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INTRUSION SHIP DETECTION USING WIRELESS SENSOR NETWORKS

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ABSTRACT

A Wireless Sensor Network (WSN) has been emerging in the last decade as a powerful tool for connecting physical and digital world. WSN has been used in many applications such as habitat monitoring, building monitoring, smart grid and pipeline monitoring. In addition, few researchers have been experimenting with WSN in many mission-critical applications such as military applications. An innovative solution for intrusion detection system in sea is being presented. Intrusion detection on the sea is a critical surveillance of problem for harbor Protection, border security, and the protection of commercial facilities, such as oil platforms and fisheries. Equipped with the three axis accelerometer sensors, we deploy an experimental Wireless Sensor Network (WSN) on the sea surface to detect ships. Using the signal processing techniques and cooperative signal processing, we can detect any passing ships by distinguishing the ship-generated waves from the ocean waves.

KEYWORDS

intrusion detection, wireless sensor networks, border protection, target monitoring, signal processing.

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1. INTRODUCTION

The traditional methods of detecting ships entail the use of radars or satellites which are very expensive compared to other. Besides the high cost, satellite images are easily affected by the cloud cover, and it is difficult to detect small boats or ships on the sea with marine radar due to the noise or clutter generated by the un even sea surface.

Hence, we go for the new system. Terrestrial intrusion detection with Wireless Sensor Networks, deploy magnetometers, thermal sensors, and acoustic sensors is monitored areas to detect the presence of intruders. Though such networks are work well on the land, it is challenging to deploy these sensors on the sea surface for ship detection. The main challenge is that when sensors are deployed on the sea surface, they cannot static and get tossed by ocean waves.

A v-shaped wake and its resulting waves are generated by a ship passing through the water. We proposed a system of ship detection by taking an advantage of the characteristics of ship-generated waves with WSNs. To detect ships three-axis accelerometer sensors is used with the iMote2 on buoys on the sea surface. Using signal processing, we observed that ocean waves and ship-generated waves have been different energy spectrums.

We designed three-tier intrusion detection for system to detect intruding vessels. In this System, we propose to make use of spatial and temporal correlations of an intrusion to increase detection reliability. This is the first detailed, systematic experimental study of ship intrusion detection with WSNs.

FIG. 1: WAKE WAVES GENERATED BY BOAT

2. ASPECTS OF WAVES

A Wave is disturbance or oscillation (of a physical quantity), that travels through matter or space, accompanied by a transfer of energy.
Wave motion transfers energy from one point to another, often with no permanent displacement of the particles of the medium-that is, with little or no associated mass transport.
They consist, instead, of oscillations or vibrations around almost fixed locations. Waves are described by a wave equation which sets out how the disturbance proceeds over time.
The mathematical form of this equation varies depending on the type of wave.

3. TYPES OF WAVES

There are two types of waves.
1) Mechanical waves
2) Electromagnetic waves

The Mechanical waves propagate through a medium, and the substance of this medium is formed. The deformation reverses itself owing to restoring forces resulting from its deformation. For example, sound waves propagate via air molecules colliding with their neighbors.
When air molecules collide, they also bounce away from each other. This keeps the molecules from continuing to travel in the direction of the wave.
The electromagnetic waves do not require a medium. Instead, they consist of periodic oscillations of electrical and magnetic fields generated by charged particles, and therefore travel through a vacuum.
These types of waves vary in wavelength, and include radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation-rays, and gamma rays.

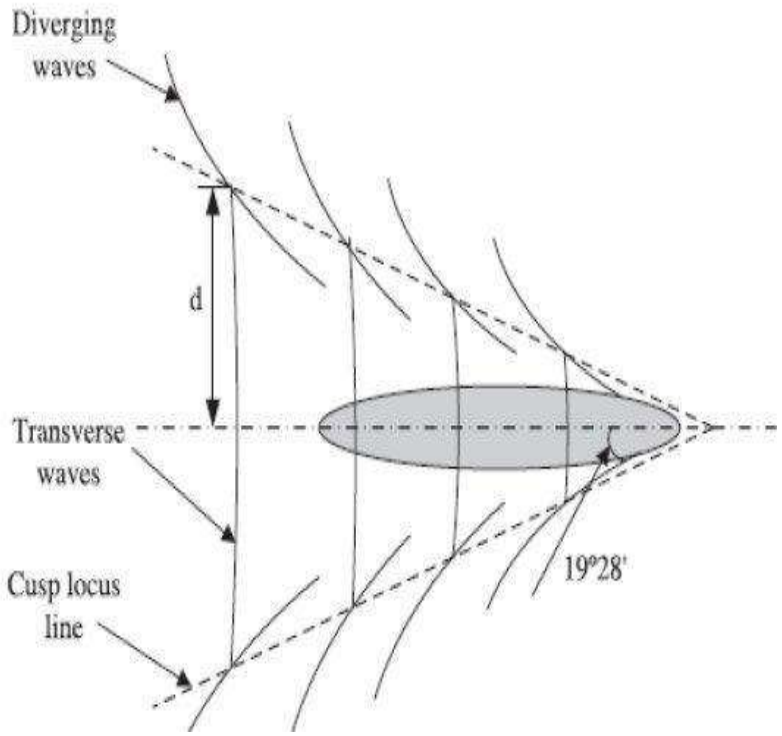
4. WAVE GENERATION

Wave is generated by forces that disturb a body of water. They can result from a wide range of force-the gravitational.
Out in the ocean, as the wind blows across a smooth water surface, air molecules push against the water.
This friction between the air and water pushes up tiny ridges or ripples on the ocean surface. When waves are being generated by strong winds in a storm, the sea surface generally looks very chaotic, with lots of short, steep waves of varying heights.
Ocean waves often have quite a different aspect, forming long, rolling peaks of uniform shape. For this reason, physical oceanographers differentiate between two types of surface waves:
Seas and swells. Seas refer to short-period waves that are still being created by winds or area very close to the area in which they were generated.
Seas are short-crested and irregular, and their surface appears much more disturbed than for swells. Swells refer to waves that have moved out of the generating area, far from the influence of the winds that made them.
Wave energy is dissipated as waves travel, and short-period wave components lose their energy more readily than long-period components.
As a consequence of these processes, swells from longer, smoother, more uniform waves than seas.

5. MEASUREMENT OF WAVES

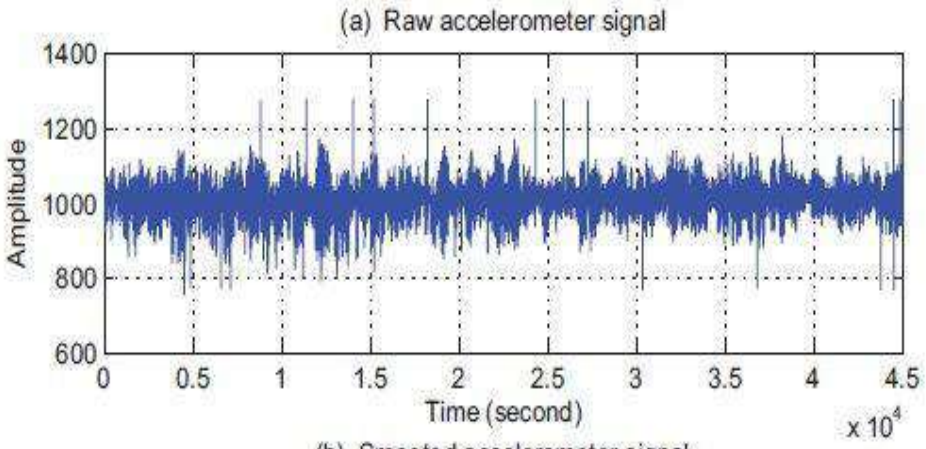
When a ship moves across a surface of water, it can be generating waves which comprise divergent and transverse waves.
The old method of measuring ship-generated waves is to measure the pressure fluctuations at some elevation points in the water column, then transform the pressure into the wave height.
However, this method requires an expensive equipment. It is difficult to deploy the devices underwater.
Touse an accelerometers to measure the actual surface movement of ship-generated waves.
When the accelerometer is used in an ocean environment, then buoy and the accelerometer undergo a generally oscillatory, sinusoidal-like vertical acceleration due to wave action.

FIG. 2: SHIP GENERATED WAVE MODEL



In order to distinguish between ship-generated waves and ocean waves, we can use Short Time Fourier Transform to process the measured signals.
With 2,048 point sample STFT, we observe that the ship-generated waves a normal ocean waves have a different energy spectrum.
Its Spectrum has a high, single waste away concentration around a characteristic period around 1 Hz. On the tendency, the spectrum of the ocean waves combined with the ship waves.

FIG. 4: (a) RAW ACCELEROMETER SIGNAL



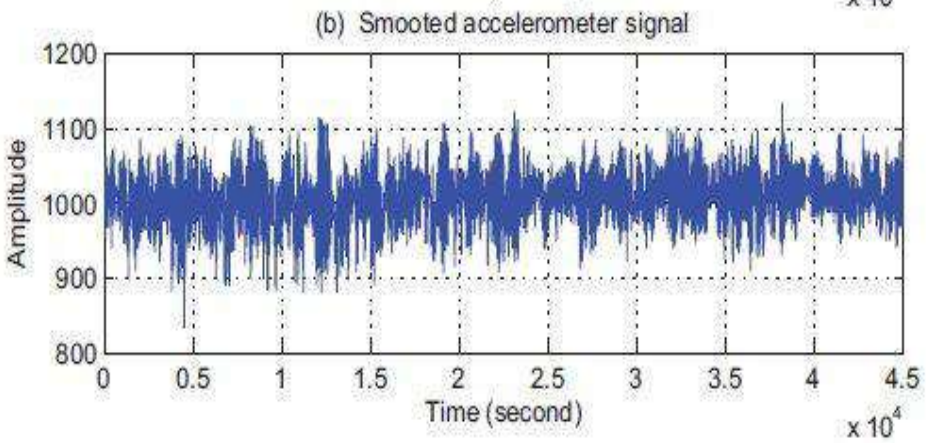
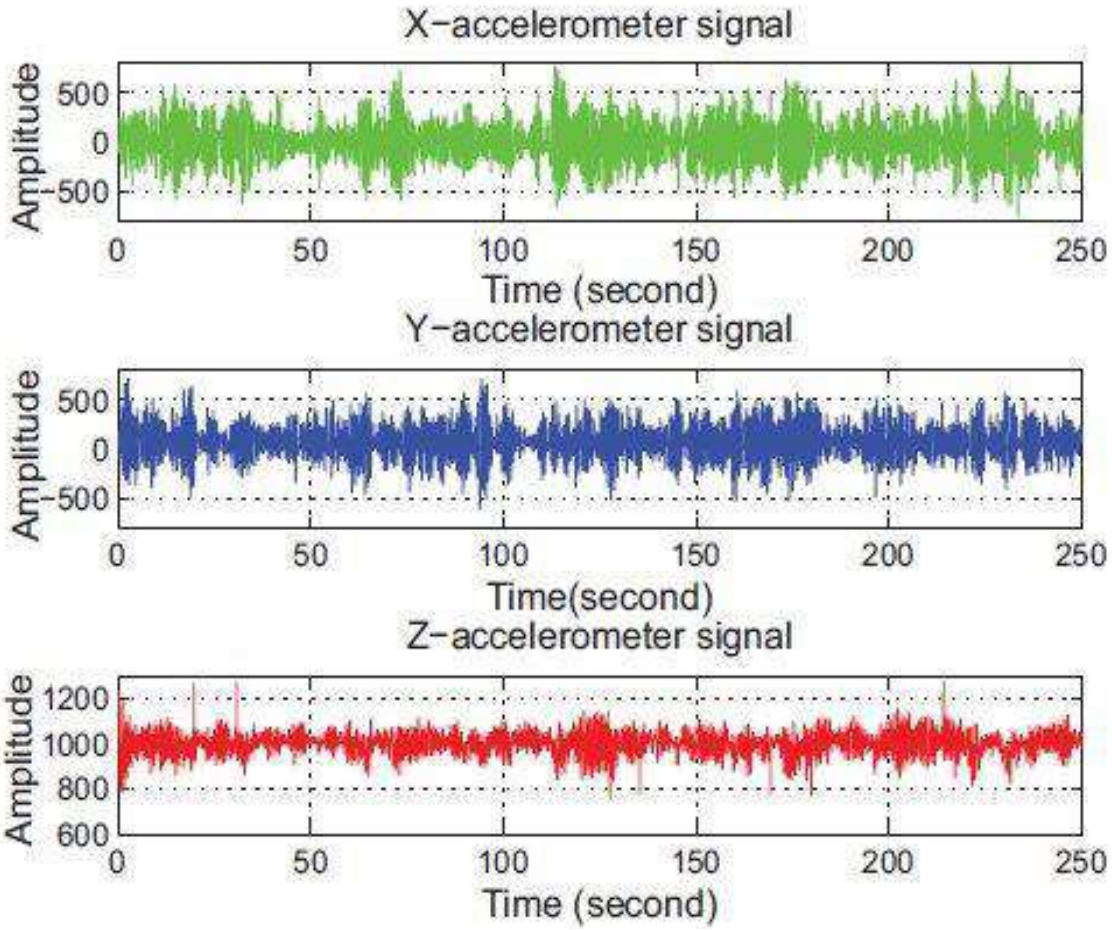


FIG. 4: (b) SMOOTHED ACCELEROMETER SIGNAL



6. SYSTEM DESIGN FOR SHIP INTRUSION DETECTION

In this section, we first present the architecture of the distributed intrusion detection system, and then discuss the three-tier intrusion system in detail.

6.1. ARCHITECTURE OF INTRUSION DETECTION SYSTEM

A reliable intrusion detection system involves node level detection, cluster-level classification, and sink-level classification.

The node-level detection involves the sampling event and extracting features. Once a node can detect a target, it is better that only the extracted features are transmitted to the local head node or a sink for further signal processing and classification, due to the energy constraints of the sensor node and the limitations of the communication bandwidth.

A Cluster-level classification deals with more complicated tasks, such as Collaborative Signal Processing or regional data fusion.

The clusters are formed according to the geographical locations of nodes or the migrations of the external "event" after the network is deployment.

In each and every cluster, local head node takes charge of the data fusion or other coordination tasks within the cluster. Sink-level detection involves the processing type data sent from local head nodes, and the final decision will be reported to the external used via satellite or other means.

To cause a real long-term intrusion detection surveillance system, some power management should be used. To avoid this need for expensive periodic battery changes, the nodes may need expensive solar panel or other perpetual-powering solutions.

Some middleware services should be considered, such as the location of nodes, time synchronization, and routing infrastructure.

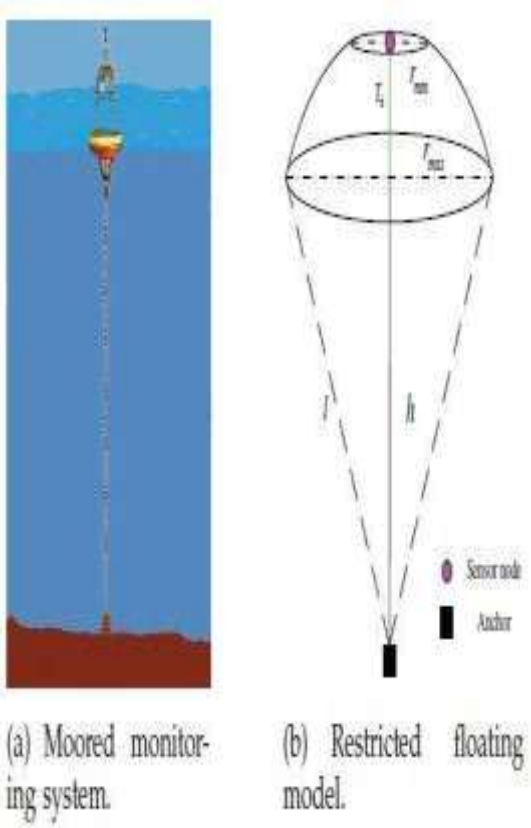
6.2. NODE-LEVEL DETECTION

At node level detection, the task for a single node is to detect when a ship waves generated by a near by passing ship.

So, in order to do that, the individual node periodically samples.

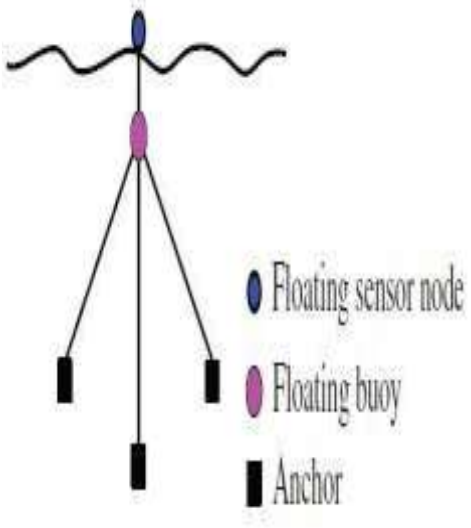
The event and processes the sample data to extract features and then event and processes the sampled data to extract features for node level detection.

FIG. 5: ANCHORED NODE DEPLOYMENT



(a) Moored monitoring system. (b) Restricted floating model.

FIG. 6: NODE DEPLOYMENT WITH THREE ANCHORS



6.3. CLUSTER-LEVEL DETECTION

When a ship travels through the sensor networks, the waves are generated by the passing ship disturb the sensor areas A1; A2; A3 in sequential manner. These areas have been spatial and temporal correlations.

By making use of these correlations, we can improve the reliability of the detection system. In order to monitor the entire deployed area are temporary clusters are combined with static clusters.

The static clusters are formed according to the geographical location of the nodes, and then temporary clusters are formed on demand when a node's alarm is trigger. Since the nodes positions are fixed, they know where their neighbors are located in system.

When a node discovers a ship intrusion, it is initiating a temporary cluster, informs its neighboring nodes and automatically becomes the temporary cluster head.

If more than one nodes are detects a ship intrusion before it receives detection signals from other nodes, it sends out their average detection energy, thus the node with the higher detection energy becomes the cluster head.

If the nodes within the cluster also find the intrusion, they report findings to the temporary cluster head. If the cluster head has not received any report within a certain period of time, it will be cancel the temporary cluster because its positive finding maybe a false alarm.

6.4. SINK-LEVEL DETECTION

Processes the data sent from local head nodes and the final decision will be reported to the external user via satellites or other means.

The multi-target detection monitors several intrusion targets at the same time indifferent geographical areas over large distances.

It increases the reliability of the intrusion detection with reduced false alarms with respect to special and temporal correlations of detection.

The self organizing localization algorithm which enhances the sensor nodes to be location-aware is deployed in the proposed system.

7. PROPOSED SYSTEM

The process of finding accurate location of sensor node is called as localization. The issue of energy efficiency and efficient data transmission is critical due to limited battery power and then limited storage capacity of sensors.

The Spatial correlation is more doubtful due to higher distance among sensors and long propagation delays.

PROPOSED ALGORITHM

Adaptive self-organizing localization algorithm is used to develop in proposed system. It can be able to operate under modes of parameters such as:

Temperature: Ranges 23to26 degrees centigrade within 33 meters.

Distance: Node's deployment distance D is within 40 meters.

The proposed localization techniques use only the distance estimation between the reference Nodes (RN) and Ordinary Nodes (Or N).

RNs can be able to detect their position by means of GPS to find the accurate location of OrNs. OrNs are those nodes which can execute without any centralized control to make randomly deployed WSN to be location-aware.

In order to perform a collaborative sensing tasks the sensor nodes must estimate their position by means of a distributed positioning algorithm. Average Error (AE) is calculated to weight the efficiency of proposed algorithm,

$$AE = \frac{\sum_{i=1}^{500} \sqrt{(x_i - x_i^*)^2 + (y_i - y_i^*)^2 + (z_i - z_i^*)^2}}{500}$$

Where (xi, yi) is a real sensor position and (xi*, yi*) is estimated localization.

7.1. NETWORK MODEL AND NODE LEVEL DETECTION

An undirected graph G (V, E) where the set of vertices V represent the mobile nodes in the network and are presents set of edges in the graph, which can be represents the physical or logical links between the mobile nodes.

Sensor nodes are placed at a same level of task. Two nodes are communicating directly with each other are connected by an edge in the graph. Let N denote a network of m mobile nodes, N1, N2...Nm and let denote a collections of n data items d1; d2;... ; Dn distributed in the network. For each pair of mobile nodes and Nj, let tij denote the delay of transmitting data items of unit-size between these two nodes.

The experimental system is with 30 nodes deployed in such a way that five nodes in a row and a total number of six rows is kept. The node deployment distance D is 25 m.

A ship travels along with one side of the deployed area with three different speed levels and with each speed the test runs some defined rounds.

The Node-level detection Sample the event and extract those features. Once the node detects a target the extracted features are transmitted to the local head node or a sink for further signal processing and classification due to the energy constraints of the sensor node and the limitations of the communication between bandwidth.

Sample the signal value at time t is ai, then the total number of sampling points in time period T is u.

The moving average and the standard deviation is defined as

$$m_T' = \beta_1 \times m_T + m_{\Delta t} \times (1 - \beta_1),$$

$$d_T' = \beta_2 \times d_T + d_{\Delta t} \times (1 - \beta_2),$$

The anomaly frequency is defined as

$$a_f = \frac{NA_{\Delta t}}{N_{\Delta t}}$$

7.2. CLUSTER-LEVEL DETECTION AND SINK-LEV EL DETECTION

If more than one node detects a ship intrusion before it receives a detection signals from other nodes, the nodes contend to become the temporary cluster head. To simplify the process, when the nodes are trying to set themselves up as cluster heads, they could also send out their average detection energy thus the node with the higher detection energy becomes the cluster head. If the nodes within the cluster also find the intrusion then they report the findings to the temporary cluster head.

If the cluster head has not received any report within a certain period of time, it will be cancelling the temporary cluster because it's positive finding maybe a false alarm.

However, if it receives enough positive reports in a timely fashion it will be process the received data using the spatial and temporal correlations of the ship waves. We define time correlations in row i.

Because the cluster head knows the positions of each node, we arrange all the reports according to their position and reporting time. If the number of ordered reports is N,

$$C_{rt(i)} = \frac{N}{n},$$

The group's time correlations Nt

$$C_{Nt} = \pi C_{rt(i)}$$

CNe describes the cluster's energy correlation of coefficient C measures the spatial and temporal correlations in a cluster and is defined as

$$C = C_{Nt} \times C_{Ne},$$

Estimate the speed of the intruding ship using the equation,

$$V = \frac{D \sin(\alpha - 70^{\circ})}{(t_4 - t_3) \sin \beta},$$

7.3. SINK-LEVEL ESTIMATION

The intruding ship will keep moving it will be eventually move away from the monitored area. When it raises the false alarm when several clusters are affected and disappears.

It processes the data sent from local head nodes and the final decision will be reported to the external user via satellites or other means. To distinguish between the friend and foe ships add ID to friendly ships.

When such ships come the system will not sound intrusion alarms. Then it increases the reliability of the intrusion detection with reduced false alarms with respect to spatial and temporal correlations of detection.

7.4. NODE LOCATION ESTIMATION

The proposed localization technique uses only the distance estimation between the reference Nodes and Ordinary Nodes.

RNs are able to detect their position by means of GPS to find the accurate location of Ordinary Nodes. Ordinary Nodes are nodes which execute without any centralized control to make randomly deployed WSN to be location-aware.

In order to Performa collaborative sensing tasks the sensor nodes must estimate their position by means of a distributed positioning algorithm.

Average Error (AE) calculated to weigh the efficiency of proposed algorithm using the formula 1.

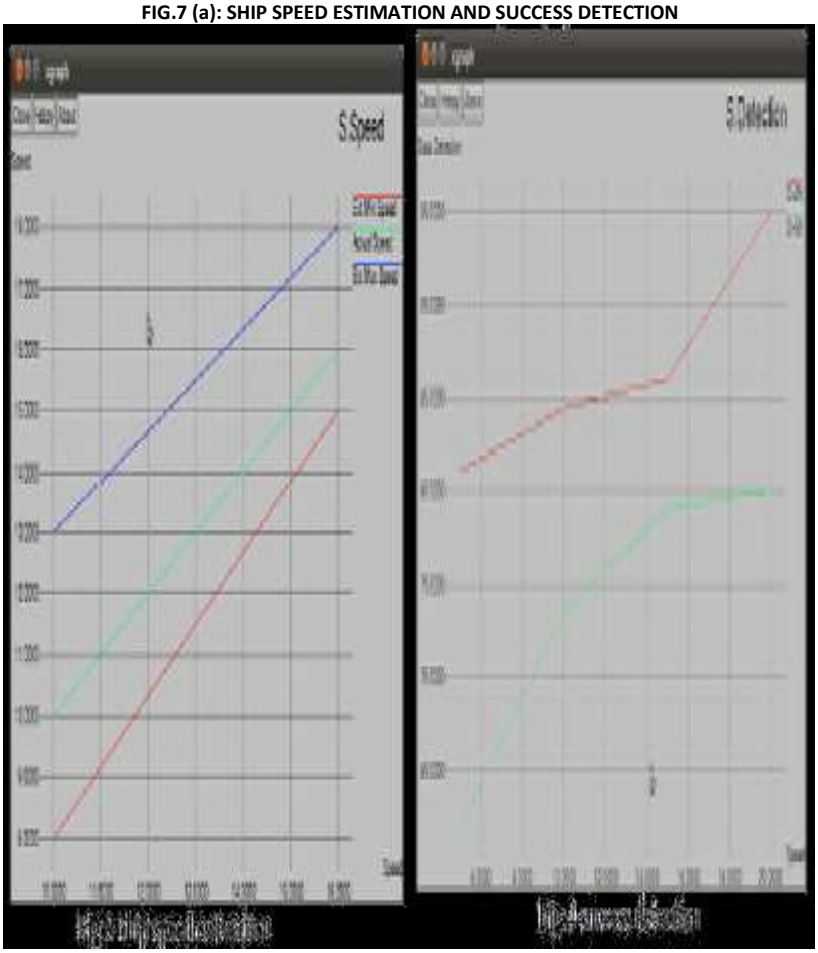
8. ANALYSIS OF PROPOSED SYSTEM

In order to improve the energy consumption in efficient way, localization algorithm is proposed.

Its consistency caused due to erroneous depth which is calculated using pressure sensors and find the average error in calculated node location.

It autonomously performs the assigned task without human intention. The block diagram describes the overall methodology of the proposed system,

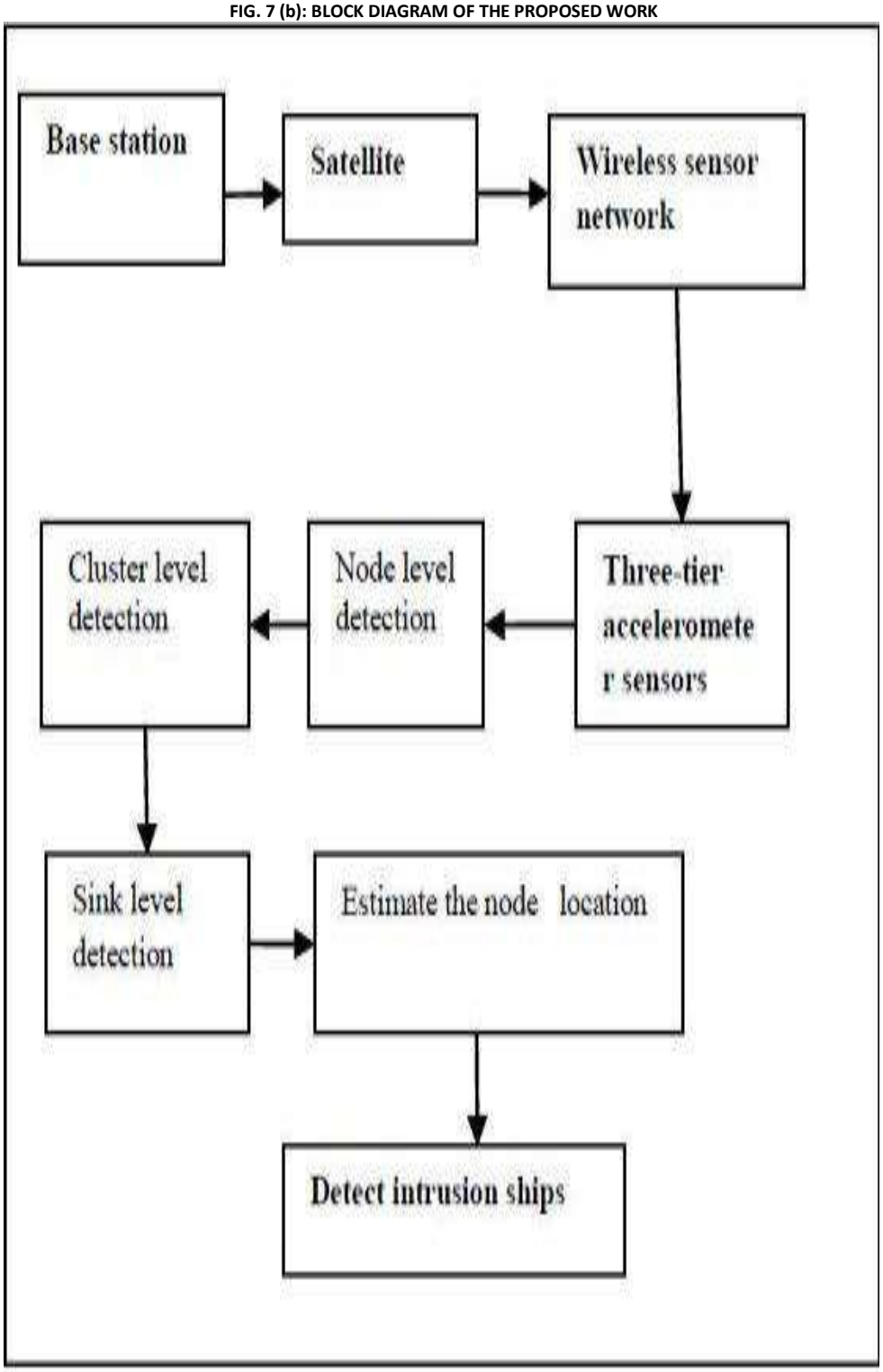
FIG.7 (a): SHIP SPEED ESTIMATION AND SUCCESS DETECTION



The above graph shows the ship speed estimation and success detection in accordance with the intruder ship.

The minimum and maximum and the average speed that the ship could attain, any ship that exceeds the ratio calculated is considered to be an intruder ship.

FIG. 7 (b): BLOCK DIAGRAM OF THE PROPOSED WORK



The below block diagram describes the working methodology of the proposed system. Using the three-tier accelerometer sensor to detect the intrusion ship. We introduced four algorithms namely node level, cluster level, sink level and node location detection to detect the intrusion ship more efficiently and accurately.

9. CONCLUSION

The developed architecture enables the system to conduct efficient information of processing including detection and classification in a large-scale WSN.
This architecture naturally distributes sensing and computation tasks at different levels of the system so that the sensor network can support high-quality of sensing and reliable classification without involving special high-power nodes.
With evaluation data collected from field tests in physical environments, the evaluation demonstrates excellent performance on the detection rate, classification result, attribute (velocity) computation accuracy and the timely information delivery.
Then the developed approach is further extended in future in many ways. Propagation of ship waves over large distances is not concentrated in the existing system. Real sensor network system drops buoys from a plane rather than the grid environment have to be analyzed. The main limitation of our schemes is that it requires a relatively dense network, especially to detect a high detection ratio with the small boats because of the high noise on the sea.
The power management in sink level detection is another methodology to improve the performance of the detection system in efficient way. On the other hand, seek solutions for supporting online intrusion detection system.

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PROFITABILITY ANALYSIS OF SELECT BANKS IN INDIA

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ABSTRACT

Reforms in the Indian economy and banking sector have witnessed growth and development of financial institutions particularly scheduled commercial banks in India. These ever-changing reforms and technology advancements increase financial risk which reduces the profitability of banks. The present study is persistent on analysis of relationship among spread ratios and net interest margin (Profitability) of SBI and HDFC banks. For the study purpose have taken ten years' financial reports of select banks and used Pearson's correlation coefficient analysis for processing of data.

KEYWORDS

assets, financial institutions, liabilities, net interest income, profitability, spread.

JEL CODE

G20

INTRODUCTION

The financial and economic conditions in the country are far better-quality to any other country in the world, due to India's banking sector is adequately capitalised and well-regulated by Reserve Bank of India (RBI). The Indian banking system consists of 12 public sector banks, 22 private sector banks, 46 foreign banks, 56 regional rural banks, 1485 urban cooperative banks and 96,000 rural cooperative banks in addition to cooperative credit institutions As of November 2020, the total number of ATMs in India increased to 209,282. According to the RBI, bank credit stood at Rs.108.79 trillion and bank deposits stood at Rs. 155.14, as of July 16, 2021.

As of June 23, 2021, the number of bank accounts—opened under the government's flagship financial inclusion drive 'Pradhan Mantri Jan Dhan Yojana (PMJDY)'—reached 42.55 crore and deposits in Jan Dhan bank accounts totalled higher than Rs. 1.44 lakh crore. In the Faster Payments Innovation Index (FPII), the digital payments system in India has evolved the most among 25 countries with India's Immediate Payment Service (IMPS). Through immediate payment service (IMPS), reached the number of transactions upto 303.76 million (by volume) and amounted to Rs. 2.84 trillion. Due to digital payment the 3.25 billion transactions worth Rs. 6.06 lakh crore recorded by Unified Payments Interface (UPI).

Total of 32 Mergers and Acquisitions (M&A) the Indian banking and financial services witnessed activities worth Rs.172 crore in 2019. The commercial banks recorded a recovery of Rs. 400,000 crores of NPAs (Non-Performing Assets) in the last four years including record recovery of Rs. 156,746 crores in the financial year 2019. The RRBs which are unable to maintain minimum Capital to Risk weighted Assets Ratio (CRAR) of 9% as per the regulatory norms prescribed by RBI, do the continuation of the process of recapitalization of Regional Rural Banks (RRBs) by providing minimum regulatory capital to RRBs for another year beyond 2019-20 - till 2020-21 given approval by the Cabinet Committee on Economic Affairs.

SPREAD

The spread measures the efficiency of a financial firm's intermediation function in borrowing and lending money and also the intensity of competition in the firm's market area.

Spread = (Interest Income / Avg. earning Assets) – (Interest Expense / Avg. Interest Bearing Liabilities)

SPREAD RATIOS

1. **Spread to Total Income**

Spread to Total Income = Spread ÷ Total Income

Then Total Income = Interest income + Other Income

2. Spread to Working Fund

Spread to Working Fund = Spread ÷ Working Fund

3. Interest Earned to Working Fund

Interest earned to Working Fund = Interest Income ÷ Working Fund

4. Interest Earned to Total Income

Interest Earned to Total Income = Interest Income ÷ Total Income

5. Interest Expended to Working Fund

Interest Expended to Working Fund = Interest Expense ÷ Working Fund

6. Interest Expended to Total Income

Interest Expended to Total Income = Interest Expense ÷ Total Income

NET INTEREST MARGIN (PROFITABILITY)

It is a measure of the differences between interest income generated by the banks and the amount of interest paid to the outsiders.

Net Interest Margin = Net Interest Income ÷ Earning Assets*100

Or

Net Interest Margin = (Interest Income – Interest Expenses) ÷ Earning Assets*100

REVIEW OF LITERATURE

Manju Rajan Babu (2019) evaluated profitability and liquidity position of banks with reference to pre and post-merger in India during the period of 1998-2016. The author had taken total 17 banks from both public sector and private sector banks. For processing data used CAMEL and data envelopment analysis. It was observed

that ICICI bank had a better performance after merger. The mixed trend was also observed in the analysis of acquirer banks. The return on net worth, profit per employee and total asset growth rate ratios in post-merger years: HDFC Bank, Federal Bank and Bank of Baroda were efficient as compared to other banks and the financial performance of Kotak Mahindra Bank was efficient for post-merger years.

Santosh Kumar (2019) study conducted on the profitability of banks impacted by income diversification for the period of ten years from 2008 to 2017. For study purpose the author had taken 43 foreign banks, 21 nationalized banks, 6 SBI associate banks and 20 private sector banks. To process the data used ANOVA - F test and Multiple Regression analysis. The study was found that DS_1 positively impacted on ROE, ROA and RAROE and negatively impacted on RAROA. The DS_2 was positively impacted on ROE, ROA, RAROE and RAROA during the study period.

Biraj Kumar Mohanty and Ravees Krishnankutty (2018) analysed the profitability of 39 banks of 390 observations. They analysed profitability of banks from 1999 to 2015. They used correlation analysis to know the association among the variables. The study concludes that ROA has a significant positive association with last year solvency ratio, capital adequacy ratio whereas 2 and 3 years lag ROA, has a negative effect with size, GDP growth, loan to deposit ratio, expense ratio and productivity ratios.

Albulescue (2015) had a study on banking sector of emerging six Latin American countries during 2006 – 2013. The author finds out that capitalization, liquidity and interest rates margin positively influence the banks' profitability margins whereas NPA and non-interest expenses have negative impact. The author found out either ROA or ROE is robust to measure the profitability of a bank. It was further suggested that banking sector should take care of quality of loans to increase the profitability. A well- Capitalized banking sector is eventually a profitable one.

Rakhe P.B. (2010) had study on profitability of foreign banks vis-a-vis compared with Indian public sector banks and private sector banks during the period of 2002 to 2009. For analysis of data the researcher used regression analysis. The study indicates the access to low cost funds, diversification of income, adequate other income to fully finance the operating expenses are the important factors leading to the higher profitability of foreign banks. The analysis is also found that efficiency of fund management is the most important factor determining profitability in the banking system followed by generation of other income.

Mittal and Aruna (2007) compared the profitability of various bank groups using ratio analysis during the period 1999-2000 to 2003-04. The study found that foreign banks were the most profitable bank group in India followed by private sector banks and public sector banks. The study also noted that the profitability of the public sector banks has witnessed improvement over the last five years.

OBJECTIVES OF THE STUDY

1. To analyse the profitability of SBI Bank
2. To analyse the profitability of HDFC Bank

HYPOTHESIS OF THE STUDY

$H0_1$: There is no significant relationship among spread ratios and net interest margin of SBI bank.

$H0_2$: There no significant relationship among spread ratios and net interest margin of HDFC bank.

METHODOLOGY OF THE STUDY

The study is based on the secondary data in the form of consolidated financial information contained in annual records and reports of selected banks in India, and the published journal, articles data from RBI's centre for monitoring Indian economy (CMIE).

SAMPLE SELECTION CRITERIA

Selection of banks for study purpose used the criteria of: The Banks whose equity shares are being traded in National Stock Exchange for not less than 10 years; The banks' trading frequency should be at least 90% in the last six months and banks are representative of 'The Nifty PSU Bank Index' and 'Private Sector Bank Index'.

CORRELATION ANALYSIS

Correlation analysis helps to determine the strength of the linear relationship between the two variables X and Y, in other words, as to how strongly these two variables are correlated. Karl Pearson, in 1896, developed an index or coefficient of this association in cases where the relationship is a linear one, i.e., where the trend of the relationship can be described by a straight line. The Pearson's coefficient of correlation is designated by r. The coefficient of correlation r can be designed as a measure of strength of the linear relationship between the two variables X and Y.

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{n\sum X^2 - (\sum X)^2}\sqrt{n\sum Y^2 - (\sum Y)^2}}$$

TESTING OF HYPOTHESIS

$H0_1$: There is no significant relationship between spread ratios and Net Interest Margin (Profitability) of SBI Bank.

TABLE - 1: SBI - CORRELATION BETWEEN SPREAD RATIOS AND NET INTEREST MARGIN (NIM)

		Net Interest Margin
Net Interest Margin	Pearson Correlation	1
	Sig. (2-tailed)	
Spread to Total Income	Pearson Correlation	.609
	Sig. (2-tailed)	.062
Spread to Working Fund	Pearson Correlation	.683*
	Sig. (2-tailed)	.029
Interest Income to Working Fund	Pearson Correlation	.803**
	Sig. (2-tailed)	.005
Interest Income to Total Income	Pearson Correlation	.727*
	Sig. (2-tailed)	.017
Interest Expense to Working Fund	Pearson Correlation	.379
	Sig. (2-tailed)	.281
Interest Expense to Total Income	Pearson Correlation	-.470
	Sig. (2-tailed)	.171

* Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table – 1 show that correlation between the net interest margin and spread ratios that influences the net interest margin of the SBI. The Net Interest Margin (NIM) significantly correlated with spread to working funds (r = 0.68; 0.05), interest income to working funds (r = 0.80; 0.01) and interest income to total income (r = 0.73; 0.05), signifies higher the banks' earning capacity indicates the greater NIM. And hence other ratios were not found to be significantly correlated with NIM. It indicates NIM not depends on other spread ratios. The null hypothesis "There is no significant relationship between spread ratios and Net Interest Margin of select public and private sector banks", was rejected in the ratios of spread to working funds Vs NIM, interest income to working funds Vs NIM and interest income to total income Vs NIM. It was accepted in remaining other spread ratios of SBI.

HO_2: There is no significant relationship between spread ratios and Net Interest Margin of HDFC Bank.

TABLE – 2: HDFC BANK - CORRELATION BETWEEN SPREAD AND NET INTEREST MARGIN

		Net Interest Margin
Net Interest Margin	Pearson Correlation	1
	Sig. (2-tailed)	
Spread to Total Income	Pearson Correlation	.035
	Sig. (2-tailed)	.923
Spread to Working Fund	Pearson Correlation	.030
	Sig. (2-tailed)	.935
Interest Income to Working Fund	Pearson Correlation	-.058
	Sig. (2-tailed)	.873
Interest Income to Total Income	Pearson Correlation	-.115
	Sig. (2-tailed)	.752
Interest Expense to Working Fund	Pearson Correlation	-.177
	Sig. (2-tailed)	.625
Interest Expense to Total Income	Pearson Correlation	-.303
	Sig. (2-tailed)	.394

* Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table – 2 shows that correlation between the net interest margin and spread ratios that influences the net interest margin of the HDFC Bank. The Net Interest Margin (NIM) positively and insignificant correlation with spread to total income and spread to working funds, and it was negatively and insignificant correlation with remaining all variables. It indicates NIM not depends on all spread ratios of HDFC bank. The null hypothesis "There is no significant relationship between spread ratios and Net Interest Margin of select public and private sector banks". Accepted and alternative hypothesis was rejected.

COMPARATIVE RESULTS

When compared the test results of HDFC bank with SBI bank, during the study period 2010 – 2020, HDFC bank's NIM has not associated with its all Spread ratios. Hence the SBI bank's NIM has a significant association with Spread to working funds, interest income to working funds and interest income to total income. It can understand that SBI bank consists of better utilization of its funds to generate the profits.

SUMMARY OF FINDINGS & CONCLUSIONS

The SBI bank' The Net Interest Margin (NIM) significantly correlated with spread to working funds (r = 0.68; 0.05), interest income to working funds (r = 0.80; 0.01) and interest income to total income (r = 0.73; 0.05), signifies higher the banks' earning capacity indicates the greater NIM. And hence other ratios were not found to be significantly correlated with NIM. It indicates NIM not depends on other spread ratios. The HDFC bank' The Net Interest Margin (NIM) positively and insignificant correlation with spread to total income and spread to working funds, and it was negatively and insignificant correlation with remaining all variables. It indicates NIM not depends on all spread ratios of HDFC bank.

The study concludes that the SBI bank having huge profits through its traditional income, by offering higher loans and advances to the customers. Hence the HDFC banks' traditional income does not correlate with its profitability tells us they generate the profits through non- traditional income.

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