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An Investigation on Data Fusion for Underwater Wireless Sensor Networks in Acoustic Routing

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Abstract: Sensor data fusion depends of the influence of noise and the ability of individual sensor measurements. Sensing radius is one of the foremost aspects which decide the data acquisition process. In the proposed work the depth based sensors in aquasim patch used with Network simulator-2. Spatial model is decided where at specific depth within the surface directional antenna are used to fast transfer based on the judgement of current sensed data and its prior sensed data. The changes of sensing ability and fusion of individual sensor is closely associated with the another sensor. Underwater Data fusion using Pearson's correlation coefficients had been proposed and validate through simulation.

Keywords: Pearson correlation, Networking.

I. INTRODUCTION

Underwater sensor there is a strong relationship between depth of sensors and its sensing ability. Aggregation tree in wireless sensor networks states the level in which data has to be fused and the tolerable errors. In [1], the influence of fusion process with the topological coordinates with need of synchronization is stated. The overall taxonomy has been classified as fusing raw data or priorly fused data and the influence on latency has been stated [1]. A consolidated work from data acquisition to data fusion has been stated in [5] with external and mobile sensors. The influence of data processing is highly elaborated as it depends on environmental condition and timing of sensors.

Spatially separated sensors which perform data fusion insist on transmitting the information to sink. The process is a sequential decision based on target time this had been discussed with target tracking application in [6]. In [7], Kalman filter based fusion strategy had been used to estimate the fusion process in target. The prediction and the level of covariance model used in data provided by feedback make results superior. In [8] the significance of particle filter in removing noise had been found to be superior compared to time of flight measurement. In this paper two sensors are paired and acquire data at same depth using Pearson correlation and its coefficient if positive relation is observed. Then in the subsequent hop sensory data is fused and transmitted with directional antenna to the sink. Alternatively, if a negative correlation coefficient is observed it waits for the next hop for data fusion.

The section two deals with data fusion and the tribulation faced. Proposed algorithm depicted in section 3 Section 4 deals with results of UDFPCC. Conclusion is stated in section 5.

II. RELATED WORKS

Some of the main challenges faced in fusion of sensor data is its imperfection, correlation and inconsistency. The reason for imperfection lies behind several factors such as incomplete data and uncertain data. The hindering factor leading to inconsistency is the outlier and conflicts involved in communication [2]. Reducing the sampling rate as per the noise covariance to achieve the desired target tracking has been achieved by fusion estimator in [3]. In [4] the process of achieving "measurement fusion" is entirely dependent on geometric fusion gain in a terrain and sensors. This process varies to that of tracking fusion [4] in the application of tracking fusion.

III. ALGORITHM

3.1 Underwater Data fusion using Pearson correlation coefficient (UDFPCC)

Different level of association between sensors with a terrain is done using Pearson correlation coefficient for

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sensing radius. Initially, the covariance is estimated with equation 1 below.

$$Cov(S1,S2) = \frac{1}{n}\sum_{i=1}^{n}(s1_i - \mu_{s1})(s2_i - \mu_{s2}) \quad (1)$$

In equation 1, the S1 and S2 denote the radii of sensing in a particular depth by sensor 1 and sensor 2 respectively. The mean of sensor radii 1 and sensor radii 2 is denoted as μ_{s1} and μ_{s2}. The independent nature of sensing of sensor 1 is associated with dependant nature of sensor 2. Pearson Correlation Coefficient is given by equation 2 below.

$$\rho_{(S1,S2)} = \frac{Cov(S1,S2)}{\sigma_{s1}.\sigma_{s2}} \quad (2)$$

The standard deviation is given by σ_{s1} and σ_{s2} respectively for sensor 1 and sensor 2. If Pearson's coefficient is positive then fusion is initiated. Else fusion is not initiated and waits for next pairing.

Sensor nodes design sends data to surface where sink is localized. So as in the topology fusion at horizontal depth and transmission at vertical depth has been used most terrains. Special nodes with directional antenna placed at specific point accumulate the fused data and communicate to sink.

IV. RESULTS

In every time frame in order to affirm the previously fused data is not fused iteratively we use directional antenna to send chunks of data to sink. Totally 75 nodes are used for analysis with 10 nodes incorporating directional antenna a maximum depth of 500m had been used with terrain area of 500 m^2. Demonstrating networking is done with Aquasim [9] supported by NS-2. Easily cope up with networking the situation Depth based routing [10], is taken and compared for results. Total number of sink used is 5 placed on the surface.

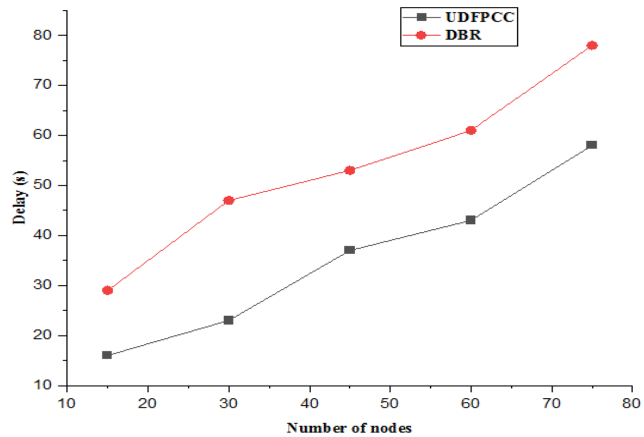

Figure 1. Total number of nodes versus delay.

Number of nodes	*UDFPCC(s)*	*DBR (s)*
15	*16*	*29*
30	*23*	*47*
45	*37*	*53*
60	*43*	*61*
75	*58*	*78*

Table 1. Trace file data of simulation with delay.

In figure 1, the delay plot is shown which is plotted is shell script and the numerical values are obtained with the trace file as shown in table 1.

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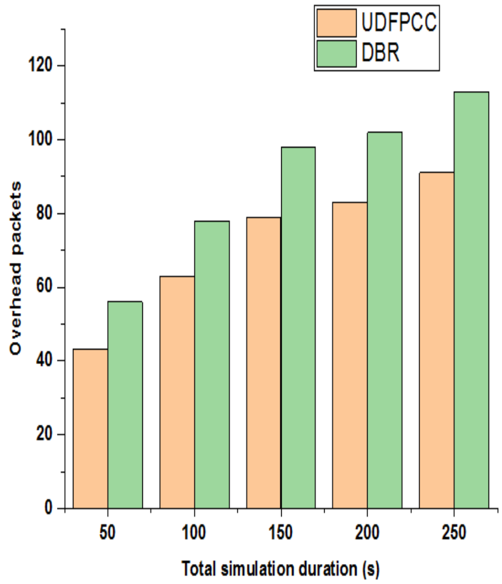

Figure 2. Total simulation duration versus overhead.

Total simulation duration (s)	***UDFPCC***	***DBR***
50	***43***	***56***
100	***63***	***78***
150	***79***	***98***
200	***83***	***102***
250	***91***	***113***

Table2. Trace files data of simulation with overhead

In figure 2, the overhead plot which indicates the control packet sent is shown with its plot using shell script. The numerical values are obtained with the trace file data as shown in table 2 with overhead.

V. Conclusion

Perimeter of fusion helps in deciding of appropriate fusion strategy to routing there reducing latency. Improving fusion of data involving joint accumulation at different depth leads to networked system performing better in wireless sensor nodes which handles fusion rate consistently. The directional antennas find the coordinates of sink as sensor are localized. However, in scenario of no localization UDFPCC fails as spatial coordinate misalign.

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