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2 Framework of Low Cost IOT System to Monitor Coal Mining Wastewater Quality

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Abstract. Water is one of essential element to support life ecosystem. 1 While water is abundant in earth, but clean water is not always readily available. Therefore, water usage must be cautiously planned. Coal mining industry is one of the industries that consumes enormous amount of water. The industry needs 800-3000 gallons to produce 1 ton of coal. The consumption pushes local water resource to the limit. Therefore, mining company has responsibility to conserve water. However, the problem is not only the water consumption, but also the pollutants from the mining process. Wastewater must be properly treated before the water returned back to water resource. Indonesian government required coal mining company to frequently report wastewater quality to ensure the treated wastewater quality meet government regulation. Therefore, online monitoring is required to be able to monitor wastewater continuously. Advancement of low cost IOT technology allows deployment of wastewater IOT system in remote area. Therefore, the paper presents framework of low cost IOT system for wastewater quality monitoring. Further, the paper

discusses the advantage and disadvantage of low cost IOT system. Then, cloud based IOT system architecture is selected as the architecture is suitable for remote area. In addition, dashboard presentation of wastewater quality is designed for web-based and android application. Deployment the IOT system in mining site confirms the applicability of the framework.

INTRODUCTION

4 Water is the most important element for every creature on earth. Water presents around 60% in the earth, however clear water is not easily available as most water on earth is saltwater. Therefore, water has to be conserved 1 to be able to support life on earth. Poor water quality is one of the major caused of disease and death[1]. Mining industry such as coal industry requires huge amount of water to mine and process coal. The industry needs 800-3000 gallons to produce 1 ton of coal. Wastewater from the coal mining process causes pollutant to the water, therefore the water has to be treated before channeled back to water resources. The wastewater is settled in the pond and treated using caco3 to balance the level the acidity and to precipitate particles from the wastewater. For that reason, the wastewater must be monitored regularly to ensure the wastewater quality parameters meet government regulation before channeling the wastewater to river.

Monitoring the wastewater regularly is a laborious task. Coal mining site usually located in remote area. Further, the mining site size is wide and is not uncommon to have several wastewater ponds. Consequently, the monitoring task is laborious, not only the environment, health, and safety (EHS) staffs have to cover vast area of site, but also have to take sample and measure the wastewater quality. Indonesian government has issued regulation 1 to monitor wastewater continuously in 2018. Coal mining industry is among the industries that have obligation to monitor wastewater continuously. Waste water quality parameters that need to be reported are PH, Total solid suspended (TSS) and debit. Further, those parameters have to be hourly recorded in company server and the data then must be sent to environment and forestry ministry system. Internet of thing (IOT) is a system that enable computing device to transfer data without any human intervention. Therefore, IOT system is suitable solution for such laborious task.

Big scale mining companies can afford expensive industrial sensors, but for small scale mining companies, the cost is burdensome. However, quality of low cost sensor quality is increasing. Further, functionality of low cost sensor can be increased by applying suitable algorithm to increase reliability of low cost system. Therefore, utilization of low cost sensor to monitor wastewater quality is promising. For that reason, this paper proposes a framework of low cost sensor for wastewater monitoring IOT system.

LITERATURE REVIEW

Water quality monitoring has been an object of research due to the importance of water for living creatures. Water quality is determined by its chemical and physical properties. The easiest monitor of water quality is by visually observed the water. Water must be clear, tasteless and odorless at certain pressure and temperature. However, visually observation is not adequate and can be deceiving as many toxic materials are also odorless and clear. Various parameters has been used to indicate water quality, the most common water quality parameters are pH, electrical conductivity, oxidation reduction potential (ORP), and turbidity[2]. PH is important as human body has to maintain PH between 7.35 – 7.45 in arterial blood. Therefore, safe PH level is between 6.5 and 8.5 for drinking water. Further, Turbidity is indicator of water clarity, by visual observation the water must be clear and transparent. The water turbidity scale is NTU, the maximum value of healthy water turbidity is 5 NTU, while the recommendation is 1 NTU.

Another measurement of turbidity is TSS, TSS measures suspended material in water by mass per volume. While both can be used to measure water clarity, but TSS can measure sedimentation, therefore is more suitable for wastewater in coal mining site. However, TSS has drawback that the sensor is more expensive than turbidity sensor. Both sensor measure ability of water to pass the light, Holliday et.al (2003) concluded that turbidity is able to estimate TSS[3]. Recently, low cost sensor system has gain popularity, Schmidt et.al (2018) proposes a low cost buoy system to monitor water quality in coastal area[4]. The system could stand from gale force sea conditions and able to monitor water quality satisfactorily, then suitable for aquaculture in coastal area.

Pule and Chuma (2017) shows that wireless sensor network (WSN) has promising implementation. The benefit of WSN is the ability to be installed remotely and provide data in real time. However, it has deficiency in term of processing power, memory, communication bandwidth and energy/power. Nowadays, solar panel and computation hardware becomes more affordable. Combination of solar panel as energy resources and low cost computation hardware such as raspberry pi can solve the energy and processing power problem. Further, Shahanas and Shivakumar (2016) compiled various technologies and platform for smart water management system (SWMS) and designed framework for SMWS using low cost computing raspberry pi[5]. Therefore, this paper proposes a framework of low cost sensor IOT system using raspberry pi as computing devices, PH meter, and turbidity sensor to estimate TSS.

PROPOSED FRAMEWORK

Location of coal mining in remote area becomes another challenge for transmitting sensing data. Communication infrastructure in the area has to be stable to be able to send the data in real time to data center. The coverage of companies network infrastructure usually do not cover wastewater pond because the location is far from site office and high infrastructure investment cost. Consequently, data communication must rely on provider infrastructure. Therefore, the sensing equipment must be equipped with communication module. Provider infrastructures in remote area often experience a decrease in service quality. As a result, the data often cannot be transmitted to data center. Therefore, the sensing equipment must have capability to temporarily store data. Further, to ensure data integrity and security the data must be encrypted.

Although government only required companies to measure wastewater quality hourly, but the companies may need to acquire data as often as minutely for analysis purpose. Consequently, huge data can be generated from monitoring equipment. Because a company may have several mining sites and the wastewater ponds are spread throughout coal mining site, cloud computing is the best alternative solution to solve the problem. The company does not need to invest dedicated server in each site.

Eventually, a framework was designed specifically to solve the problems in coal mining site. The framework has five layers as shown in figure 1.

1. Sensing layer is the layer for measuring water quality; the layer contains PH meter, turbidity sensors, and temperature sensors.
2. Physical layer is the layer for mechanical interface to control pump.
3. Controller and communication layer have function to control sensors and mechanical layers. Further, the layer also has function to encrypt sensing data.
4. Computation layer has function to store the sensing data, and modeling turbidity data to TSS information.
5. Visualization layer is human interface to display information about wastewater quality.

FIGURE 1. Wastewater monitoring IOT system framework

PROPOSED VISUALIZATION

Human has capability to process visual data better than any other data. Therefore, visualization is important to communicate the data to be understood by end users. The proposed framework used dashboard as a communication medium to the users. The dashboard has gauges with traffic light color-coded. The traffic light colors red, yellow, and green was choose as the colors are familiar color, therefore easy to be understood. Green represents safe quality, yellow represents warning, and red means the wastewater quality is not safe. The dashboard also has graphical information to show wastewater quality trend over time. Therefore, the users can know when the wastewater passes the threshold quality indicators. The users may use the information to make further analysis.
Dashboard is designed as a responsive web so that the layout is able to adapt to users screen size. Figure 2.a shows the dashboard layout on monitor screen, while Figure 2.b shows the layout on mobile phone screen. Figure
3.c shows the graphic layout on monitor screen.

(a) (b)

(c)

FIGURE 2. Proposed Dashboard

RESULTS AND DISCUSSIONS

Due to high benefit to cost ratio, utilization of low cost for industrial application is increasing. Adequate sensing quality of low cost sensors outweighs its price. While, industrial sensors have better sensing capability, high investment cost makes the utilization for non-critical application less attractive. The proposed low cost sensors monitoring IOT system has been tested in laboratory and implemented in a mining site to monitor wastewater quality. However, the location of wastewater cannot be disclosed for confidentiality. The framework has been tested and performs satisfactorily to sense and send data to cloud in laboratory. However, during field testing, the sensors need to be calibrated again before use, consequently the model to estimate TSS value from turbidity must be calculated again. The turbidity sensor reading is also affected by sensor position placement and air bubble. Another disadvantage of the framework is the raspberry pi 3 and GPRS module energy consumption is high. As a result large solar panel and battery is needed to ensure the system is running well during rainy seasons.

CONCLUSIONS

The proposed framework has been implemented and performs satisfactorily in a coal mining site. Carefully designed equipment and correct computation model make low cost sensors an alternative solution for noncritical industry application. However, further research in sensor equipment and container is needed to improve the monitoring equipment sensing capability. Future research direction is utilization of low energy consumption technology for IOT monitoring system.

Sources

1	https://ui.adsabs.harvard.edu/abs/2020AIPC.2217c0148T/abstract INTERNET 14%
2	https://sinta3.ristekbrin.go.id/authors/profile/5975884/?view=googlescholar INTERNET 1%
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