IoT Based Seismic Data Interpretation

B. Kannan
Senior Engineer, McDermott Engineering, Chennai, Tamil Nadu.

Abstract

In Oil and Gas extraction process, seismic exploration is being widely used and well known by geophysical technique among various survey methods. Moreover, Acoustic signals and Geophones/Hydrophones data is collected and thereafter convolutional model of seismic data is made use of to understand how trace is formed under the seabed. Accordingly, for survey purpose, Artificial Intelligence system like snake Robot, Flying Drones which reduces travelling time in offshore environment is proposed in this paper. IoT (Internet of things) Controller can be fixed with Flying Drones to send live data from hydrophones to Cloud platform using satellite communication as IoT and Cyber physical system might play a vital role in the upcoming years in majority of fields. For instance, Robot can capture the temperature, pressure, wind velocity, Water depth, Humidity etc. and transmits the received data to IoT cloud environment. Digital image processing techniques is used to convert the data received at onshore station to image in addition to the above-mentioned techniques.

Key words: Seismic exploration, geophysical technique, Convolutional model, Snake Robot Artificial Intelligence.

I. INTRODUCTION

Oil and gas are extremely important natural resources for human beings. During 2008 -2009, for example the world used 150,000 l/s of Oil, the highest when compared to previous year. According to Cambridge research associates, 3.7 trillion barrels oil is left. Today global challenges require new and innovative approaches. Oil and Gas deeply buried in deep land or marine subsurface geologic structures. In order to produce oil, first we need to determine the subsurface structure that is clear and accurate image of the sub surface through large- scale data acquisition. Then oil well can be drilled for commercial purpose.

The Exploration seismic method is the most widely used and well known geophysical technique for surveying method. In addition based on digital image processing acoustic wave converted and verified accordingly. Seismic method involved three stage seismic data acquisition, seismic data processing, and seismic data interpretation. The main aim of the exploration seismic method is knowledge of the distribution of wave impedance that reflects the subsurface geology.

Exploration seismic typically penetrates the subsurface up to a few kilometers in depth. Basically, one records has amplitude of the reflected seismic waves and time at which such amplitudes arrived at the receiver. Then the data can be processed and interpreted using signal and image processing algorithms, which ultimately influence the decision on where to drill wells that will eventually produce hydrocarbons. The first stage in exploration seismic survey is the acquisition

stage , where the seismic data are collected by an array of receivers (geophones for land and hydrophones for marine), transmitted over a narrow band- channel and stored for processing.

The acquisition can be done to acquire 2D or 3D seismic data. Next comes the processing of the acquired seismic data sets. Seismic data processing involves the use of many sequential mathematical and signal processing techniques, which are blended with a somewhat subjective interpretation by an experienced geophysicist. This includes seismic data processing like geometric spreading, frequency filtering, de-convolution, velocity analysis, seismic migration, and imaging. Finally, process data goes to interpretation stage. Seismic data interpretation aims to extract aims all available geologic information from the processed and imaged seismic data. Interpretation involves sophisticated image processing algorithms. Concept involved in both onshore and offshore both are same only difference (Hydrophones used in Marine environment and Geophones used in Land).

II. ROLE OF SURVEY

Survey like to be precise as well as accurate, in the offshore world there are added complexity for the team and the equipment. The word survey covers wide range of services includes Positioning, Geophysical surveys. Positioning offshore is provided by utilizing the multiple satellite constellations that now orbit the earth , of which the US department of defense GPS system is the best known example. Other system are GLONASS (Russia), IRNSS (India). Geophysical surveys are carried out from vessels to acquire seismic, sonar, bathymetry, oceanographic and environmental data which is used by the hydrocarbon, telecommunications, dredging and subsea mining industries. The surveys identify drilling hazards and establish corridors for pipelines and cables as well as the seabed conditions for sub-ocean mining. This requires cutting-edge technology as the water depths vary from 5 meters to 4,000 meters – yes 4 kilometers straight down.

III. EXISTING SYSTEM

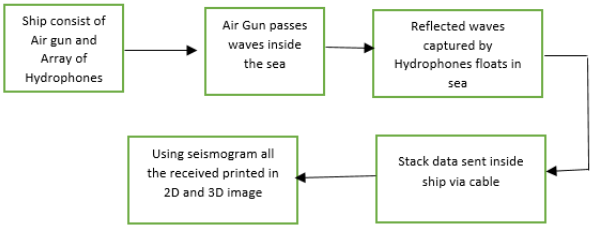

Fig 1.Basic Principle of Seismic Method

The basic principle of Seismic method are based on determinations of the time interval that elapses between the initiation of a sound wave from detonation of a dynamite charge or other artificial shock and the arrival of the vibration impulses at a series of seismic detectors (geophones). Since the middle of the last century seismic reflection surveying has undergone rapid development and has become, arguably, the foremost method for imaging the structure of the Earth's crust. referred to for more information. Reflection seismic surveys are currently widely used in a range of disciplines in academia and industry (primarily hydrocarbon exploration), with many millions of kilometers of data acquired. Refer fig 1&2&3.

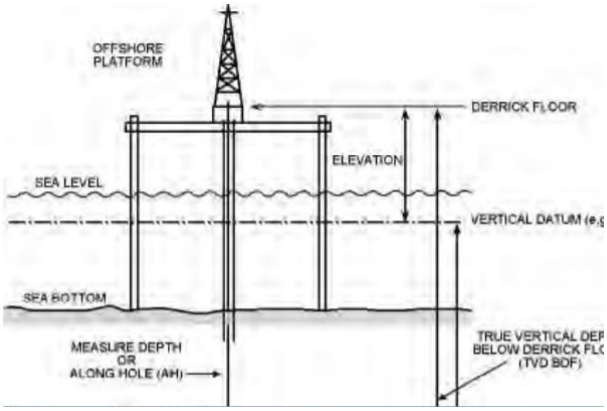

Fig. 2

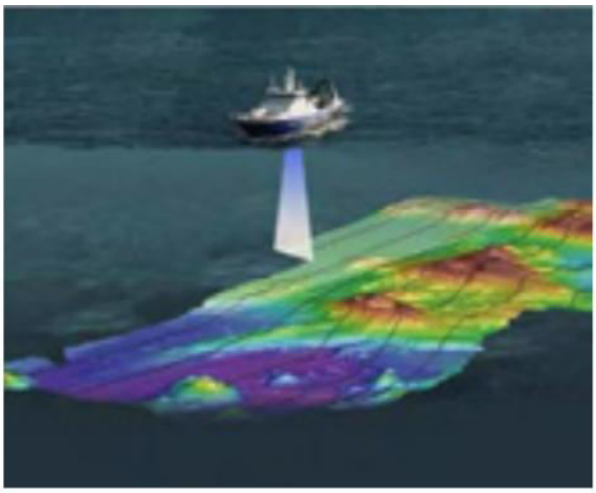

Fig. 3

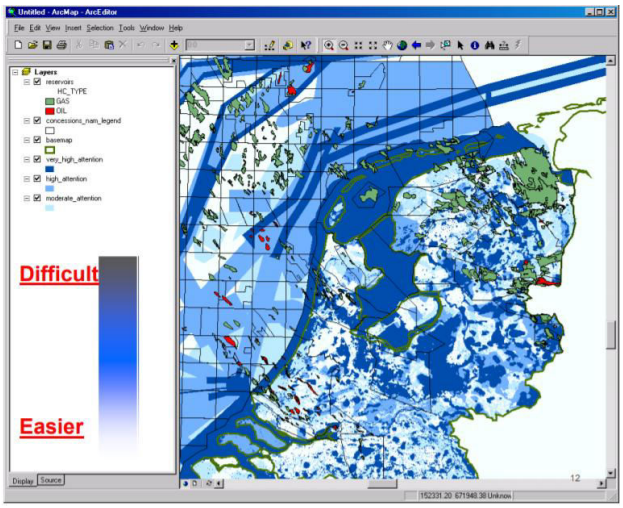

Fig. 4

Figure-1 side view of the offshore platform in the marine environment, figure-2 shows the seismic waves capture in the ship. Figure-3 shows GIS analysis to access ease of access to drilling permits underlying data protected habitats, migratory birds, fish & mammals.

IV. PROPOSED SYSTEM

AI Drone

Artificial Intelligence (AI) is the science of instilling intelligence in machines so that they are capable of doing tasks that traditionally required the human mind. AI based systems are evolving rapidly in terms of application, adaptation, processing speed and capabilities. Machines are increasingly becoming capable of taking on less-routine tasks. While, human's intelligence is actually 'taking' a perfect decision at the appropriate time, AI is merely about 'choosing' a right decision at the appropriate time. One of the main tools to achieve artificial intelligence is machine learning (ML).Human brain can solve certain types of learning problems. For example, there are plenty of optical neurons in the visual system which makes object recognition easy for humans. Learning is not only restricted to humans, it is diversified to animals, plants, etc. A bird learns to fly, a child learns to speak, plants learn to adapt to the environment and so on. Our very survival depends on the ability to learn and adjust to the environment. Refer Figure-4 Proposed Block diagram where Drones and Snake robot can be used for survey purpose. Drone has Inbuilt GPS System, IoT Controller,

Battery system, Motor, I625 Material to withstand in marine environment, swing blades, ESC (Electronic speed controller), GPS system.

Even a few decades back, nobody could have imagined having a video chat with their families in a different continent. Nowadays, it is a common thing. All of these is due to technology getting cheaper, and devices emerging with new and improved capabilities. People can get things done with a click on their smartphone, be it sending emails, paying bills, transferring money or booking a cab.

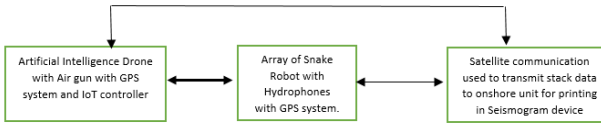

Fig 5: Proposed Block Diagram

IoT (Internet of Things):

Apart from being used inside smart homes, IoT has a huge application area in the various industrial sectors. These solutions perform statistical and financial analysis of a company as a whole and finally provide predictions using some AI and machine learning algorithms. Since various things are continuously connecting to form an IoT, there are various disciplines that get associated with IoT. Therefore, IoT can also be thought of as a combination of various domains. Figure 7 gives a representative list of some domains (most of these overlap with each other. in terms of concepts and techniques) constituting the IoT. Internet of things is just a connected system of physical things (like appliances, crop fields, plants, animals, etc.) and humans. Humans are connected to these devices using some smart objects attached to both which are capable of sending, receiving and analyzing data. These smart objects represent the entity (a human or a physical thing), it is attached to, in the network Also Fig 5. Shows how Drone is connected with IoT and Stacked data pushed to the Cloud platforms. List of cloud platforms are EWON, Amazon web services, SAP HANA, Siemens Mind sphere etc. By using Cloud platform all the available data in IoT device can be pulled using MQTT, HTTP Protocol via packets.

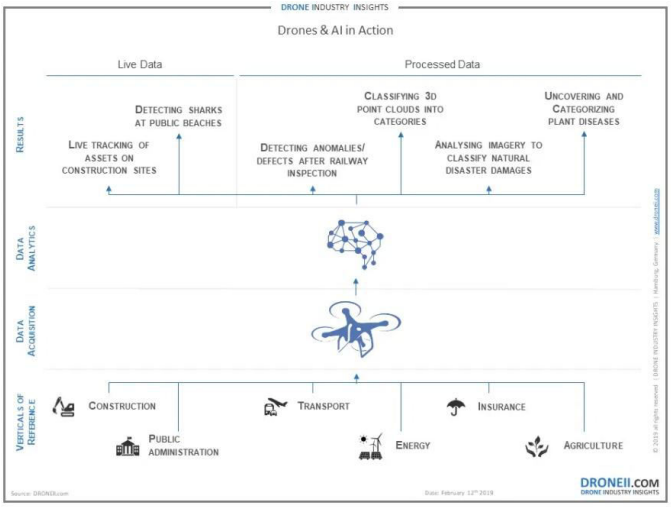

Fig 6: AI Drone Connected with IoT Cloud

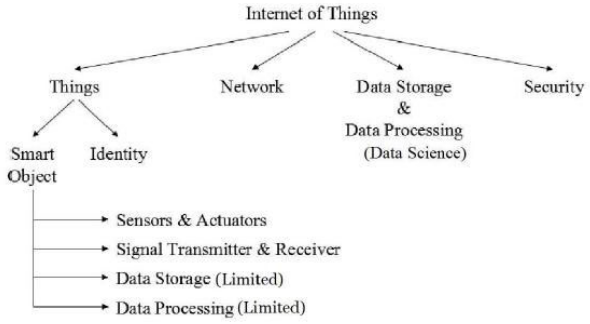

Fig 7: IoT Tree

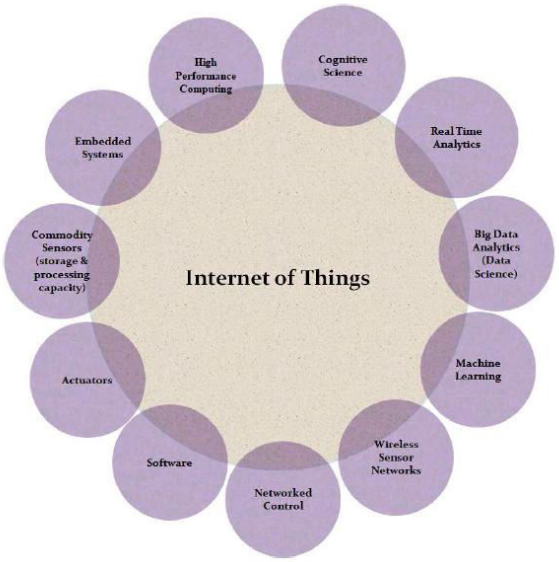

Fig 8: IoT into Different Fields

AI Enabled IoT

IoT is a vast concept encompassing too many sensors, actuators, data storage and data processing capabilities interconnected by the Internet. Thus any IoT enabled device can sense its surroundings, transmit, store and process the data gathered and act accordingly. The last step of acting accordingly is entirely dependent on the processing step. The true smartness of an IoT service is determined by the level of processing or acting that it can perform. A non-smart IoT system will have limited capability and will be unable to evolve with the data. However, a smarter IoT system will have artificial intelligence and may serve the actual goal of automation and adaptation. In this context, few examples of existing IoT services with the working of AI behind them are Voice assistants like Alexa, Siri , Google Assistant.

V. CYBER PHYSICAL SYSTEM:

When it was coined by Helen Gill at the National Science Foundation in the United States. CPS according to National Science Foundation (NSF) are “engineered systems that are built from, and depend upon, the seamless integration of computational algorithms and physical components”. Today it is thought of as a system that Works on and is monitored by computer-based mechanisms (built inside each component as well as in the complete system), strongly connected via the Internet and is easily accessible to its users.

Satellite Communication

For offshore oil and gas, satellite communications seems made to order. It's fast, simple to use, and capable of moving huge amounts of voice, fax, and data from here to there, anyplace on the globe, in a fraction of a minute. Nearly everybody benefits one way or another - drillers, logging, and seismic contractors. And their clients, of course, the producers. Inmarsat A provides a high-quality phone, telex, fax and data service at transmission speeds of 9.6 kilobits per second (kbps).

GPS (Global Positioning System)

Worldwide media and scientist attention have put Unmanned Aerial Vehicles (UAVs) in the spotlight. UAV or also known as a drone is an unmanned aerial vehicle that has the main functions for intelligence, reconnaissance and surveillance. The recent developments of drone for sprayer pesticide applications and used for delivering items, for example the

Amazon Prime Air, where Amazon used an octocopter to deliver items with weighs less than 5 lb or around 2.3 kg. Drone also can be used as a tool to survey a building [4], aerial photogrammetry and mapping. Recent advances also pushing drone technology to adopt a newer way of communication, such as an implementation of Mobile Edge Computing (MEC) [6], and Low Power Wide Area Network (LPWAN). Geodetic coordinate system is a coordinate system which a position defined by 3 numbers, a latitude, longitude, and altitude. A position which defined by geodetic coordinate system is a position on a globe. Latitude is a line that intersects the defined position and a line which parallel to an equator line. Longitude is a line that intersects the defined position and a line which parallel to a prime meridian line. Altitude is a distance between defined position and the ellipsoid. Our proposed method uses Air gun Outlet sensor as switch which provides information whether waves are transmitted inside the seabed. This drone will be keeping distance between sea level and drone is 10 Meter. Using ultrasonic sensor distance is measured based on same AI algorithm is developed accordingly. The system has a few features such as altitude and speed settings. Proposed system designed to be able to interact with interactive sensors. Other than that, the navigational algorithm itself could be further enhanced and fixed using a more precise and adaptive algorithm that could navigate from any distance and for any usages.

Snake Robot

Snake robots carry the potential of meeting the growing need for robotic mobility in unknown and challenging environments. These mechanisms typically consist of serially connected joint modules capable of bending in one or more planes. The many degrees of freedom of snake robots make them difficult to control, but provide traversability in irregular environments that surpasses the mobility of the more conventional wheeled, tracked and legged types of robots. Research on snake robots has been conducted for several decades. Early empirical and analytical studies of snake locomotion were reported already in the 1940s by Gray, and Hirose developed the world's first snake robot as early as 1972. In the last 20 years, the literature on snake robots has flourished enormously with numerous proposed approaches to modelling, development, and control of these mechanisms. In this paper we suggest to use snake robot in marine environment to collect the reflected waves from the sea bed. There shall be array of snake robot to collect the waves.

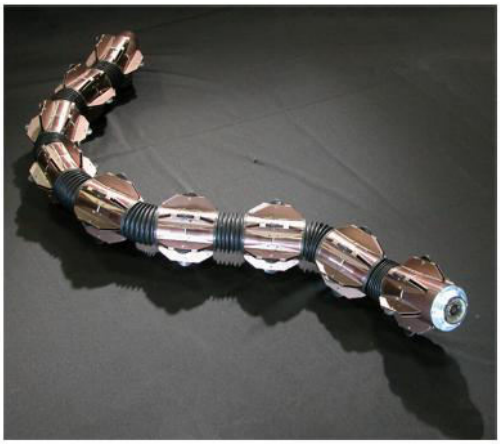

Fig 9: Typical Snake Robot

Control of Snake Robot

a) Joint Actuation Mechanism:

The articulation mechanism of each joint module (see Fig. 11) has two degrees of freedom (pitch and yaw) and consists of two links supported by bearings in a steel ring. Each link has a connection point that allows it to be connected to the next joint module by two screws. A magnet measuring 6 mm in diameter is attached to each link so that it rotates above the rotary encoder as shown in Fig. 9.Each link is driven by a Hitec servo motor (HS-5955TG) by connecting the output shaft of each motor to a worm gear (gear ratio of 1:5.71) through a steel roller chain

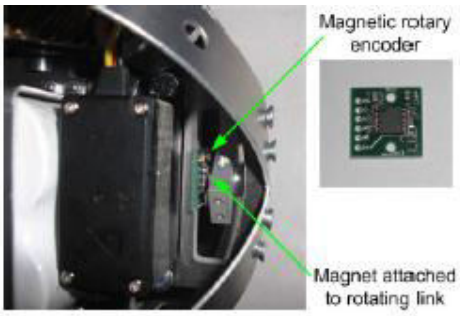

Fig 10: Magnetic Rotary Encoder for measuring the joint angles.

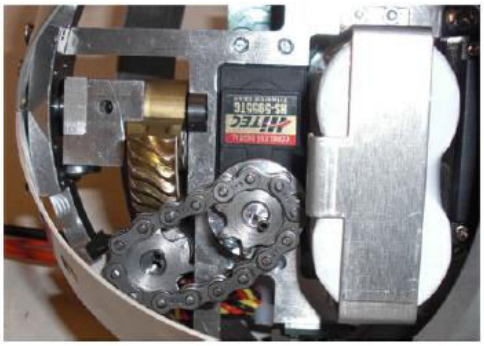

Fig 11: Roller chain connecting the servo motor to the worm gear

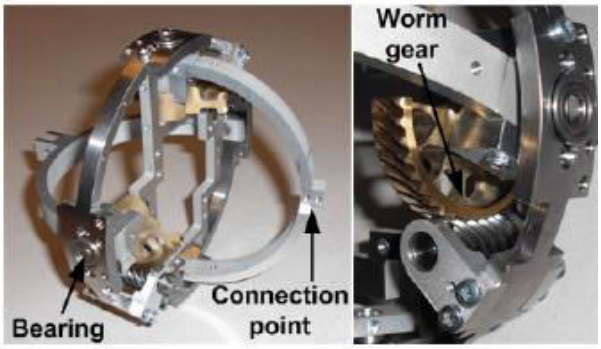

Fig 12: The articulation mechanism of the joint modules

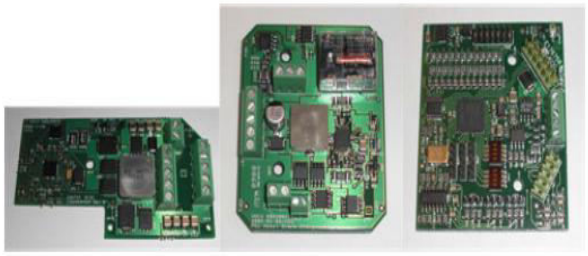

Fig 13: The Voltage Regulation Card. Middle: The battery Charge card. Right: Joint Controller card

b) Controller:

Each joint module is controlled by the microcontroller card shown to the right of Fig. 12, which is based on the Atmel microcontroller AT90CAN128. This card continuously measures the joint angles and the contact forces, and generates PWM pulses for the servo motors. The card has a CAN bus interface for communicating with the other modules of the robot refer fig 12. The head is also equipped with a small wireless camera and two IR distance sensors

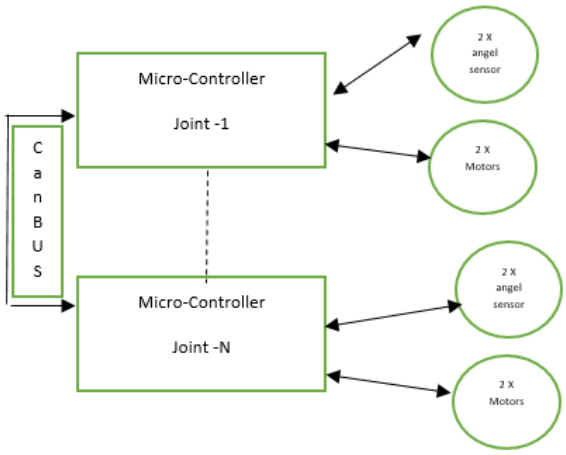

Fig 14: Data Flow between Modules

c) Power Supply:

Each joint is powered by two serially connected Lithium Ion batteries (6.6V at about 2.3Ah), which are charged by a battery charger card (see the middle of Fig. 12). Regulation of the voltage to the internal components of a joint is handled by the card shown to the left of Fig. 12.

d) The exterior Gliding surface:

The exterior gliding surface by covering each joint module by two hemispherical shells can be made by Inconel 625 or higher grade material to withstand in corrosive water environment. Each shell is attached to the joint mechanism by the screws.

e) Force sensor:

Four force sensing resistors (FSRs) with diameter 13 mm are mounted on each side of a joint module to measure contact forces. A FSR is a polymer thick film device that exhibits a decrease in electrical resistance when the force applied to the sensor increases

VI. RESULTS AND DISCUSSION

Drone makers are collaborating with oil and gas companies to develop custom drones with data collection technology to obtain real-time insights. One of the early adopters of drones, BP, started conducting pilot studies in 2006 at its oilfields in Alaska. The studies evaluated the effectiveness of drones in monitoring gravel road conditions. This helped ensure safe and efficient movement of trucks supplying oilfield equipment to the production site. Chevron is leveraging the aerial data acquisition capabilities of drones for improving safety and productivity at oilfields. The company is applying augmented reality to drone feed for evaluating field equipment and infrastructure during inspection and monitoring operations. Chevron is also experimenting on the application of drones in the event of industrial accidents, particularly for assisting in oil spills. Apart from this drone can be used in automated data gathering, Maintenance, integrity, surveillance workflow, pipeline inspection, flare inspection.

VII. CONCLUSION

An Offshore Industry can be replaced with Drones and Snake robot to reduce the time, man power for the Industries. In addition in Subsea system already snake robots plays vital role in installing umbilical's, riser and Flow arms under the sea. Snake robot used as a mechanic to operate the subsea system. I strongly recommend to implement ideas present in this paper practically to overcome many circumstances.

FUTURE ENHANCEMENTS

- Future work will include other testing like simulating the system using LABVIEW software.
- Need to analyze the best back up system for batteries.
- Need to analyze the best back up system for batteries.

REFERENCES

[1]P.Liljeback , K.Y. Pettersen , O.Stavdahl, J.T Gravdhal I., "A Review on Modelling , Implementation , and Control of Snake Robots ", Norwegian University of science and technology .

[2] Ashish Ghosh , Debasrita Chakraborty, Anwesha Law " Artificial Intelligence in Internet of Things " IET Research Journals.

[3] Eleni Kelasidi and Kristin Y. Pettersen Department of Engineering " Modeling of Underwater snake robots".

[4] Pal Liljeback,Member IEEE, Kristin Y.Pettersen ,Senior member IEEE and Kristin Y. Pettersen Department of Engineering " Modeling of Underwater snake robots".

[5] Lin fa ; Lei wang ; Yuan Zhao,Lin liu, Yazuan zheng, Nan Zhao , Meishan Zhao , and Guohui li " Research progress in acoustical application to petroleum logging and seismic exploration ", School of engineering , XI'an' university of post and telecommunication , Xi an Shannxi, China .The james frank Institute and department of checmistry , the university of Chicago , Illinois, USA.

[6] Daniel Sopher "Converting scanned images of seismic reflection data into SEG-Y format. Methodology Article.