Oil Well Detection System for Seismic Surveying Based on Internet of Things (IOT)

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Abstract. Seismic Surveying is a geophysical survey that was conducted to measure the physicals principle in earth's geography like magnetic, gravitational and thermal. There are several simulations that have been produced to be used in oil and gas field, such as Petrel by Schlumberger and ECLIPSE. however, this simulation is confidential and cannot be used by individuals outside the company. Therefore, some of petroleum geologists are not able to use the simulations in their geology analysis. This issue is also experienced by students studying in this field as they are not able to access any simulations. Hence, making them not able to experience the real environment of the process for their future used. The existing software also do not analyse real time data, which will be covered in this project. Oil Well Detection System for Seismic Surveying is a web-based system that aims to analyse data for seismic surveying to give user better understanding on the process before conducting it in real life. This system also uses real time data in order to generate the result for the simulation. Users are able to generate the data in numeric data sets, 2D or 3D images. Notifications will be sent to users whenever there are data generating the best limestone result. This is to make sure that users have the best field for new oil reservoir and comparing the data of seismic surveying to make sure the best region to drill. The sensors technology will be used to detect the elements in limestone and send the data to user's smartphones. Prototype Model Methodology is used throughout the development process alongside Firebase Cloud Database for storing information. This project will help petroleum geologists and students to experience the real time simulation in order to have better understanding about seismic surveying before conducting it in real life. They also can use it as study purposes as it is beneficial to students.

1. Introduction

OWDSS is a new system that is developed to help oil and gas industry to minimize processes in order to save the cost of detecting new oil well in the future. These project will help petroleum geologist to be prepared for their seismic survey in order to prevent them from using the bad dropper that can cause a false earthquake and give a bad impact to the marine wildlife. It also can be used by petroleum students as their learning process and mechanism. This project will also include several hardware such as sensors and new technology applications for consumer use.

Other than that, OWDSS can help people in this industry to explore more features that technology bring them and also to help them in managing better experiment before conducting Seismic Surveying. OWDSS can also be used in other field to help in analysing the soil composition for other project in the future.

Domestic shale extraction of natural oil and gas has brought big impact to the world economy for almost every country in this world. Due to the world active demand on this natural resource as reported by the International Energy Agency (IEA), 18% of this world's electricity would be generated by wind farms by 2050 compared to 2.6% in 2013 and there is still likely to rely on oil and gas sector that causes the sources to become limited day by day. They are some consequences faced by this sector in term of maintaining the market demand of oil which highly increases daily, for example, the failure of maintaining the oil market price and also the breakdown of green environment protection.

Additionally, Malaysian oil and gas companies are also trying to make the operations more sustainable by making it more environmentally friendly while still offering the best security and safety of their crews, and it might be particularly difficult for this firms. The biggest challenge faced by the firms is coping with high costs of operations as many current wells and fields are drying out of sources and the natural gas suppliers have been forced to explore new deep-water options which causes them to handle with another risky challenge.

Despite the fact that they are facing those challenges, they also come out with a different solution that will help them to continue in providing the best sources of world demand. They are trying to overcome the skilled labour shortage issue by encouraging fresh graduate and youth to jump into the science and engineering disciplines and slowly attract them into oil and gas industry.

Other than that, they also have an idea of having collaboration about the integration across upstream, midstream and downstream and also join the investments with outside host country instead of using technology to cope with management and information issue. Additionally, they are also trying to remain the operation effectively while trying to maintain the margins within the environment to handle with fluctuating crude prices issue.

2. Related Work

Oil and Gas field is a big environment that is not yet fully explored by technology. There are several existing simulators [1-7] in this field that can simulate seismic surveying. Figure 1, 2, and 3 show the existing simulators for seismic surveying which are: Petrel Geology and Modeling, ZetaWare Inc, and ECLIPSE Industry – Reference Reservoir Simulator. The objective of this study is to compare the technology used in existing system to help in developing OWDSS. Table 1 shows the comparison of existing system with OWDSS.
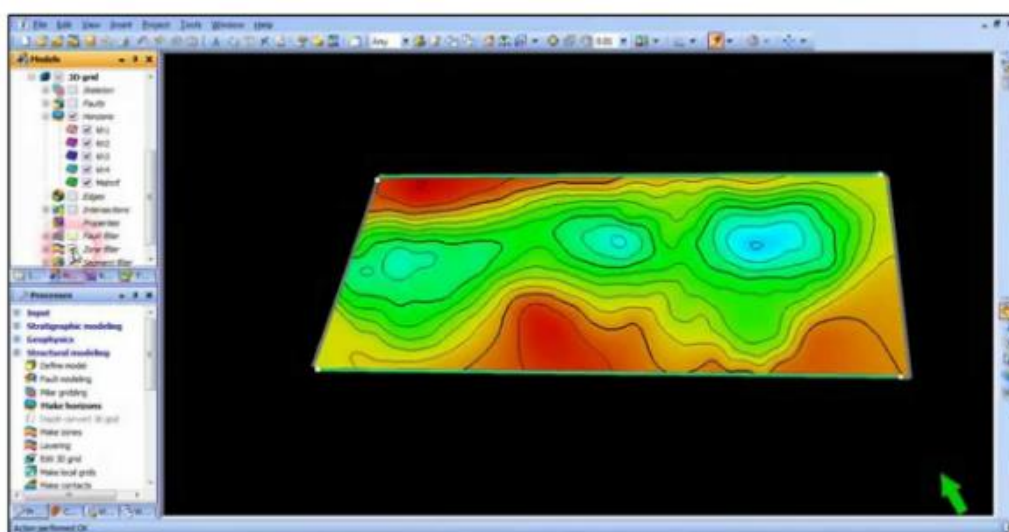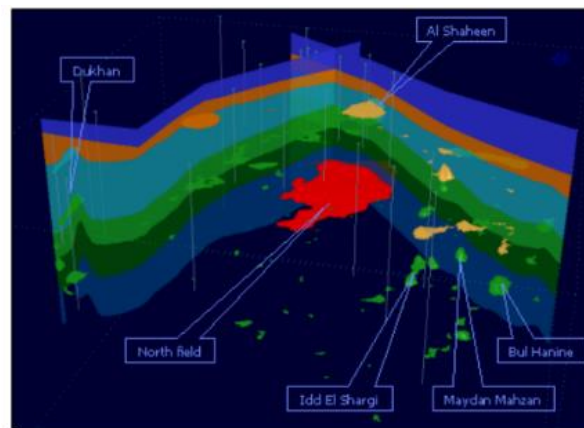

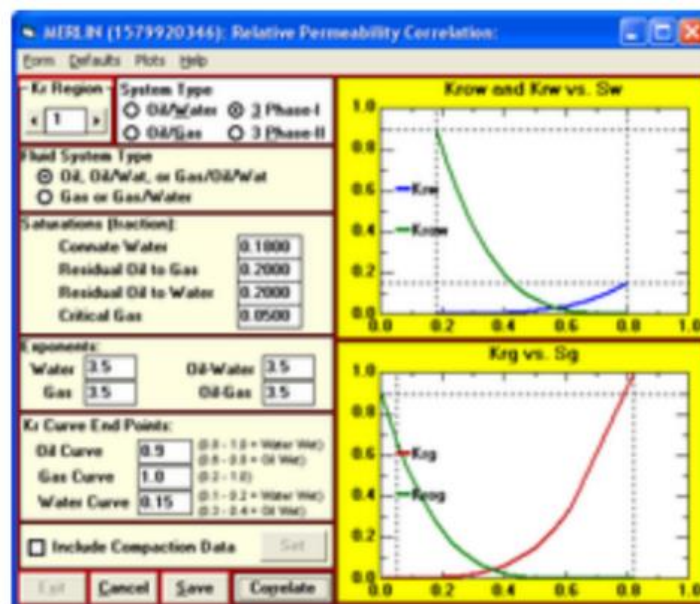**Figure 1.** Petrel Geology & Modelling

Figure 2. ZetaWare Inc.

Figure 3. ECLIPSE Industry – Reference Reservoir Simulator.

Table 1. Comparison between existing systems.

	Petrel Geology & Modelling	ZetaWare Inc.	ECLIPSE Industry-Reference Reservoir Simulator	Seismic Surveying Simulation (This research)
Type of System	Web-based	Web-based	Web-based	Web-based
Processing Time	Medium	Medium	Fast	Fast
Cost	Expensive	Expensive	Expensive	Cheap
Type of Data	2D and 3D images	2D and 3D images	Numerical Data	Numerical data and 2D or 3D images
Field of Study	Geology modelling	Geology & basin modelling	Reservoir	Seismic Surveying
Real-time Data	No	No	No	Yes
Ease of Organizing	Yes	Yes	Yes	Yes

3. The Proposed Methodology

Prototype model is built to understand the requirement of the project, instead of freezing the requirements before proceed with design or coding. This methodology is a software development model which is based on the current requirements.

The interactions between the project and client enable the client to experience the real environment on using the applications or systems and enable them to understand better on the requirements needed by the system. This model does not involve manual process or existing system to help on choosing the requirements and it makes the model suitable for complicated and large systems development. Figure 4 shows the architecture of the prototype showing the interactions between the data and the system.
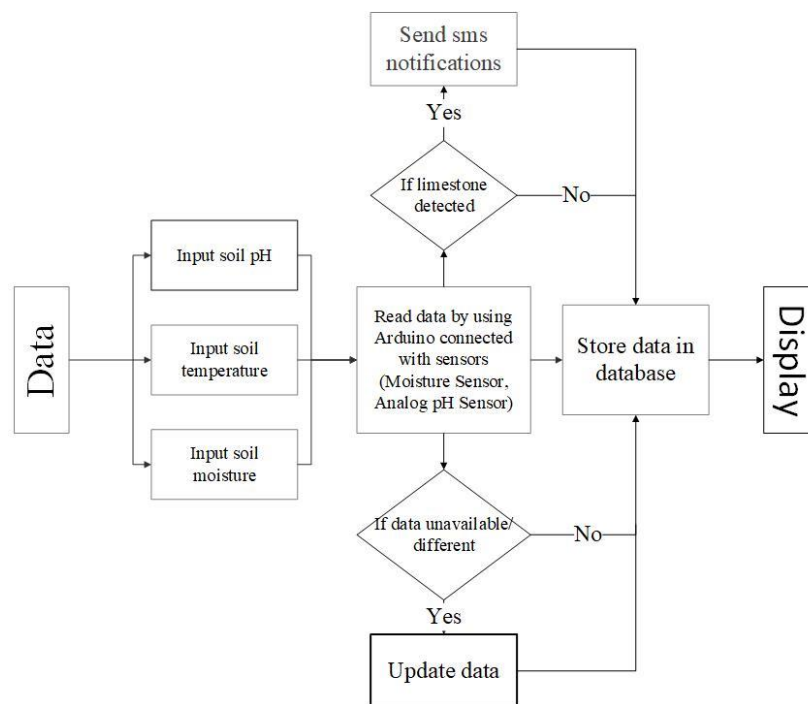

Figure 4. Architecture of the system.

There are several steps or processes need to be done in this methodology which are requirement gathering from the client, quick design or sketching by the developers, building the prototype framework, customer evaluation, refining the prototype process which will be done between the developers and the clients, and the last one is engineering product or final product. The processes are shown in figure 5.
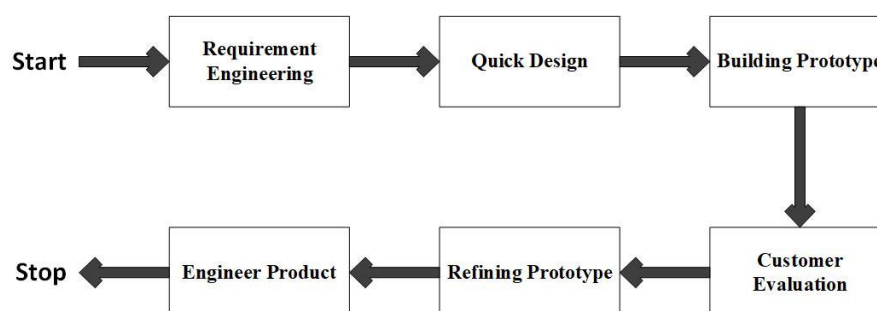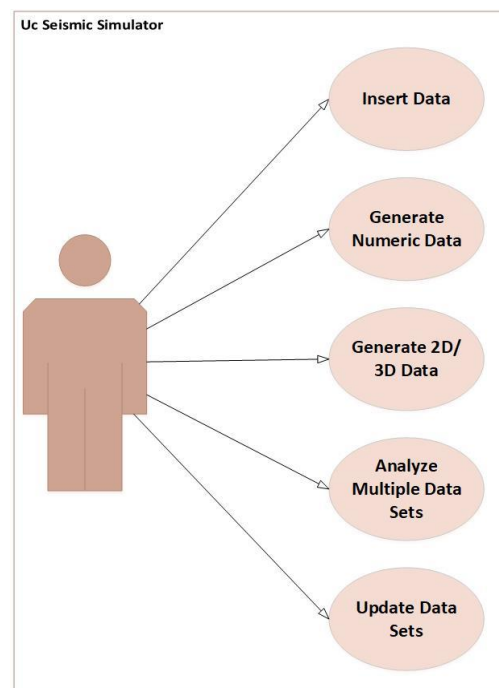

Figure 5. Prototype Model Methodology.

Figure 6. OWDSS Use Case.

3.1. OWDSS Use Cases
Figure 6 shows OWDSS use case diagram, it explains the interactions between the actor and every functions of the system.

3.2. Technology Used
- The Analog pH Sensor
  This sensor is used in this project to measure the pH of the soil pore water. The sensor will read the pH value simultaneously to be used in data analyzation.
- Temperature Sensor
  This sensor is used to detect the foundation for all advanced forms of surrounding temperature to make sure the survey conducted is suitable as needed.
- Moisture Sensor
  Moisture sensor reads the amount of moisture present in the soil surrounding it in order to confirm that the soil is good for the future survey.
- Ethernet Shield for Arduino – W5200
  This Ethernet shield is based on Wiznet W5200 Ethernet Chip which helps to connect Arduino to the internet. It supports four simultaneous socket connections and uses the Ethernet library to write sketches which connect the internet using the shield.
- GY-NEO6MV2 Flight Control GPS Module
  This GPS receiver based on u-Blox Neo-6M GPS module is used to locate the possible oil well for the Seismic Surveying. This device also have built-in EEPROM that gives better signal reception and have ceramic antenna that is connected to the board via U.FL connector.
- Arduino Uno REV3
  An open-source hardware with microcontroller board based on ATmega328P datasheet. This Arduino has 14 digital input/output pins, 6 analog inputs also an ICSP header and a reset button. It differs from the other board because it does not use the FTDI USB-to-serial driver ship and it features the Atmega16U2 programmed as a USB-to-serial converter.
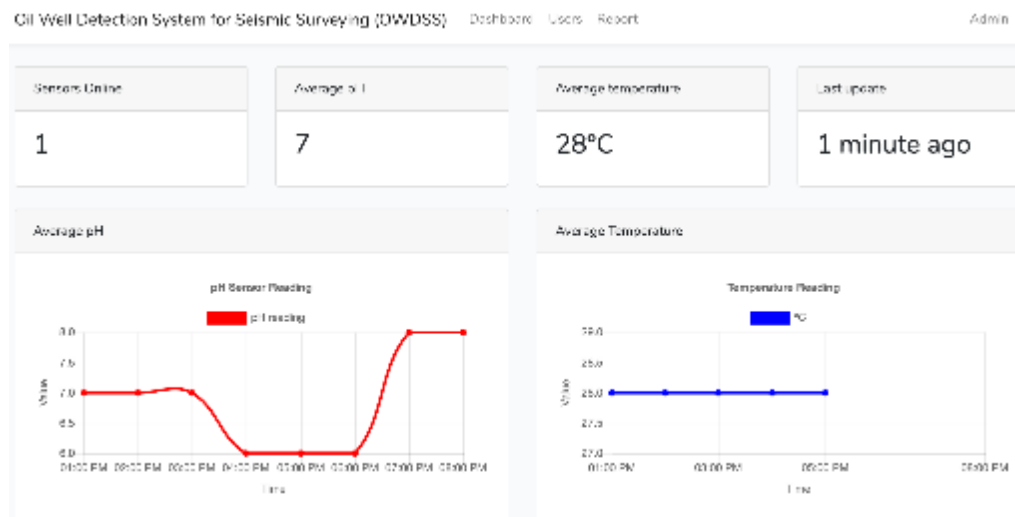
3.3. Source Code Language
- Please Laravel
  The language used in this project is Laravel. This language is chosen due to its performance, features and scalability. It follows Model View Controller (MVC) and is better than PHP.

3.4. System Design
OWDSS web-based system is a system that consist of several hardware components like sensors, Raspberry Pi and Arduino. User will interact with the sensor to get real-time reading of soil pH value, moisture and also temperature to be generated to use for the seismic surveying. When user sign-up for the system, user's information will be updated in the Firebase cloud database and will be monitored by the system admin. This system was developed to be user friendly to ensure that the system is easily used and understood by users. Figure 7 and 8 shows the Dashboard Interface and Login Interface of OWDSS respectively. Figure 9 shows the Report Interface which includes all the historical data of the system.

Figure 7. OWDSS Dashboard Interface.

Figure 8. OWDSS Login Interface.

Figure 9. OWDSS Report Interface.

3.5. System Database

The development of IoT based application or web-design requires a wide range of data to be stored and can be worked with. Thus, a stable database is required to make sure that the system can store and collect data from the database correctly. With the emerging cloud database, Google have introduced Google Firebase cloud database to the public.

Firebase is a cloud database that runs backend code without the need to manage the server so that the data can be delivered with speed and security. It also stores real-time data which is a suitable feature for IoT project which requires real-time data to work with. All the data will be stored and served at Google scale which is a cloud storage. Therefore, Google Firebase is chosen for this project to store real-time data from the sensor and other components. Figure 10 shows the configuration for Firebase Database.

Figure 10. OWDSS Firebase Database.

4. Results and Discussion
Throughout the system testing phase, the failure issues shall be fixed by the developer after the testing phase is finished. This is to ensure that the system developed is reliable and consistent when it is used by users. Other than that, the system testing is also used to measure the achievement of project scope which was identified during the early documentation phase. Usability test and user acceptance test is often used by the developer for system testing.

Moreover, usability test is a test that conducted by software tester to a measure of how easy the system can be used by end users, where it consists of five following features, learnability, efficiency, memorability, error and satisfaction.

For OWDS, the system testing was conducted by giving questionnaires to possible users who are familiar with Seismic surveying systems. Overall, three users responded to the given questionnaires. Based on the response, 66.7% users found the system easy to use while 33.3% of the users found the system not easy to use. 100% of the users understood the workflow of the system, found the system to be easily navigated, and agree that the system output is displayed correctly as user expected.

5. Conclusion
This system is developed in the hope of helping the world to keep producing natural resources while saving the marine wildlife. The properties of efficiency and user-friendly in this project can be beneficial to petroleum student, academia and also petroleum geologist. Other than that, it helps petroleum students to visualize and experience the real situation of seismic surveying without the need to spend money on expensive software. This also helps UTM in saving money while providing the best tool and service to their student in order to produce excellent graduates from this field.

References
[1]   Bailey, H., Senior, B., Simmons, D., Rusin, J., Picken, G., & Thompson, P. M. (2010). Assessing   underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. *Marine Pollution Bulletin*, 60(6), 888–897. doi: 10.1016/j.marpolbul.2010.01.003

[2]   Goold, J. C. (2009). Acoustic Assessment of Populations of Common Dolphin Delphinus Delphis In Conjunction With Seismic Surveying. *Journal of the Marine Biological Association of the United Kingdom*, 76(3), 811. doi: 10.1017/S00253154000314771. S. Jacobs and C. P.

[3]   Gordon, J. C. D., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M. P., Swift, R., & Thompson, D. (2004). A review of the effects of seismic surveys on Marine Mammals. *MArine Technology Society Journal*, 3–4.

[4]   Coulson, S., Cutts, A., Sweeney, D., Hinsch, R., Schachinger, M., Laake, A., & Towert, J. (2009). Satellite Sensing: Risk Mapping for Seismic Surveys. *Oilfield Review*, 20(4), 40–51.

[5]   Richard, E., Mead, B., Zlotnikov, E., Park, H., Us, N. J., Haders, D., & Nj, S. (2011). United States Patent, 2(12), 19–35. doi: 10.1145/634067.634234.

[6]   Di Iorio, L., & Clark, C. W. (2010). Exposure to seismic survey alters blue whale acoustic communication. *Biology Letters*, 6(1), 51–54. doi: 10.1098/rsbl.2009.0651

[7]   McCauley, R. D., Production, A. P., Association, E., Fewtrell, J., Duncan, a J., Jenner, C., & Mccabe, (2000). Marine seismic surveys — A study of environmental implicazions. *APPEA Journal*, 40(1), 692–708.