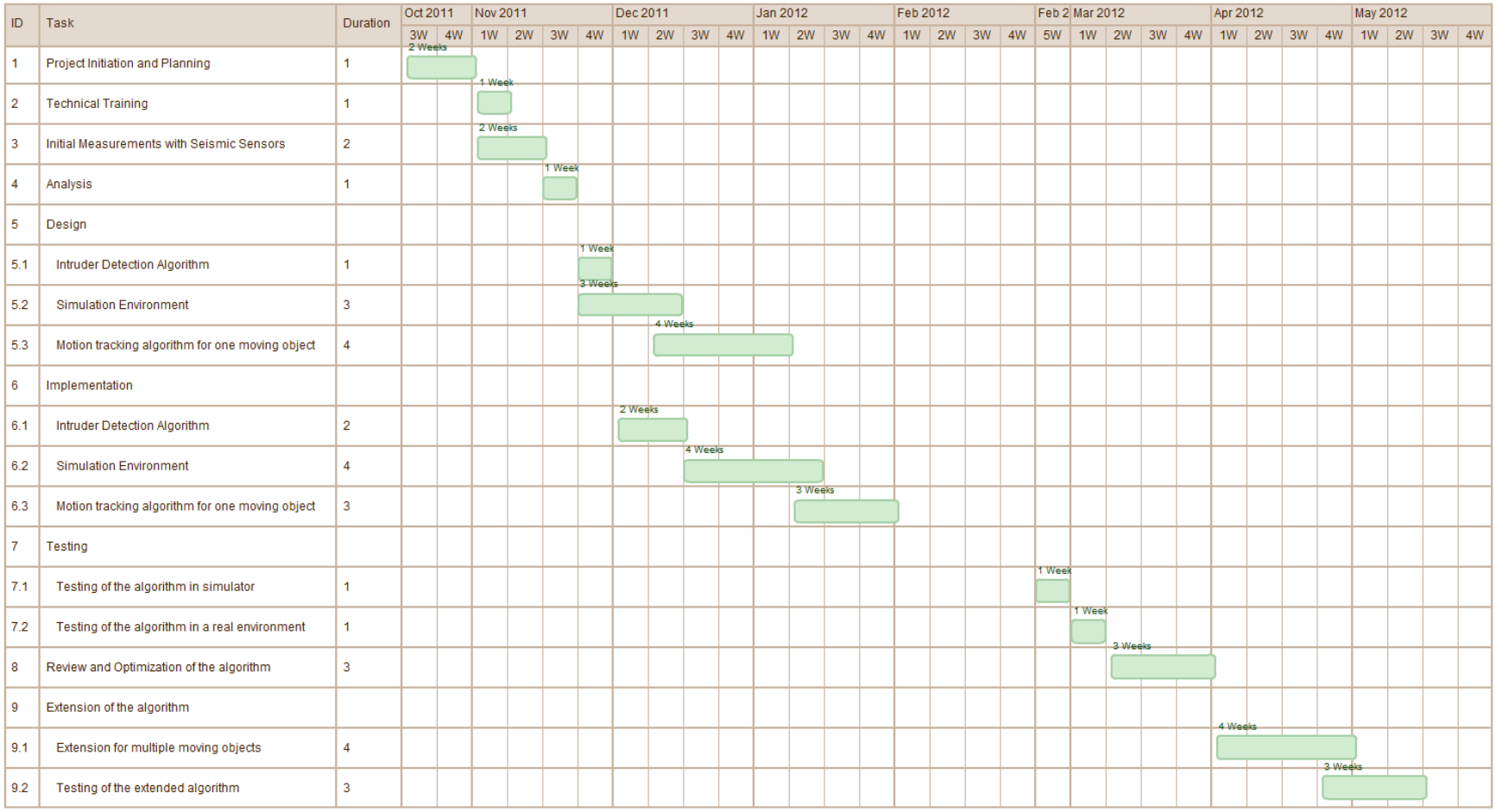

Figure 1: Gantt chart of the work plan

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