Knowledge Assistance for Ground Target Tracking and Resource Management

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Abstract— **Tracking slow moving ground targets from airborne phased array radar is a challenging task. Some of the major issues are heading accuracy of slow moving target and radar resource management in clutter regions. In this paper, we propose a novel tracking framework using digital map and clutter knowledge bases to efficiently track the ground moving target using airborne phased array radar. The proposed technique uses offline processed digital map for fast retrieval of road parameters. Also, the proposed radar data processor provides feedback to populate and update the clutter knowledge-base. A fast yet robust method is employed for ground mapping of targets and to detect map features such as road junctions. Experimental results show (i) the robustness of the map knowledge assisted tracking approach when target moves along different kinds of path (i.e. on/off the road) (ii) better heading accuracies achieved by knowledge assistance and (iii) radar resource management in clutter region with knowledge-base.**

***Index Terms*—Knowledge Based System, Constrained Tracking**

I. INTRODUCTION

Effective radar data processing is one of the crucial tasks in radar system. In response to increasing severe threats, radar surveillance with aided knowledge has become essential. Capraro, *et al.* [1] has presented a tutorial overview of Knowledge Based (KB) radar signal and data processing techniques, involving ground correlated map data for performance enhancement. Work by Garren [2] discusses trends and techniques for ground target tracking and mentions challenges involving high clutter, manueverability, low visibility due to terrain etc.

On the ground, target movement is in fact locally constrained by roads and other ground obstructions. In such scenario, the tracking algorithm needs to be improved by fusion of ground pre-knowledge and by applying constraints on the target positional parameters. In KB systems with available ground map, tracking of a moving object continuously requires mapping of target coordinates followed by detecting map features such as road junction. In [3] road constraints are implemented in filter by imposing relationship between the state variables whereas, cubic spline curves are used to approximate the target motion constraint in [4]. One of the most popular approaches for incorporating knowledge about ground map within the filtering framework involves use of multiple models (Kastella [5]). Work by Kirubrajan [6] has provided detailed description of variable structure interacting multiple model (VS-IMM) algorithm for tracking.

Although inclusion of road information into tracker has been proven to be successful, the availability of detailed information about ground poses a challenge. *Usually, the raster maps or the digital maps contain information about road, river, state boundaries etc. but details such as road junctions, visible area, clutter regions etc are not directly available from map. In order to overcome the above limitations, in this paper, we employ a grid based technique to obtain features such as road junction.*

Another challenging task with slow moving target tracking is to obtain good heading accuracy. *In this paper, we have incorporated road's direction as one of the input measurement, simulation results show that heading accuracy improvements are obtained.*

In case of ground moving target tracking, a major challenge lies in clutter handling, involving determination of clutter region, efficient radar resource (time and energy) utilization in the region and finally building knowledgebase for clutter. In this paper we propose a simple and efficient method to determine clutter regions and provide it as feedback to update the knowledge-base (KB) and handle track data differently in clutter and non-clutter regions.

The paper is organized as follows. In Section II, we explain pre-processing of the digital map which involves partitioning into grids, identification of junction points, and a novel scheme for updating the KB on data processor feedback. The assistance of map information in tracking to improve heading accuracy is described in Section III. Scheme for radar resource management in clutter region is devised in Section III. Section IV provides the experimental results and finally, Section V concludes the paper.

II. MAP KNOWLEDGE ASSISTANCE

The proposed constrained target tracking is based on the assistance from the digital map and requires map pre-processing that consists of (i) grid partitioning, followed by (ii) identification of road junction. The clutter knowledge base is updated in real time based on feedback from data processor. Various blocks of the proposed scheme are depicted in Fig.1.

A. Map Pre-Processing : Grid Partitioning

The choice of partitioning digital map into grids allows efficient identification and retrieval of road junction related information. In our work, we use digital map of the area in