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EFFICIENT TRACKING AND SECURITY ENHANCEMENT IN UNDERWATER WIRELESS SENSOR NETWORK

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ABSTRACT

Underwater sensor network consists of a number of underwater sensor nodes, autonomous underwater vehicles (AUV) that are deployed to perform collaborative monitoring and resource exploration tasks over a given area. But submarine detection and tracking referred to as anti-submarine warfare (ASW) is one of the most important application. In ASW system port-starboard (Ps) ambiguity is the most challenging issues which cause severe performance degradation. In the Bayesian approach, the dynamic state estimation is used to construct the posterior probability density function (pdf) of the state based on all available information, including the set of received measurements. Since this pdf embodies all available statistical information, it contains the complete solution to the estimation problem, and the optimal estimate of the state may be obtained from the posterior .the data from the sensors are not identically distributed as each sensor has its own location/ orientation with respect to the target, which can be time varying, this characteristics a key feature to solve the Ps ambiguity. The contribution of the proposed work in three fold by using game theory; First, Efficient target tracking with security enhancement, Second, prolong the life time of wireless sensor network by reducing the power consumption, Third, Comparison of K^{th} parameter in Bayesian approach versus game theory.

Keywords: underwater wireless sensor network (UWSN), security issues, PS ambiguity, mean field game theory, ASW, AUV.

1. INTRODUCTION

In underwater domain most commonly used autonomous system for many applications because, the autonomous systems avoid the human presence [1]. Generally Underwater wireless sensor network consists of a number of underwater sensor nodes, Autonomous Underwater Vehicles (AUVs) that are deployed to perform collaborative monitoring and resource exploration tasks over a given area [2, 3]. AUV having the capabilities are Search and Recovery of Government Property, pressure and temperature, Pictures of visual light, bioluminescence, Discovery of never seen before species and footage. But most important application is tracking and detection of submarine in anti-submarine warfare [4]. Figure-1 shown about Active ASW systems are classified as monostatic and bistatic, the monostatic as opposed to multistatic systems [5], Acoustic waves are used to communication in underwater. then the single best solution for communicating underwater ,lower frequency 10hz lesser then that it's not possible to propagation of sound ,higher frequency 1mhz above are rarely used because they are absorbed very quickly and then buoy is one of the important hardware in my project [1, 2, 5, 6].

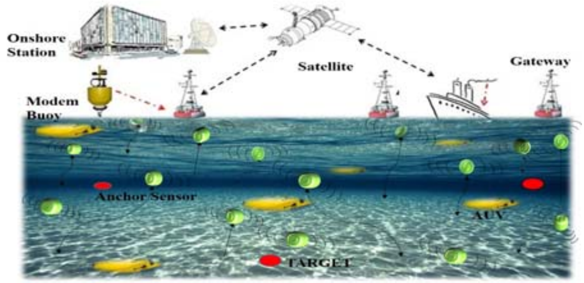

Figure-1. Mobile underwater ad hoc network.

Receiving sensor has limited onboard computational capabilities and therefore used linear arrays, single line array receiver are cylindrically symmetric. Because they cannot discriminate if a detected echo comes from the port or from the starboard (this problem is called as Ps-ambiguity), these ambiguity complicates the detection and tracking algorithms and they may cause severe performance degradation [7, 8, 9, 10, 11].

Tracker would always generate two trackers they are true one and ghost one; this is symmetric with respect to the array heading. In order to resolve the Ps ambiguity, some degree of diversity is needed to collected data because using antenna that antenna is Omni direction, that diversity are spatial diversity, time diversity. Time diversity can be obtained with single antenna array. Bayesian approach under particle filtering and mou etc…now purposed mean field game theory is used to find malicious node [12].

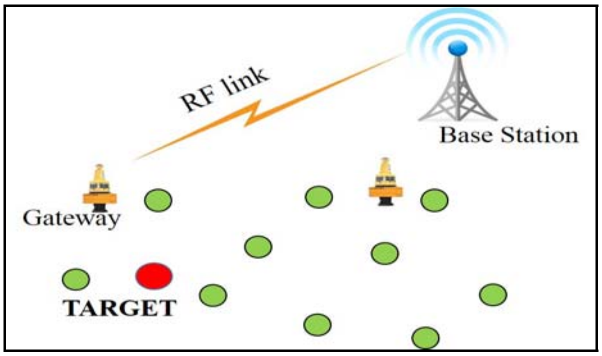

Figure-2. Single target tracking.

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Rest of the paper is organized as following: Section II describes the problem formalization, Section III describes proposed method mean field game theory, Section IV describes the simulation environmental, and Section V concludes the paper.

2. PROBLEM FORMALIZATION

In the ASW scenario considered here there is only one target of interest. However it is possible to have several target-like objects (e.g., large gross tonnage vessel, rocks, etc.) moving in the surveillance region. For trim notation we in this work assume only a single target, but the extension to the multi-target case is straight forward .Let us consider a WSN made of sensors monitoring a certain surveillance region inside which a single target is sailing[10].

A. Target tracking model

In this subsection we summarize the target dynamic model, see also more details in [5]. The target state is defined in Cartesian (North-East) coordinates and expressed in terms of a Markova process

$$X_K = F_K \left(X_K - 1.V_K \right) \quad (1)$$

Where $F_K\ (.)$ is in general a non-linear function valid for time K, X_K is the target motion state vector and V_K is the so-called process noise. The nearly constant velocity model in virtue of the typical target's behavior

$$X_K = F_K X_{K-1} + \Gamma^K V_K \quad (2)$$

Where F_K is the state transition matrix, $\Gamma^K V_K$ takes into account the target acceleration and V_K Gaussian with zero-mean and covariance matrix.

In Case-1

1D $X_K = \left[X_K \dot{X}_K \right]^T$ (3)

Where X_K is position of target and $\dot{X}_K$ is the velocity

In Case-2
2D,

$$X_K = \left[X_K \dot{X}_K, Y_K \dot{Y}_K \right] \quad (4)$$

Where $X_K \dot{X}_K$ is position of target and $Y_K \dot{Y}_K$ is the velocity

B. Measurement model for the PS problem

Let us now consider the model for the measurements originated by the target. In the presence of PS ambiguity, there are two measurements originated by the target, and the system does not know in advance which of these is correct. Accordingly, the measurement function has two output measurements,

$$\begin{cases} z_k^p = z_k, z^s_{k=g_k(z_k^p)} \\ z_k^s = z_k, z^p_{k=g_k(z_k^s)} \end{cases} \text{ if target on port, if target on starboard} \quad (5)$$

Where $g_{k(z)}$ is a deterministic function mapping the contact to its specular position with respect to sensor.

C. Detect the missing object

The data set $z_{s,k}$ of the whole measurements for the $s^{t,h}$ sensor at time k is defined as

$$z_{s,k} = \left\{ \left(z^p_{i,s,k} \right) \right\}_{i=1}^{m_{s,k}} \quad (6)$$

Where $m_{s,k}$ is represent as the number of measurements.

3. FIELD GAME THEORY

Mean field game theory is devoted to the analysis of deferential games with a (very) larger Number of small players. By small player, we mean a player who has very little influence on the overall system [12].

A. Attention upgrade for significance tracking

In the MFGT approach used to estimate state of the object by construct the posterior probability density of current information, it contains complete solution of existing problems. The *Pdf* provide optimal solution for Ps-Ambiguity.

$$\partial_{tm} - \frac{\sigma^2}{2} \Delta m + div(m \partial p H(t, x, \nabla v, m)) = 0(m/t) = 0 = m_0 \quad (7)$$

The mathematical structure of this system captures many features of MFG modeling. It is a forward-backward system coupling two PDEs.
Alternative way to identify the node behavior

$$Node\_BHR_i = \begin{Bmatrix} \text{"well-behaved"}; AN_i \le 0 \\ \text{"misbehaved"}; AN_i > MAN_i \\ \text{"accused"}; otherwise \end{Bmatrix} \quad (8)$$

The Maximum Accusation Number (MAN) of each node is updated, where MAN is used to determine the maximum allowed number of which node is characterized as a suspected. As the behaviors of monitored nodes are characterized, the Accusation Number (AN) of each node as updated accordingly [11, 12].

B. Security enhancement model

In proposed scheme having some of inbuilt capable such as individual decision making, and it as provide accurate mathematical model with multiple players. This approach can analyse the characteristics of every node in network. Each sensor node can identify the

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behavior of neighboring node by analyses the threshold vale of each node, the threshold values compute as,

$$T_H = 2E^{12} \quad (9)$$

And duration of packet receiving and sending rate, misrouting rate, packet forwarding rate, etc… [14, 15, 18]. After identified the malicious node meanwhile ignored the illegitimate node and rest of nodes are used for communication purposes.

C. Power consumption

In underwater wireless sensor networks consist of more no: of sensors deployed in underwater, if sensor have the low energy state it will takes more time to send information so delay as occurred .it as not possible to deployed the sensors within short period, in proposed scheme reduce the power feeding problem by using wake /up sleep method .In wake / up and sleep method as classified into three fold state are followed one as active state, second as passive state and finally sleep state. The proposed scheme as concentrate the power eating with help of two states such as active state and sleep state. But, more time a node as spends in sleep mode, there is chance to that corresponding node is to miss a transmission.

D. Diagram for proposed scheme

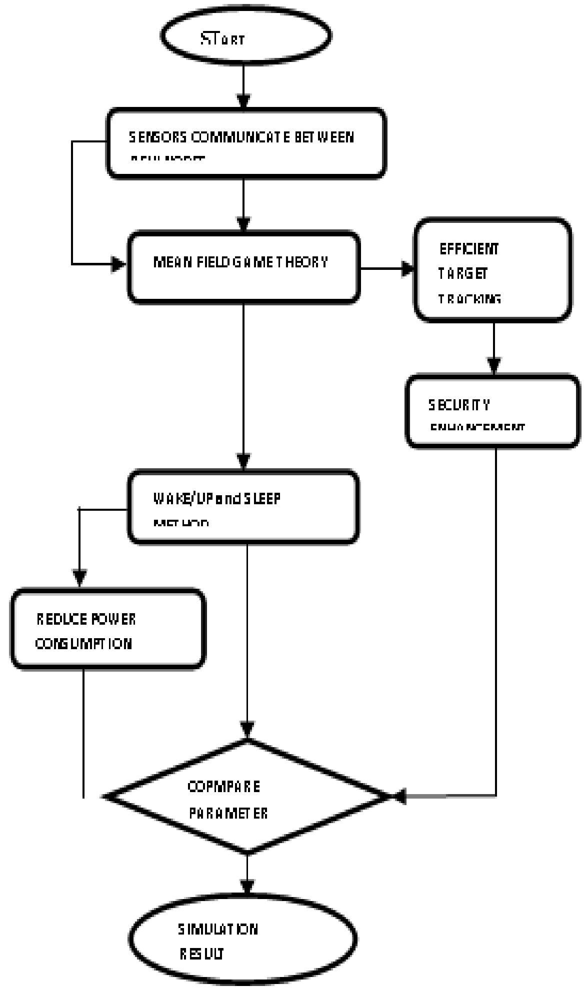

Figure-3. flow chart for proposed work.

4. SIMULATION ENVIRONMENT

Simulation parameters	Simulation value
Access Node	IEEE 802.15.4
No. of Nodes	40
Base Protocol	AODV
Algorithm	MFGT
System BW	2Mbps
Protocol Layer	Cross Layer Mac
Antenna	Omni Directional
Simulation Environment	1500*1500 m
Channel Propagation	Wireless/Two ray Ground
Improvisation	Energy Conservation

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A. Target tracking

Figure-4 shows target tracking in underwater WSN for missing object and monitoring of sea in given area for particle task and also measured the waves, current, pressure, temperature and etc.

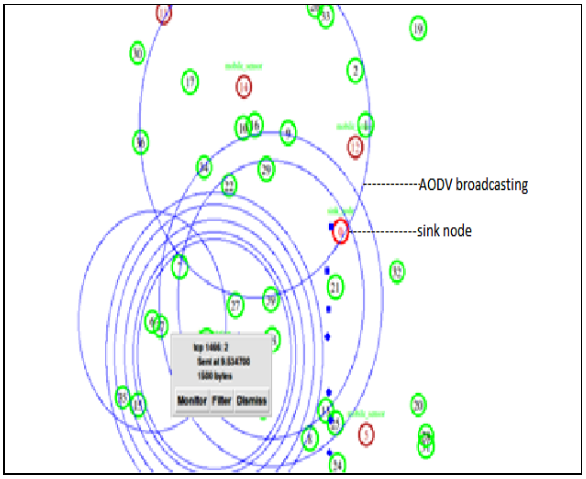

Figure-4. Target tracking in underwater WSN.

This figure consist of 40 nodes the coverage area is 400m each sensors having the range of 3.5m, sensors Are communicated through AODV routing protocol in two-way communication using Radio wave propagation. Nodes are send RTS to each individual nodes in 44 bytes and get CTS in 38 bytes. After got the acknowledgement from corresponding nodes it will establish the connection between two nodes and then send data packet through link. Green color node are defined as sensor nodes in network and maroon color are mobile range sensors red color as represent sink node and blue one as represent by base station. Sensors collecting the information about target detection and missing object regard the location.

B. Security enhancement

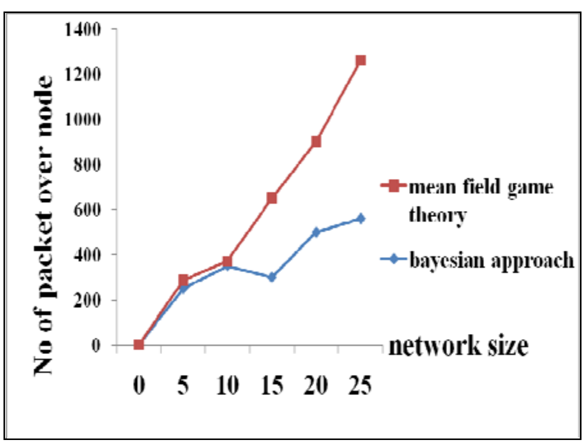

Figure-5. Security enhancement.

In Figure-5 shows the comparison of security issues between Bayesian approach versus MFGT. It as explain the security enhancement during data transmission about the target tracking location .in existing system, Bayesian approach is used to solve the Ps-Ambiguity problem but it as arise the security issues during transmit the information from one node to another node.

C. Reduce the power feeding of sensor nodes

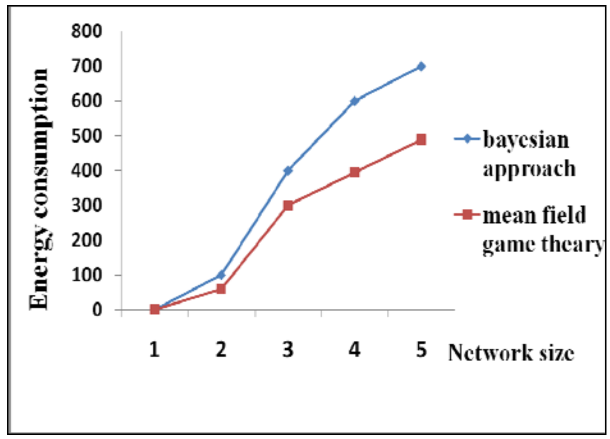

Figure-6. Power consumption.

From Figure-6 Shows comparison of power consumption between Bayesian approaches versus mean field game theory. Generally, security enhancement $\frac{1}{\alpha}$ power consumption in network and reduce the life time of sensor nodes .usually save energy by reducing communication burden, To prolong the life time of sensor by reduce power consumption using wake up/sleep technique, this technique using two state such as sleep and active state of sensor, using this way power consumption are reduce 25% compare to existing system.

D. Performance metrics

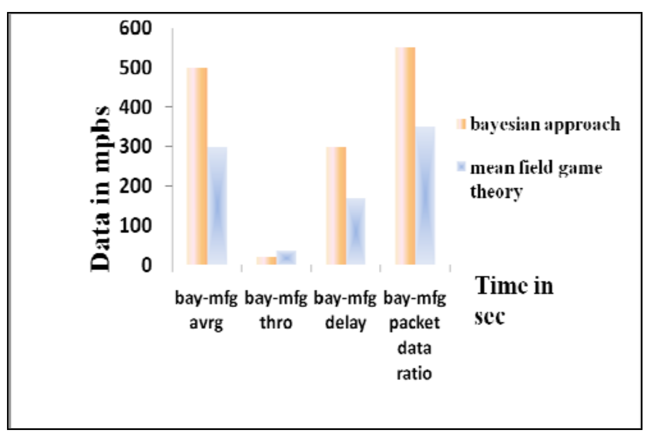

Figure-7. Peformance metrics.

Figure-7 Shows the performance metrics of K^{th} parameters such as throughput, average routing length data packet rate and delay. The result of throughput using MFGT in this proposed scheme ignore the malicious node and rest of nodes sharing the information to each other and this way to increase the throughput .it as expressed by,

$$\text{Throughput} = \frac{\text{data received} * 8}{\text{during transmission time}}$$

result of avgerage routing length that is used to detect the shortest routing path by reducing thenmalicious node and identification of node behaviour. packet loss ratio ,15% of loss is reduce by using mean field game theory compare to bayesian approach.The 7% of delay is reduced by using mean field game theory Bayesian:23% and MFGT:16%

5. CONCLUSIONS

In underwater wireless sensor network, the major problems are Port–starboard ambiguity and missed detection during anti-submarine warfare. To overcome this problem early days using Bayesian approach it was not fully rectified and also it introduces security issues. Generally the underwater wireless sensor consume more power so the lifetime of sensor will degrade In order to overcome this wake up/sleep is used to reduce the power consume .then the mean field game theory is used to improve target tracking without security issues and also compare K^{th} parameter in Bayesian vs mean field game theory .

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