

Advancement in Sensor Technology in Shipping

N.I. Shaikh, P.P. Kamble, Siddharath M.T



Abstract: Shipping Industries is one of the oldest working industry in this world, but when it comes to going hand in hand with current technologies, maritime sector lags behind. Being the backbone of world trade, it can do wonders once it is digitalized. Modern technologies such as IoT which consists of sensor technology could help us make shipping efficient and sustainable. This paper reviews the existing literature on sensor technologies and its applications which could help us in empower efficient shipping. We would also deal with challenges this technology comes with and would discuss solution for it. This culmination of different ideas would help maritime industry to get a better angle on sensor technology or IoT in general.

Keywords: Shipping; IoT; Sensor Technology; Digitalization; Maritime transport

- The IoT, today all ships and maritime artifacts are fully equipped with sensors
- cloud and edge computing
- Digital security

This work is divided into the following sections, section 2 deals with approach and methodology, section 3 provides the picture of current of IoT and its prerequisites, section 4 embodies all the logical explanation and discussion about smart ships and ports and even talks about how the ship building can be transformed with the help of sensor technologies. Finally, section 5 concludes the paper.

I. INTRODUCTION

The maritime industry is the backbone of global trade. As per the UNCTAD report for the year of 2018 it was estimated that 90% of the world trade is done through Maritime trade. Hence to keep this industry in pace with worldwide globalization, we must make this industry safe and reliable to equal the odds of economic growth to catch up with surge in the economy due to globalization. If we go with some statistics the surge in sea borne trade was 4% in 2017 which was significantly high. Hence swiftness and safety are the most concerned parameters which determines the success of this industry. This can only be done by embracing new technologies. Contrary to the needs of the time, maritime industry is being called as industrialization 4.0 is very early stages of digitalization and industrial 4.0. This industry has the potential to carry forward a wave of autonomy that can easily help in the growth of 3 main sectors of this industry namely, ship and ship building, ports and docks, maritime transit. During the research, review of different articles helped to understand the asset shipping industry had in terms of using IoT with the help of sensor technologies. This study would target to give an impression of the following trends and how can they be applied to maritime field.

II. APPROACH AND METHODS

The application of IoT in different sectors have been widely discussed and reviewed in the literature, hence, while any reviewed literature, where focus is commonly on maritime industry or IoT technologies. This paper would help to review the specific applications of advanced sensor technologies which would help if effective shipping

This research was conducted systematically first the search for applications of sensors technologies were made the search platform like ScienceDirect, Google Scholar and DOAJ were used then searches were filtered with results to engineering and management branches wherever possible. The keywords were determined iteratively by using results from one search iteration to enhance and improve the search based on the achieved results. After several hit and trails attempts, we encountered with clear studies based on these topics. The parameters which kept in mind before including my work into this review of literature are: -

- use of scientific methods
- Relevance of study
- Innovation

III. IOT & ITS PREREQUISITES

IoT being an emerging technology that uses internet and aim to provide connectivity between physical devices referred to as things. Examples of physical devices include any appliance and industrial equipment fitted with a sensor. Thus, to achieve this technology appropriate sensors and neural networks are needed it has wide range of applications. Figure 1 shows the different components needed for an IoT platform. Now to plan an IoT applications in any type of industry, the first step is to select the desired component such as sensors, communication protocol, data storage and computation needed for any intended applications. They could be in form of sensors, actuators or IoT gateway devices and many more. As we know, all over the world, vessels are being equipped with the latest sensor technologies and software solutions. This has helped in opening doors of automation into our field.

Manuscript received on May 20, 2021.

Revised Manuscript received on May 25, 2021.

Manuscript published on May 13, 2021.

* Correspondence Author

N.I. Shaikh*, Indian Maritime University Mumbai Port Campus Hay Bunder Road Sewri Mumbai (MH), India. E-mail: noumaan3435@gmail.com

P.P. Kamble, Indian Maritime University Mumbai Port Campus Hay Bunder Road Sewri Mumbai (MH), India. E-mail: prajyotp.kamble@gmail.com

Siddharath M.T., Indian Maritime University Mumbai Port Campus Hay Bunder Road Sewri Mumbai (MH), India. E-mail: arther439@gmail.com

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)



Fig 1

The IoT Platform is completely dependent on the communication protocol which enable it to receive data from different sensors and process it for better decision making. Wireless connections such as the WIFI, Bluetooth can help us in shorter distances but to keep track of data with vast distances of our ocean is much of a challenge which can only be delivered by an enhanced satellite communication system specifically made for the shipping industry. There is a technology under development which targets to get machine to machine communication using the satellites. This is being done to get access of internet at the remote places which has the potential to produce renewable energies. Thus, same can be applied to the maritime transport industry.

The next enabling technology of IoT platform is storage of data and its processing. It is also called as Big Data. It is not our surprise that shipping industry being one of the largest and oldest industries if the world would generate a tremendous data for offline storage and processing. This would be time consuming and labour intensive; it can also be a threat to the security and privacy of the industry. Here the cloud computing would come in hand and would be much more feasible than its alternative. It is the data processing platform that offers services, applications, storage and computing through the internet and allows computation of data through the internet from the IoT Devices. The significance of cloud computing is as follows

- Enhancing the computing power and storage capacity
- Having multi core architecture
- Secured system

There has being an ongoing research of using cloud computing to deliver a communication network for monitoring order and improving performance to handle scheduled issues. the proposed approach to the cloud is done via SDN (software defined network).

Being successful to provide with all these prerequisites, we would be able to easily apply IoT in the maritime industry.

IV. ENABLING IOT IN SHIP AND SHIP BUILDING

This industry comprises of the ship design, engineering and building. IoT has vivid applications in all of this sectors. This segment is here to exploit the possibilities of

applications of IoT to these industries. With the advent of industry 4.0, it is really necessary to introduce IoT in the ship building industry. In the industrial sector, IoT is known as IIoT. The application of IIoT (industrial internet of things) in a shipyard would help us communicate better with the software systems and physical devices. The aim of this application is to provide with a user-friendly decision tool to the operators and engineers at the workshops. This would in turn, increase the efficiency and connectivity in a workshop. The most important role of IoT is to offer different solutions for existing industrial system and transform them into a digital environment. This would also make this slow industry more agile and will also help in productive and innovative ship building. Technologies like robotics, additive manufacturing, horizontal or vertical integration, and simulation can help us advance this industry to newer heights. There have been different studies which imply that this technology can handle complex engineering projects such as it could create “A Digital construction site for shipbuilding”. There has been attempts to use sensor technologies to make ships under a old method of ship blocks assembly. This technique uses a laser optical device for real time monitoring of locations of parts and track down block movement until properly fitted. This sensor-based monitoring system helps how precise work we can get to do using sensor technologies.

V. SMART SHIPS: IOT APPLICATIONS

Smart ships are the unmanned or remotely controlled vessels with all the state of art devices and sensors which in future, can easily help us to make the vessel autonomous with the help of evolutions. The smart ships are one of the general applications of advanced sensor technologies and IoT. This ship supports software-based decision making and sensors to help with maintenance. The companies like rolls Royce have even tested a remotely operated vessel in their local waters in 2020 and envision to send one into the open sea by 2025. To understand these advances in the smart ship, there are 4 main elements to be understood namely, navigation, guidance, physical ship and control.



Together these 4 elements form the backbone of the sensor applications on a ship.

Sailing the smart ships with increased sensors would help to ensure safe and efficient sailing speed where the power is calculated and proposed to the skipper based on the ETA desired. The sensors would help us to provide with the real time knowledge about the following parameters which would make sailing more efficient.

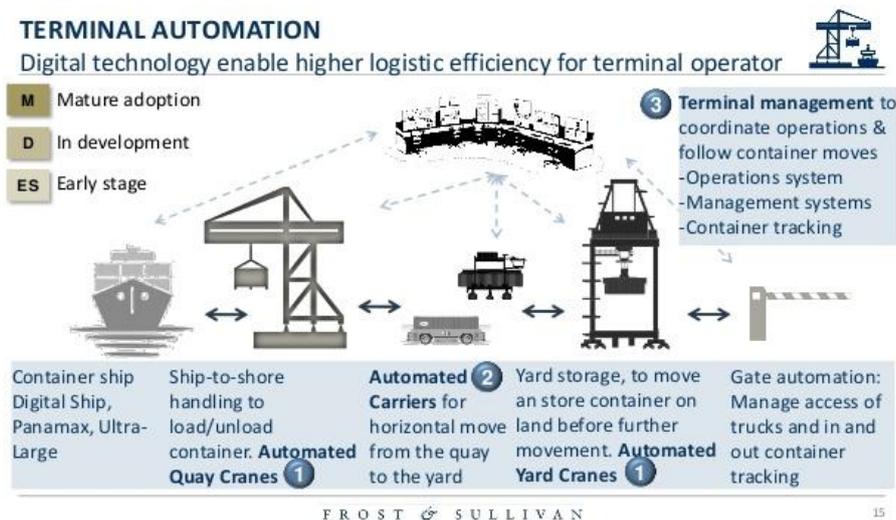
- The ship, including its current status, position, direction and speed
- Ship to ship interaction
- Sailing environment

This type of sailing would help in lower fuel consumption and lessen the human intervention which will indeed lower the costs of operating the ships. This sailing would help to avoid unnecessary idle hours on the ports and would make better use of the acquired time. There would be a large employment shift from sea to shore and hence personnel with algorithmic skills would acquire plentiful

jobs. Sailing through the locks and bridges would be very efficient as the coordination between the ships and locks and bridges would be achieved through sensor technologies. The communication between a smart ship and smart lock/bridge help as the sensors would inform the exact status of the ship such as time of arrival and sailing schedule to book a slot prior to the travel. Now the lock/bridge would communicate back with the full proof plan. This would make the operations smoother.

There have been studies going on about using a mobile middleware for providing aids ship navigation based on sensors and IoT Technology. This will help in exchange of information between ships which would help in cases of emergencies as well as would help in avoid collisions. Cargo tracking is also a way to a track supply chain location, security, status and settlement data of cargo for customers.

VI. SMART PORTS: IOT APPLICATIONS



A smart port is an automated port using data processing to make right business decisions and run operations effectively. This concept of use of smart technology to improve port performance and competitiveness. The OECD had predicted that global container handling in ports would be 4 times higher than current levels by 2030. To achieve this, we have to use sensor technologies for lessening the wait time outside of a port and easily complete procedures like mooring, towing and docking. With the help of sensors, the ship can constantly communicate its exact status to port officials and this would help officials to already prepare for the vessel.

Even the process of loading and unloading can be automated with the help of sensor technology. The sensors would provide real time location of the ship and expected arrival time. This inputs and communications between terminal and ship would streamline the operation of either loading or unloading. All the loading and unloading can be computer driven.

There are some studies and articles which have designed a system based on IoT using RFIDs with the aim to have a better port warehouse management. There is one more manuscript which applied the IoT to ports for global analysis made on information systems. By 2025, Rotterdam

would be Europe’s largest port and will host connected ships. It will use sensors to analyse real time data and a lot berths and also will look at weather, tides and many more.

At the time of researching for this technical paper, the news of blockade of Suez Canal can be treated as an excellent case in which IoT and sensor technologies could have helped and avoided this mishap. According to certain reports, there is a loss of \$400 million every due to this incident.

VII. CHALLENGES FACED

The biggest challenge for any industry to digitalise is it introduces highly sensitive data for abuse or data crimes if not secured properly. For example, Maersk suffered a computer virus attack (NatPetya) in 2017 that froze port operations in many countries. Also, privacy and compliance have to be ensured as well as how the data had to be collected and enhanced.



The solution for cyber-attacks is to use encrypted networks at the human interface ends of IoT applications.

The other major challenge for the technologies to successfully help this sector to be for efficient is that it is very much capital intensive and would also lack in human resource needed to get going. According to the report made by INMARSAT, there are 25% of the surveyed companies are ready to invest lumpsum amount (about \$3 million) over the period of next 3 years for the implementation of IIoT. The other 15% would allow only \$100,000 to be invested over the same period. This report raises the point that still main companies do not consider IoT as a safe investment and also are not convinced with fact that it would help them generate new revenues. But IoT is in much better condition than any other digitalisation processes which get less than 6% expenditure from this sector. This shows there is some faith in IoT which can in matter of a decade turn the tables for this technology.

VIII. CONCLUSION

The main conclusions which can be derived from this research is that:

- It is very much essential to adopt a protected IoT based platform to help maritime industry to compete with other industries without compromising the fact that it would face a challenge from cyber or phishing attacks.
- It is to be understood that IoT can be the reason of economy boost in the maritime industry. As the report says the application of IIoT based solutions would help in 14% of predicted cost savings within the timespan of five years.
- Automation of shipping is relatively straight forward compared to the traffic or aviation. SmartDock is example of a system developed by Finnish tech giant Wartsila
- The use of sensors will provide an excellent opportunity to improve the efficiency and safety of ships. Collecting high quality ship data with reliable sensors would helps in optimizing life cycle of the vessel.
- There would be a great employment shift from sea to shore.
- The integration of neural networks will help in certain level of intelligence for industrial control systems which are based on wireless communication channels

ACKNOWLEDGMENTS

We would like to thank our HOD-IMU MPC Mr. Hare Ram Hare Sir for guiding us in making of this paper. He also helped us research and cultivate the stated conclusions.

ABBREVIATIONS

IoT – Internet of things
UNCTAD – United Nations Conference on Trade and Development
Wi Fi – Wireless Fidelity
ETA – Estimated time of arrival
OECD – Organization for Economic Co-operation and Development
RFID – Radio Frequency Identification

REFERENCES

1. Choi, H.R.; Moon, Y.S.; Kim, J.J.; Lee, J.K.; Lee, K.B.; Shin, J.J. *Development of an IoT-based container tracking system for China's Belt and Road (B&R) initiative*. Maritime Policy Management. 2018
2. Chrysanthi Tziortzioti, Dimitrios Amaxilatis, Irene Mavrommati, Ioannis Chatzigiannakis. *IoT sensors in sea water environment: Ahoy! Experiences from a short summer trial*. Published by Elsevier B.V.2019 <https://doi.org/10.1016/j.entcs.2019.04.014>
3. COLUMBUS, *maritime sensor technologies for Europe: research, development and implementation*. Guide. Knowledge Transfer in Maritime Sensing Technologies.2017
4. Katayama, M.; Nakada, H.; Hayashi, H.; Shimizu, M. *Survey of RFID and its application to international ocean/air container tracking*. 2012
5. Naser Hossein Motlagh, Mahsa Mohammadrezaei and Julian Hunt and Behnam Zakeri. *Internet of Things (IoT) and the Energy Sector*.2020 doi:10.3390/en13020494
6. Park, N.; Bang, H.-C. *Mobile middleware platform for secure vessel traffic system in IoT service environment*. *Secure Communication Network*. 2016
7. Pedro-Luis Sanchez-Gonzalez *, David Díaz-Gutiérrez, Teresa J. Leo and Luis R. Núñez-Rivas. *Toward Digitalization of Maritime Transport?* MDPI 2019 doi:10.3390/s19040926

AUTHORS PROFILE



Nooman Shaikh, is currently pursuing B.tech (Marine Engineering -2ND YEAR) from IMU Mumbai Port Campus.(Former DMET MUMBAI)



Prajyot Kamble, is currently pursuing B.tech (Marine Engineering-2ND YEAR) from IMU Mumbai Port Campus.(Former DMET MUMBAI)



Siddharath M.T, is currently pursuing B.tech (Marine Engineering-2ND YEAR) from IMU Mumbai Port Campus.(Former DMET MUMBAI)