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Industrial IoT based VFD Control for ESP Used in Oil Fields

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Abstract - *An Advancement in technology with automated systems is the requirement of the present Industrial world. Motion control of the systems is required in large number of industries for domestic as well as industrial automation. We have proposed to develop Industrial Internet of things (IoT) platform for ESP Data monitoring and control applications. As a case study of oil industry we are considering a model of a Artificial lift oil extraction using Electrical submersible pumps (ESP). This model is having a lot of usage in Oil industry for Extraction of crude oil from very deep of earth surface. Through this project we are planning to integrate the automated device, achieve an analogous system of intelligent devices and at the same time focusing attention on Quality and energy management.*

Keywords: PLC, Variable frequency drives (VFD), IOT, Mqtt cloud, raspberry pi, Industry 4.0, Electrical submersible pump(ESP).

1. INTRODUCTION

The Internet of Things (IOT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators and connectivity which enables these objects to connect and exchange data[1]. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing internet infrastructure. Over the Internet of things, cyber-physical systems communicate and cooperate with each other and with humans in real time, and via cloud-computing, both internal and cross-organizational services are offered and used by participants of the value chain[2]. For our project we are including the IOT platform to the existing infrastructure. It is having long lasting effects in the industry such as higher productivity, low maintenance cost of equipment, low downtime, overall cost saving.

Using IOT platform, in dangerous working conditions, the health and safety of the worker can be improved dramatically. Crude oil extraction chain could be more readily controlled when there is data at every level of the well fluid extraction process. Computer control could produce much more reliable and consistent productivity and output. The results for many industries could be increased revenues, market share and profits.

In our model, we have implemented the cloud MQTT which are managed mosquitto servers in the cloud. Mosquitto implements the MQ Telemetry Transport protocol, MQTT, which provides light weight methods of carrying out messaging using a publish/subscribe message queuing model.

Fig. PUB/SUB Architecure

MQTT is the machine-to-machine protocol of the future. It is ideal for the "Internet of Things" world of connected devices. Its minimal design makes it perfect for built-in systems, mobile phones and other memory and bandwidth sensitive applications. Message queues provide an asynchronous communication protocol. The sender and receiver of the message do not need to interact with the message queue at the same time. Messages placed on the queue are stored until the recipient retrieves them or until the message times out.

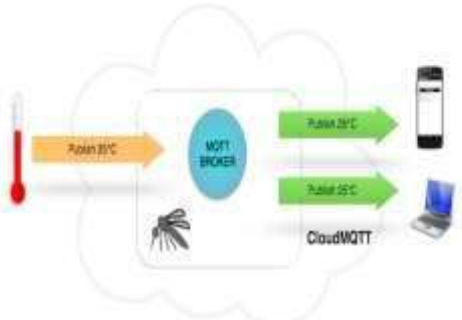

Fig.Cloud MQTT

Using an IOT platform for our devices, we are depicting the changing trends of a conventional factory i.e. basically making a system/process more automated. By compiling to the Industry 4.0 standard we are able to increase the deliverability of the production. It also helps us to reduce the machine downtime thereby increasing the efficiency of the production in hand.

2. CONCEPT OF PROPOSED MODEL

The model which we are trying to propose here is that of a ESP which consists of a schematic arrangement of control valves and VFD system as a surface equipment to extract

crude liquids. It is known as Artificial lift system. The ESP which power up using suitable electrical supply through transformer and controlled variable frequency supply by VFD system to drive ESP for optimum production rate of crude oil (downhole fluid).

The downhole fluid is a combination of water, cumulative gases and crude oil. A safety valves is placed between ESP and production line to control the flow of liquid into the main trunk. Thus downhole fluid taken out by ESP is fed to Separators (High pressure separator and low pressure separators) from the production tubing and separate the mixture of the oil water and Gas which is displaced from the outlet. The quality of the oil and gas being Separated is dependent upon the level of H2S Gas in well fluid and uniform stirring through the motor. Monitoring of downhole ESP intake and discharge pressure along with motor current, torque and frequency is very important to maintain smooth production. control of ESP parameters and safety valves is carried out through the PLC system. The relay operated valves are placed to maintain the quantity of Fluid that is fed through the production tubing. The pressure sensors are used to monitor the downhole pressure level. Thus we have written a PLC ladder program taking into account the following factors of the product being formed:

1. Safety
2. Quality
3. Delivery
4. Cost
5. Morale
6. Environment.

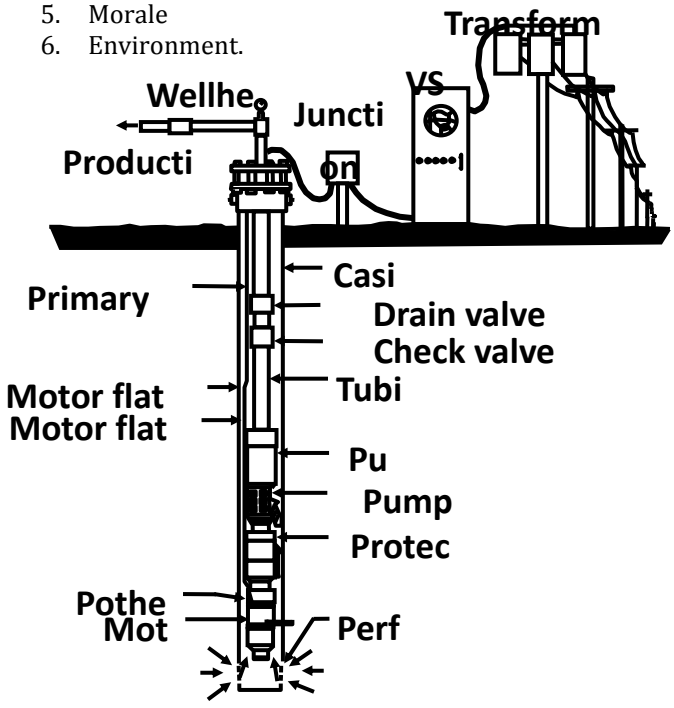

Fig 3: Functional Block diagram of model ESP

Now moving along to the IOT functionality of our model. We have connected all the devices i.e. the solenoid operated safety valves, pressure sensors and VFD separately to a raspberry pi computer in order for data analytics and processing through the cloud. We have provided all these devices an individual Identity number (ID) so that they function as smart and intelligent devices when connected over the cloud. Basically all these connected devices would be dual programmed. They will be programmed through the PLC as well as the raspberry pi computer. Connecting the devices to a raspberry pi makes them more intelligent as individual devices connected to the internet.

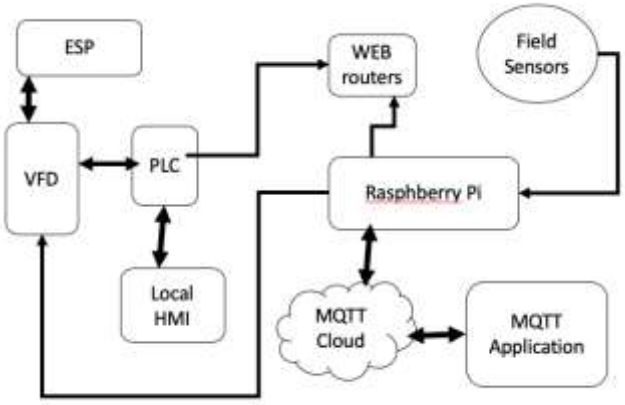

Fig. : Functional block diagram

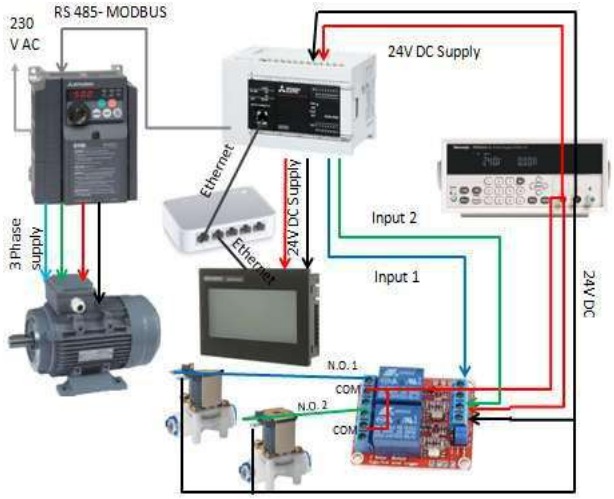

Fig.: Electrical diagram of process

Raspberry pi enables an IOT platform for our Industrial setup. As a compliant to the Industry 4.0 standard; we are controlling critical parameters of the VFD namely Start/Stop and Fwd/Rev commands through the pi. Instead of client server model we have used a Publisher/Subscriber model (PUB/SUB) as it is having more advantages than the former in terms of operational efficiency. In our model, the critical parameters which we are trying to control are published through Mqtt platform over the cloud. We have used cloud services for connecting the devices over the internet. (Mqtt platform)

In our project what we have achieved is through PUB/SUB model the data will be published over to the cloud. Only

those authorized users having a username and password would be able to subscribe to the data connected over the cloud. Once subscribed the authorized user would be able to view as well as control the important process parameters which are ongoing in his plant/system.

So according to the hierarchy different users will get access to different data over the cloud. The data can be made available to the users according to their access levels. For example an operator may be more interested in all the critical parameters to control the system in hand, whereas the manager would be requiring the overall production output of the day/week/month along with the quality of the product being formed.

3. RESULT AND CONCLUSION

The core areas comprising our model are Integrating the automated device, achieving an analogous system of intelligent devices and at the same time focus our attention on quality and energy management. The process which we have designed and developed is being used in most of the oil industries so we thought about making an industry ready model. Using an IOT platform for our devices we have depicted the changing trends of a Artificial Lift technology. By making any process IOT compliant we are able to improve its process parameters; improve the quality of the product being manufactured; increase the productivity; reduce the cost of the product being made as well as safe and healthy environment where the process is being undertaken.

Using IOT as a future scope for our process, we could implement machine learning algorithm. Using this al7gorithm we could be able to detect the Mean Time to Failure (MTTF) of the components used in the process. Using this we could plan for predictive as well as preventive maintenance activities. This helps us to improve the deliverability of the process being manufactured. We are also able to reduce the machine downtime thus helping us to improve the efficiency of the product.

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REFERENCES

1. Hsu, Chin-Lung; Lin, Judy Chuan-Chuan (2016). "An empirical examination of consumer adoption of Internet of Things services: Network externalities and concern for information privacy perspectives". Computers in Human Behavior. **62**: 516–527. doi:10.1016/j.chb.2016.04.023.

2. Erlich, Yaniv (2015). "A vision for ubiquitous sequencing". Genome Research. **25** (10): 1411–1416. doi:10.1101/gr.191692.115.ISSN 1088-9051. PMC 4579324 . PMID 26430149.

3. Sanjay Sarma, David L. Brock & Kevin Ashton. The Networked Physical World. MIT Auto-ID Center White Paper, October 2000. p.

4. Demiris, G; Hensel, K (2008). ""Technologies for an Aging Society: A Systematic Review of 'Smart Home' Applications"" (PDF). "IMIA Yearbook of Medical Informatics 2008": 33–40. Retrieved 27 October 2017

5. Markus Liffler; Andreas Tschiesner (6 January 2013). "The Internet of Things and the future of manufacturing | McKinsey & Company". Mckinsey.com. Retrieved 2016-11-30

6. Lee, Jay; Lapira, Edzel; Bagheri, Behrad; Kao, Hung-an. "Recent advances and trends in predictive manufacturing systems in big data environment". Manufacturing Letters. **1** (1): 38–41. doi:10.1016/j.mfglet.2013.09.005.

7. Sarvari Peiman Alipour, Alp Ustundag, Emre Cevikcan, Ihsan Kaya, and Selcuk Cebi. "Technology Road map for Industry 4.0." In Industry 4.0: Managing The Digital Transformation, pp. 95-Springer, Cham, 2018

8. Schmidt, Lanny D. (1998). The Engineering of Chemical Reactions. New York: Oxford University Press. ISBN 0-19-510588-5