IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 8, August 2016

Movement Detection of Target in Wireless Sensor Network

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Abstract: Target tracking is one of the eye catching applications in wireless sensor network. The network employees the object tracking practices which track the affecting target when it moves through sensor network. Existing work mostly involves face tracking edge detection algorithm which tracks the movement of target in timely fashion. In this paper, we propose a new tracking framework, which involves prediction and detection of the target in a face. Here "Kalman filter" is introduces which is used to predicts the objects location individually in a face and "Face Tracking Framework" for target detection. Kalman Filter is capable of tracking a target with high resolution in the presence of compromised or colluding malicious beacon nodes. Face Tracking employs, the nodes of a spatial region surrounding a target, called a face. Edge detection algorithm is used to generate each face further in such a way that the nodes can arrange onward of the target's moving, which helps tracking the target in a timely basis and recuperating from special cases, e.g., sensor fault, loss of tracking. Also, optimal selection algorithm is used which select the sensors of faces for enquiry and to acceleration of the tracking data. Simulation results, compared with existing work, show that new tracking methodology achieves better tracking accuracy and energy efficiency and effectiveness.

Keywords: WSN, target tracking, tracking techniques, Tracking methods, face tracking

1. INTRODUCTION

Wireless Sensor network (WSN) is a sprouting technology with great potential to be active in criticalsituations. Providing reliable and precise information of the environment in which the sensors are installed is the main objective of Wireless Sensor Network.The inauguration of development of wireless sensor networks is military applications like battlefield examination. However, Wireless Sensor Networks are also used in many areas such as Manufacturing, Resident, Health, Territory Monitoring, Environmental and Military, Home and Office application areas, tracking targets of interest. Moving target detection and tracking is more noteworthy application for sensor networks when it moves through a sensor network. Wireless sensor network technology make it possible to implement the wireless sensor network (WSNs) in anunevenness of circumstances because of its continuous assessment [1]. In WSN occurrence of interest is tracked by tiny sensor nodes deployed in a physical environment. The sensors nodes deployed in the surrounding area of the target have ability to monitor it and report back to the sink. A sink sensor node connects with outside world such as workstation, base station. Sensor nodes which plays a vital roles in traffic control, pitch, region monitoring and intruder tracking in recent years [2]. Maintain the equilibrium between energy, bandwidth and overhead. In this target tracking application, sensor nodes turns an active when they sense the moving object otherwise they will be in inactive mode. Sensor nodes has conserve energy when they are in inactive mode and as sensor nodes operate on limited battery power, energy usage is a very important concern in a WSN [1]. The purpose of this paper is to track the moving target with high accuracy, efficiency and effectively. Achieving high accuracy with energy efficiency is challenging task in WSN because of below mentioned difficulties [3].

- Forming groups of nodes with precise measurements of a target's movements is difficult, as WSNs are impenetrable/thin, unattended, untethered, and deployed in usually random environments.
- Gaining accurate target localization is impossible in a real operation field, because different kinds of noises/disturbances are added during detection.
- Nodes operations maintenance i.e. turning their services off most of the time, and enabling only a group of nodes in a timely fashion is difficult.
- Loss of tracking or node failure is often possible, since WSNs are prone to fault or failure [3].

Contributions of this paper are as follows:

- We develop Kalman filter that predicts moving target location with high resolution.
- We design Face Track that detects the movements of a target using polygon (face) tracking, motivated by the planar zed algorithm, which does not trust on any global topology.
- We develop a brink detection algorithm that permits the WSN to be attentive of a target entering the polygon a bit earlier, and to work in a timely fashion.
- We formulate an optimal selection algorithm which reduces number of active sensors by selecting couple nodes [3].
- We evaluate the performance through simulations and comparing with existing solutions[3].

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2. PRELIMINARIES AND MODELS

In this section, we first present the objectives and then, we briefly discuss the preliminaries and introduce the system models.

A. Objective

The objective of this paper is to design Face Track with Kalman filter prediction to achievean efficient and real-time tracking through predicting and detecting the movement of a target using faces tracking.

B. Assumptions and Notations

Some of elementary assumptions are as follows:

- The mobile target (event) that is of interest is sensedand optionally observed by a WSN is acoustic signal.
- Sensors are assumed to be homogeneous.
- All nodes are synchronized and follow a state transitionpolicy to be active/inactive.
- Assumed that WSN having some defective/impaired nodes.

This assumption is made becausethe target does not carry any form of classification, nor can any different target be distinguished.

Table 1 gives the mathematical notations that are used during this paper.

TABLE I. MATHEMATICAL NOTATIONS

Symbol	Description
Pc	Active/ current polygon (where the target is now in)
Pf	Future polygon (where the target is moving to)
Pi	Number of neighboring polygons of the node
PN	The number of sensors node in the polygon
NN	The number of neighboring nodes in the polygon
ON	The optimal number of sensor nodes
CN	Couple nodes
D	Brink length

3. DESIGN OF KALMAN FILTER AND FACE TRACKING

First define how the Kalman filter works for predicting the target, polygon localization in Face-Track detection. Then, we explain our brink detection algorithm and optimal node selection algorithm.

A. Target Prediction using Kalman Filter

The Kalman filter is nothing but the set of mathematical equations that provides an effective computational means to guesstimate the state of a process, which minimizes the mean of the squared error. The Kalman filter is used to estimate past, present, and future states. It can useful when the nature of the modeled system is undefined. Mathematical equations used in Kalman filter are predictor-corrector type estimator. In prediction state, one step ahead time estimation is taken and In correction stage, updated measurement is taken where the correction happened [4]. Kalman filter design are divided into two groups 1. Time update equation and 2. Measurement update equation. The time update equations are accountable for calculating forward (in time) the current state and error covariance estimates for next state. In measure update equation firstly compute the Kalman gain. After each time measurement is updated and update the error covariance [4].

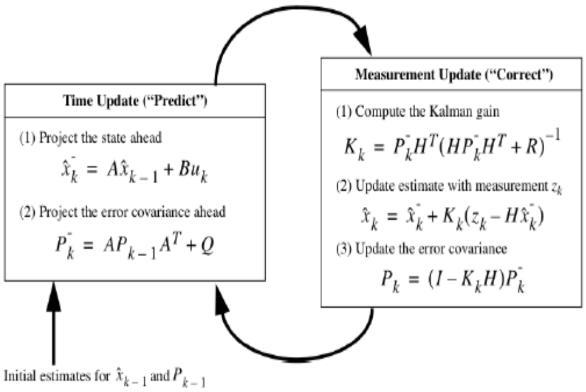

Fig 1: Kalman filter design

B. Localized Polygon

To identify the target moving path we used polygon. Polygon should be self-overlapping PN is the number of nodes in a polygon PN= (v1, v2, v3….vp) where p >=3. If target is detected by a node present in polygon P7 means P7 is active polygon and node v5 who detected the target is active node. Polygon shape can be triangle, square, rectangle or pentagon. When target moves from active polygon to adjacent polygon then that polygon is called as future/forward polygon. Active node keep information of its adjacent nodes, active nodes and adjacent polygon i.e. P2, P3, P4 and P7. Adjacent node that corresponds the active polygon is called immediate neighbor. In this case v4 and v11 are immediate neighbor. Here v5, v4 and v11, v5 are couple nodes CNs. In this way edge is identified which will cross by active target.[3]

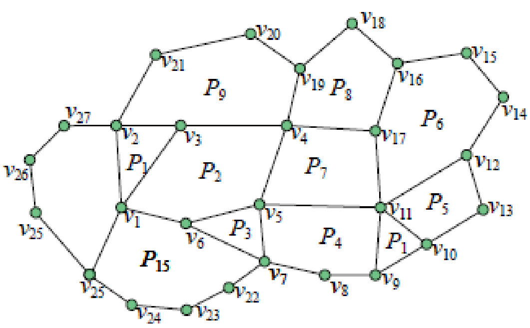

Fig2: Localized polygon in sensor field

C. Brink Detection Algorithm

After edge detection algorithm, brink detection is carried out which is usedto reconstruct another conceptual polygon, called a criticalregion.Blink detection is carried out in three phase

 DOI 10.17148/IJARCCE.2016.5881

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Square detection phase: - In this phase the target ispreliminarily detected by any two nodes inside active polygon but does not guarantee that the target may cross thebrink/edge between them. [3]

Rectangular detection phase: -In this phase targetmay cross the brink between the nodes.
Crossing phase:-In this phase target is about tocross the brink between the nodes.

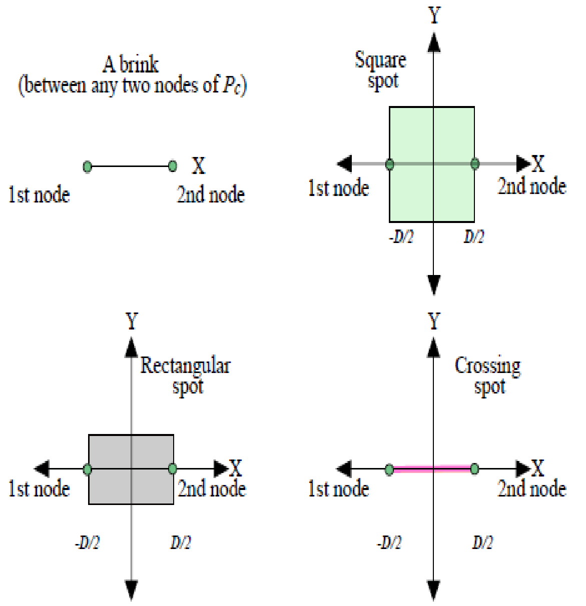

Fig 3: Brink detection phases

D. Optimal Node Selection Algorithm
An optimal number of sensors required in tracking a target in the network to aggregate data among the sensors. In Face Track, among the available sensors in a polygon, only some of them are providing useful information which improves the accuracy. If the number of active sensors in a polygon are large in a number, then we need to minimize the number of active sensors to achieve the accuracy. After the formation of brink between the CNs, the nodes enquiry and send a message to all of the neighbors (NNs) that resemble to the future polygon.

The message is full of the target estimation and sender information. However NN receives the message, they combines own measurements of the target with the CNs' estimation. Each NN calculates its weight and checks whether it is about to be a CN. After that the NN responds to the previous CNs via a bid (e.g., ID.).

When a node detects the target, it sends the bid to its immediate neighbors and also receives a similar bid from the neighbors if both of its immediate neighbors detect the target. Then, the node give rank by comparing the weight of the bids with its own bid. Locally they will decides whether they should connect in tracking, or remove from the tracking. In this way, we can select the best nodes on the target's target moving path as the CNs [4]

4. MOVEMENT DETECTION THROUGH POLYGONTRACKING

This section provides the overview for target detection using polygon tracking method.

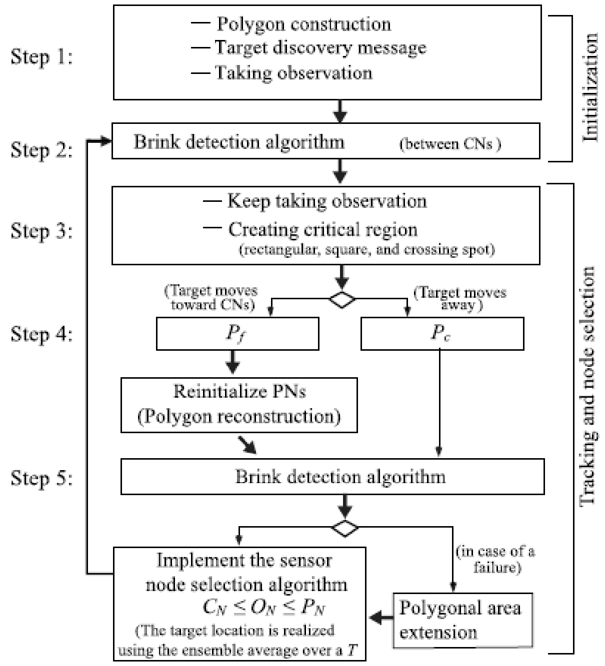

Fig 4: Face tracking flow chart

Polygon tracking process consist of 5 steps in framework. Step 1 and 2 are about the system initialization and step 3,4,5 are about the tracking and node selection. Initially all nodes in the WSN are in a low-power mode i.e in OFF status and wake up at a predefined period to carry out the sensing. When the sensors are involved in tracking then it is in active mode.

When it awake for a shorter time period, the state is awaking. When sensors are not involved in tracking activity then the sensors are in inactive mode [3].

In the starting, when a target is detected by somenodes, the nodes interconnect to all of its adjacentneighbors with their detection information, andrecreate the polygon (Step 2). Once the target is encircledby the perimeter of a polygon, it becomes active polygon Pc. Steps3 to 5 carried out including brink detection through the three-phasedetection, optimal sensor selection, and polygonal areaextension in the case of faults present in the WSN[3].

A joint-request message is sent to Pf forward polygon at the moment the target touches the rectangular phase, saying that the target is approaching and all NN changes the state to awaking and start sensing. When target crosses the blink another joint message has sent saying target is crossing the blink. After crossing the blink sensors are in inactive state and joint message has sent saying target has crossed the blink. In this way target is tracked. [3]

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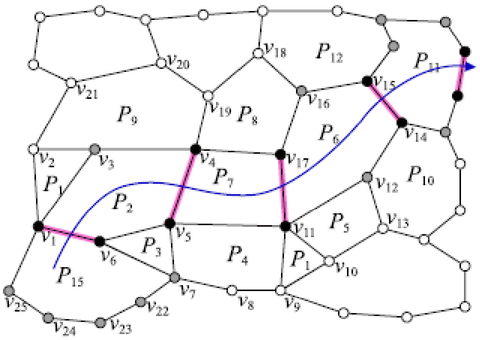
Fig 6: Path detected using Blink detection

5. SIMULATION RESULTS

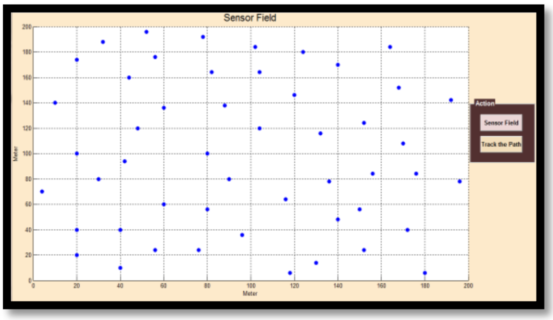

Fig7: Matlab created sensor field by giving position to sensors nodes

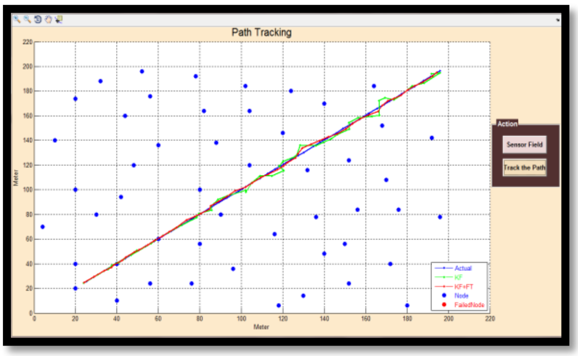

Fig8: Matlab created predicted and detected path of the target

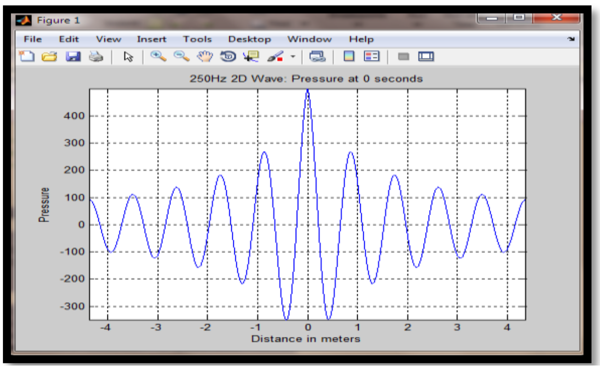

Fig 9: Matlab created 2D acoustic target which moves in sensor field

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