A Novel Data Aggregated Underwater Pipeline Communication

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ABSTRACT:

Water Pipeline Monitoring Systems have emerged as a reliable solution to maintain the integrity of the water distribution infrastructure. Various emerging technologies such as the Internet of Things, Physical Cyber Systems, and machine to-machine networks are efficiently deployed to build a Structural Health Monitoring of pipeline and invoke the deployment of the Industrial Wireless Sensor Networks (IWSN) technology. Efficient energy consumption is imperatively required to maintain the continuity of the network and to allow an adequate interconnection between sensor nodes deployed in the harsh environment. In this context, to maximize the Lifetime of the WSN underwater Distribution system domain is a primordial objective to ensure its permanently working and to enable a promising solution for hydraulic damage detection according to diverse performance metrics In this context, the data aggregation techniques are well-designed and various smart algorithms are developed to reduce the quantity of transmitted data and to minimize the energy consumption. In this project, we combine between data aggregation and clustering algorithm in order to improve the WSN Lifetime. Data aggregation applied in order to eliminate redundant data either from different sensor nodes at the same time or from the same sensor node at various time steps .NS2 simulator tool has been used to evaluate existing and proposed system performance . Then, efficient data aggregation allowing the redundancy elimination at the cluster and sensor node level improves more the results ans reduces the energy consumption

I. INTRODUCTION

At present, most pipeline sensors are connected using wired networks. Wired networks are either copper or fiber optic cables. The wired networks are usually connected to regular sensor devices that measure specific attributes such as flow rate, pressure, temperature, sound, vibration, motion, and other important attributes, see Fig.1. The wires are not used for communication only but also to transfer electrical power to different parts of the pipeline system to enable the sensors, actors, and communication devices to function. Power for the pipeline resources and networks can be provided by different sources like Solar Energy, Pipeline Flow Energy and other External Energies.

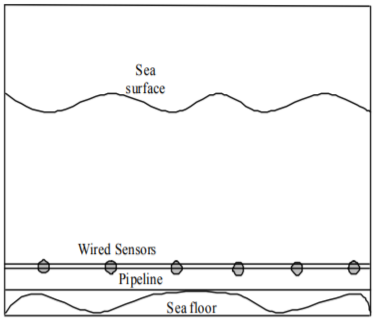


Fig.1 underwater wired sensor network

Currently, there are about 1000 Remotely Operated Vehicles (ROVs) and up to 700 AUVs in the world, according to Douglas-Westwood. In the coming 4 to 5 years it is expected that this fleet can be increased by 50-60% and may be even more than doubled.

The vast majority of AUVs currently belongs to the defense industry, where they are called Unmanned Underwater Vehicles (UUV). There is no difference in meaning between UUV and AUV, but the abbreviation UUV is used in the defense industry and in military circles, and therefore correspond to military applications; AUV is used in civil applications. In the military applications, approximately 35% are ‘heavy’ vehicles, 25% are ’middle’ vehicles and 40% are ’light’ vehicles.

The majority of heavy ROV vehicles are used in drilling and construction support of the subsea infrastructure in the oil & gas industry. Light ROV vehicles are often used in Inspection Repair and Maintenance (IRM). Of these approximately 70-80 percent of all ROVs are ‘heavy’ to ‘medium’ and 20-30% are ’light’ vehicles.

There have been attempts to shift UUV applications from the defence to civil market, assuming that AUVs will take over some IRM tasks from ROVs. Much attention has been paid to deep water ROV & AUV operations in depths up to 3,000 metres of water. Although from a market point of view, such ‘frontier types’ of vehicles will not be decisive because about 80% of the total pipelines length are located in depths shallower than 500 metres.

The Oil & Gas industry has been under pressure over the past 2 years, which has resulted in a challenge to reduce prices and therefore also a critical review of approaches to development in the industry. For example, with regard to IRM of underwater pipelines. Currently the total length of pipelines in the world is approximately 150 thousand km, and will increase by 20% towards 2019. As a majority of these pipelines is older than 20-25 years, the approaching end of their life cycle will mean that the requirements with respect to conducting regular inspections will be tightened and the inspection frequency increased.

Wired networks are considered the traditional way for communication in pipeline systems. They are easy to install and provide power supply for through the network wires. However, there are a number of reliability problems related to using wired networks with regular sensors for monitoring pipelines. These problems are:

If there is any damage in any part of the wires of the network, the pipeline communication system will be completely or partially damaged. This depends on how the wired network is organized and used. If the communication is done in one direction on the wire, then a single cut on the wire will disconnect all the nodes after the cut from the NCC. If the communication is two-directional then the negative impact on the communication is less as some nodes will use one direction for communication while the nodes after the cut can use the other direction. In this case the NCC needs to be connected to both ends of the network. However, if there are two or more cuts in the network, then all nodes between the cuts will not be able to communicate with either of the NCC. In addition, if there is a power outage, some of the nodes may not be able to operate.

In our approach, we Proposes an efficient localization AUV-based LSN (ALSN) algorithm, which provides the framework for monitoring and protection of underwater pipelines. We also consider the Range free localization method for node placement and RRT based path planning schemes for UAV paths. This approach provides a efficient results for SN, SINK and UAV communication for underwater pipeline network in terms of delay and power.

II. RELATED WORKS

Maroua Abdel hafidh et al [1] proposed an hybrid clustering algorithm based on K-means and Ant Colony Optimization (ACO); called K-ACO to improve the WSN Lifetime. Efficient energy consumption is imperatively required to maintain the continuity of the network and to allow an adequate interconnection between sensor nodes deployed in the harsh environment.

MutebAlsaqhan et al [2] presented the work of developing a low- complexity, power-efficient, scalable node for linear wireless sensor networks. The developed system is intended primarily water pipeline leakage detection applications. This work mainly tackles the communication part of the system.

Adnan Nasir et al [3] presented a human centric cyber physical framework architecture of our in-pipe water monitoring and feedback system. This system comprises of the physical water distribution infrastructure, together with the hardware and software supported intelligent agents for water allotment, leak detection and contamination spread control.

Ahmed M. Alotaibi et al [4] Proposed an energy-efficient cooperative scheme for a group of mobile wireless sensor nodes deployed inside the pipeline. The nodes are supposed to run cooperatively in order to save their resources. It is assumed that only one node shall remain active for a specific period of time while all other nodes are in sleep mode. As soon as the active node completes its cycle, it goes to sleep while another node is triggered by its timer to wake up and continue the process.

Meenakshi et al [5] designed to reduce the propagating delay and to allocate channel in optimal relay node selection by using a heterogeneous network. In underground pipeline communications, sensor nodes detect the signal and forward it to the relay node, which is placed in above ground.

Ayadi et al [6] investigates various leakage detection formulations based on WSN in order to identify, locate and estimate the leak size. In addition, a computerized techniques based on the analysis of pressure measurement in water distribution system is presented to find the defective pipe.

III. PROPOSED SYSTEM

In our approach, we Proposes an efficient localization AUV-based LSN (ALSN) algorithm, which provides the framework for monitoring and protection of underwater pipelines. We also consider the Range free localization method for node placement and RRT based path planning schemes for **UAV paths.**

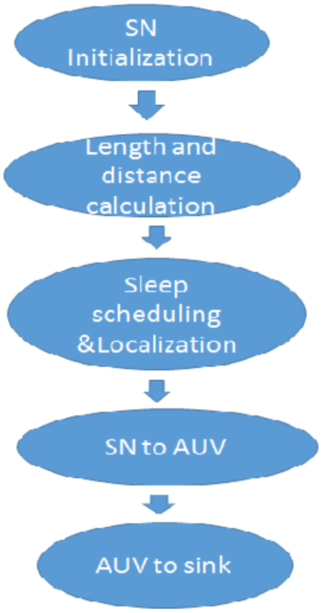


Fig. proposed flowchart

*Sink-to-NCC Link:*For the link between the sink and the NCC, use any of the medium to long range protocols that are available in that particular region.Such protocols include cellular, TDMA, CDMA, GPRS, LTE

Deployment: To maximize the Network Lifetime of the deployed LWSN along the pipeline, it is important to find the adequate placement of sensor nodes and to define the efficient distance between them. The coverage, the transmission range and the maximum permitted number of sensors (n*) are the three main constraints that should be used as expressed below

$$\max NL = \frac{E_0}{\max_{i=1}^{n}(E_i)}\ timestep$$

Sleep Scheduling: More work needs to be done in order to insure that one or more SNs are awake during the passing of the AUV within range. Additionally, some SNs might even collect data and communicate it to the SN that would be expected to be awake during the passing of the AUV in the next cycle. In the case where this strategy is adopted, such synchronization between the SNs in the same cluster, and the SNs and the AUV must be carefully designed and evaluated along with its impact on the delivery

Data aggregation: we propose an Energy-efficient and Secure Pattern based Data Aggregation (ESPDA). It is applied in order to eliminate redundant data either from different sensor nodes at the same time or from the same sensor node at various time steps.

Algorithm1: PROPOSED ESPDA

```
for each cluster Cj do
for each i=1 to Nnbr do
if Econsi ==Emax
then
Calculate num the number of nodes having
the highest energy.
// Cluster Head selection
if num ==1
then
node i is selected as a CH.
if num > 1
then
CH is selected randomly.
At t=0
// Pattern code generation
-Each sensor node generates its Pattern Code
PC  and sends it to the CH
```

// Pattern code comparaison and

select SM to send data

14 **-** CH compares the received pattern codes and eliminates redundancy.

16 **-** Among sensor nodes, having the same PC, only ones

17 with the highest energy level are kept to create unique

18 selected PC Set (PCS).

- SMs corresponding to PCS members send their data

19 to the CH which requests to drop the actual data of the

20 other SMs

21 **-** CH sends the received data to the BS.

22 **-** Recalculate the energy level at each SM.

Within each obtained cluster, redundant data is reduced by applying a pattern code technique that minimize the used bandwidth and the consumed energy during data gathering.

IV. RESULTS AND DISCUSSION

Our proposed work have been developed and simulatedby the networksimulator(NS-2) software. The results for an each process have been figured out in the following below.

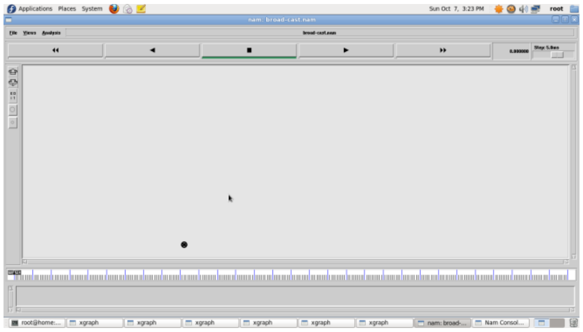


Fig. node creation

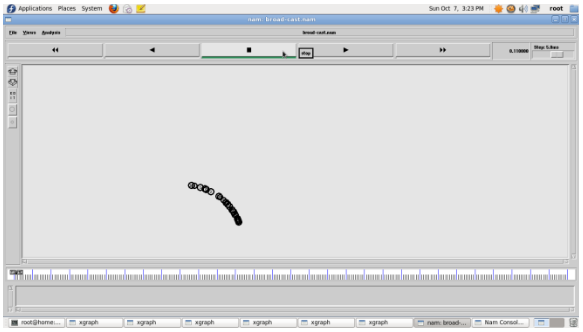


Fig.Node Deployment

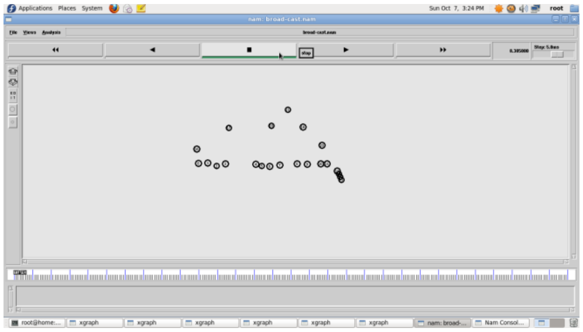


Fig.Node Defining

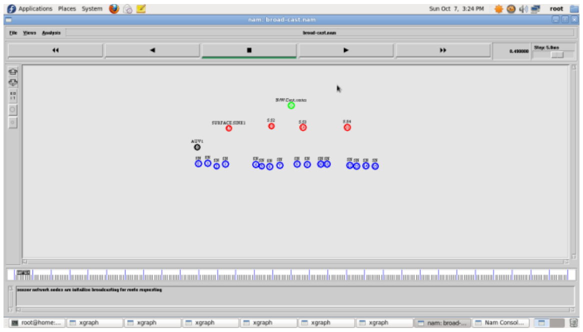
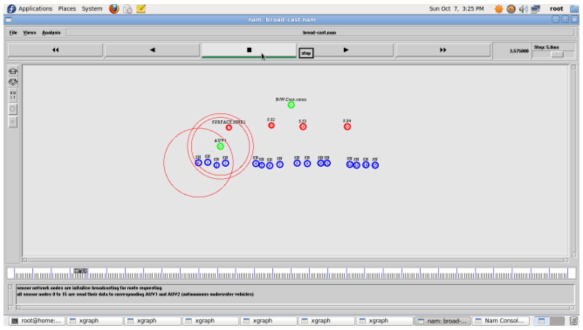


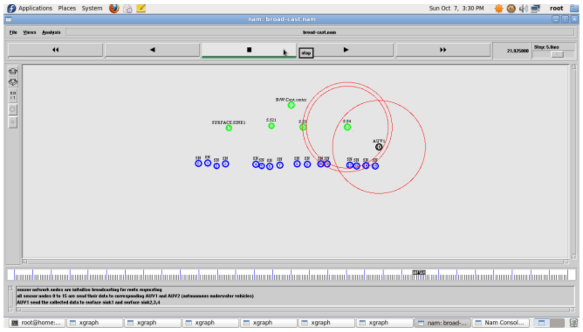
Fig. AUV Initialization

Fig. AUV to Sensor Communication



sensor network nodes are initialise broadcasting for route requesting
all sensor nodes 0 to 15 are send their data to corresponding AUV1 and AUV2 (autonomous underwater vehicles)

Fig. AUV Path Finding



sensor network nodes are initialise broadcasting for route requesting
all sensor nodes 0 to 15 are send their data to corresponding AUV1 and AUV2 (autonomous underwater vehicles)
AUV1 send the collected data to surface sink1 and surface sink2,3,4

Fig. AUV Final Data Transmission

sensor network nodes are initialise broadcasting for route requesting
all sensor nodes 0 to 15 are send their data to corresponding AUV1 and AUV2 (autonomous underwater vehicles)
AUV1 send the collected data to surface sink1 and surface sink2,3,4

Fig. Surface Sink to Network Controller Communication

V. PERFORMANCE ANALYSIS

The Performance graph of results between no. of nodes, speed, delivery ratio, delay and energy is shown in following figures.

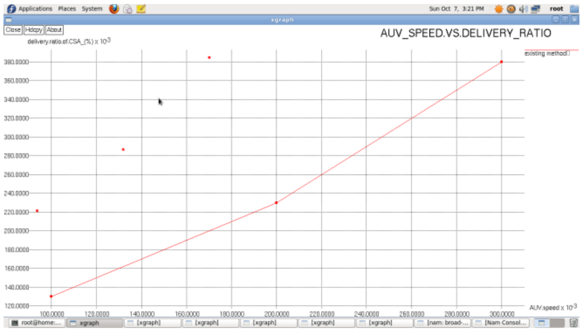


Fig. performance graph of Speed vs Delivery Ratio

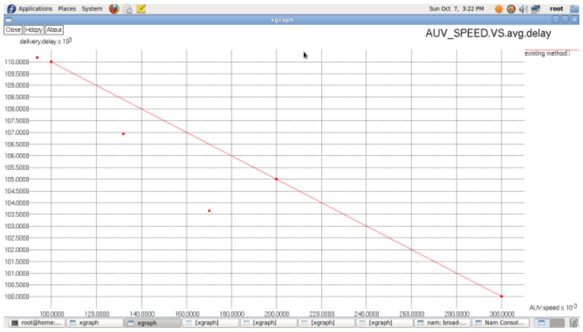


Fig. performance graph of Speed vs Delivery Ratio

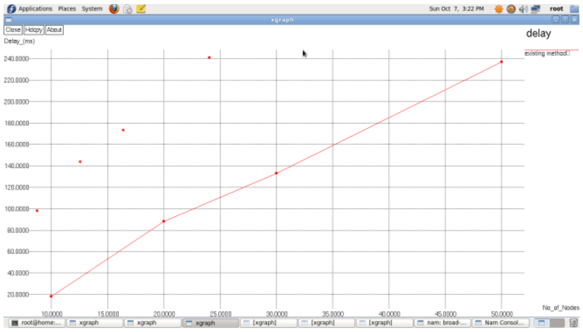


Fig. Number of Node versus Delay

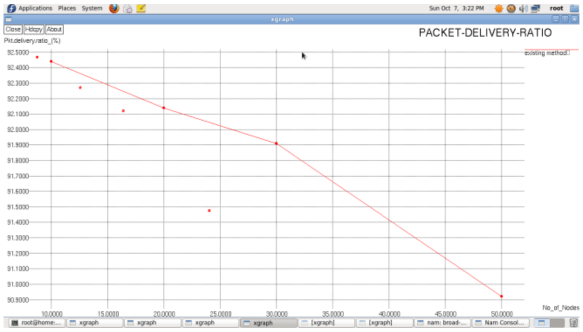


Fig.Number of Node versus PDR

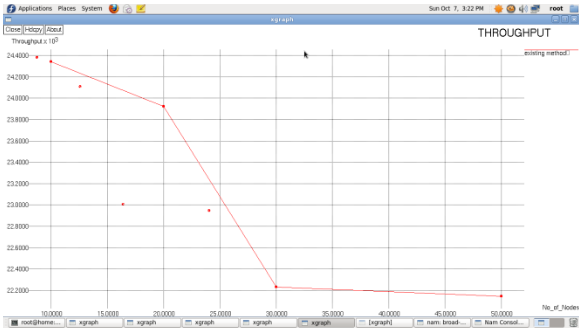


Fig.Number of Node versus Throughput

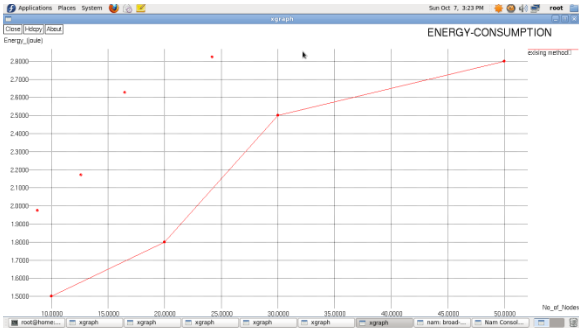


Fig. Number of Node versus Energy

VI. CONCLUSION

In this paper, we proposed the use of an AUV to collect data from SNs, which are used to monitor underwater pipelines.The AUV moves back and forth along the pipeline and collects datawhen it comes within transmission range of an SN. The AUV then transmits the collected data to the surface sinks located at the ends of the ALSN. Typically, acoustic communication technology is used to provide the needed connectivity.This data aggregated framework is appropriate for applications that involve delay-tolerant data.

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