INTERNATIONAL JOURNAL OF INTEGRATED ENGINEERING
ISSN: 2229-838X e-ISSN: 2600-7916

IJIE

Vol. 16 No. 4 (2024) 162-169
https://publisher.uthm.edu.my/ojs/index.php/ijie

A Recycling and Measurement of Floodwater Using Arduino, Potassium Alum and River Stone

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DOI: https://doi.org/10.30880/ijie.2024.16.04.020

Article Info

Received: 19 December 2023
Accepted: 23 July 2024
Available online: 27 August 2024

Keywords

Turbidity sensor, flood water, recycle water, greywater, measurement water

Abstract

Flood disasters can occur unexpectedly, causing significant damage to homes or office buildings and their contents. Moreover, they pose a serious threat to health, and the recovery process can take 3-7 days. As a result, many flood victims face challenges in accessing clean water for essential needs, which can be especially difficult in urgent situations. There is a pressing need for solutions that can improve and support flood victims. This project aims to address this need by proposing a system for recycling floodwater. It also seeks to highlight the potential usefulness of floodwater for various purposes. The project utilizes the ADDIE model to develop a tool, specifically a smart indicator called ArduPoSt, which utilizes Arduino technology in conjunction with potassium alum and river stone to monitor and enhance the quality of floodwater. The product was tested with two samples, potassium alum with and without river stone, to gauge the accuracy of water turbidity measurement. The results demonstrated that water turbidity measurement was more accurate and faster when river stones were included. This product is designed to be flexible and valuable for addressing urgent needs of flood victims. Additionally, there are plans to further enhance its usability through the development of a more interactive design with mobile applications in future iterations.

1. Introduction

Flood disasters can happen unexpectedly, causing unsightly damage to our home or office building and the contents inside, but they can be even more dangerous to our health. Recently, a few states in our country experienced flooding, particularly at the end of the year, affecting low-lying houses, and recovery will take 3-7 days. Recycling floodwater is hard for most flood victims and find it difficult to use floodwater for urgent purposes. For instance, the person uses it for ablution, taking bath, etc. that require urgence matter to complete it. Recycling floodwater or greywater is an important process and very crucial in certain conditions and priorities. Furthermore, the application of recycling of floodwater or greywater encourages people to lead to sustainable environmental. However, a few applications produced is limited compared to others especially for the technologies embedded.

As people living in floodwater is the most priority to provide recycling greywater usage for urgence purposes. It should also provide them continuous effort to other people for reuse the greywater at home. Therefore, people must concern early for the use of greywater or floodwater. Many such of greywater at home is not use wisely and people think they can use clean water that available at home. However, there is lack of work to study the greywater or floodwater for the technology that much beneficial for people, environment sustainability and low cost.

This study describes an approach to test the turbidity of water using Arduino controller panel, potassium alum and river stone. The following is how the paper is structured: Section 2 depicted the study's background; Section 3 the methodology; Section 4 tool design and implementation, which include a description of tool is developed; Section 5 the Related work and Section 6 concludes with a conclusion and future work.

2. Research Background

Greywater is the term for the wastewater that is left over after baths, sinks, washing machines, and other kitchen appliances. The largest portion of all household wastewater is contributed by greywater [2].

2.1 Turbidity Sensor

A turbidity sensor is employed to detect the presence of contaminants in water by utilizing light. The suspended particles in the water scatter and reflect the light [3]. Turbidity refers to the cloudy or hazy appearance of a fluid, caused by the presence of numerous individual particles that are typically invisible to the human eye, much like smoke in the air. Measuring turbidity is a crucial test for assessing water quality. The turbidity sensor quantifies the amount of light scattered by the suspended solids in water, which increases as the concentration of total suspended solids (TSS) in the water rises. Table 1 categorizes turbidity values into three ranges: clear, cloudy, and dirty.

Table 1 *Turbidity value range*

Category	Range Value
Clear	Below 20
Cloudy	21-49
Dirty	Above 50

2.2 Arduino

This physical equipment is something that the user can see and touch in a physical sense. These pieces of hardware are controlled by software, which performs functions such as data intake, processing, management, distribution, and storage. The Arduino hardware platform is highly affordable, making it accessible globally for widespread adoption and utilization [4]. However, when developing an Arduino-based application, it is crucial to carefully consider and define the connected devices, such as sensors, LEDs, wires, and other components that rely on the microcontroller as a control system. These components are essential for tasks like signal processing, instrumentation, and other operations, and they must be appropriately planned and designed during the product development stage [5]. Arduino UNO is a hardware example of a microcontroller used in an Arduino application, as shown in Fig. 1.

Fig. 1 *Arduino UNO*

2.3 River Stone

One significant property of aggregates is their water absorption capacity. As per the guidelines established by the American Society for Testing and Materials [6], the water absorbed by aggregates is not accounted for as part of the free water in the water-to-cement ratio calculation. Fig. 2 shows an example of a pack of river stones.

Fig. 2 *River stone*

2.4 Potassium Alum

Potassium Aluminium Sulphate, also referred to as potash alum, is a chemical compound that commonly exists in the form of a dodecahydrate. This substance finds widespread applications in various industries, including water purification processes, dyeing operations, leather tanning procedures, and as a constituent in baking powder formulations. Fig. 3 shows an example of a Potassium Alum.

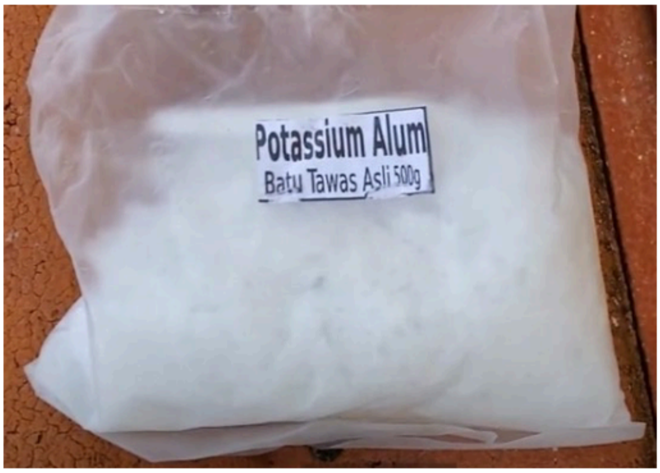

Fig. 3 *Potassium Alum*

3. Methodology

We have used the ADDIE model to develop our approach in this study. This instructional design comprises five phases as follows:

i) Analysis phase: We analyze the overall processes, including process activities. Here, all requirements were elicited, conducted by the need of requirements, target audience such as victims.
ii) Design phase: In this phase, we provide instructional strategies, design architecture, and model diagrams.
iii) Development: In this phase, we build all processes, such as hardware development, code development, and compilation, and test the program for ArduPoSt.

iv) Implementation: In this phase, the installation of all of the programs developed from machine programs to hardware that all users can access.
Evaluation: In this phase, the user acceptance is evaluated to check the effectiveness of the tool and its achievement.

4. Tool Design and Implementation

For this section, we depicted our study in two sub-sections, tool design and tool implementation.

4.1 Tool Design

This section presents the design of the suggested tool for Arduino, River Stone, and Potassium Alum using block diagrams. The architecture of tools, as can be seen in Fig. 4 and Fig. 5, demonstrates our approach.

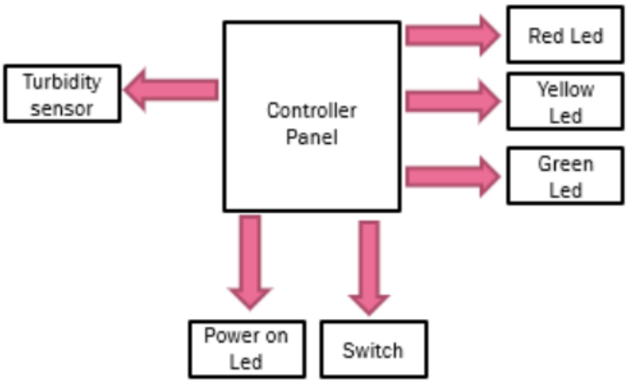

Fig. 4 *Arduino controller panel block diagram*

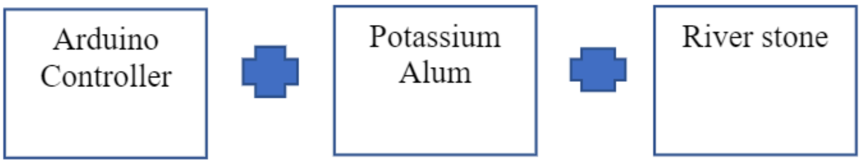

Fig. 5 *Our approach*

4.2 Tool Implementation

We have developed a tool called ArduPoSt using Arduino controller panel with potassium alum and river stone to indicate and improve quality of monitoring of flood-water especially in product development that being used for the flood victims or greywater. There are four steps to operating this process. First, as shown in Figure 6, Arduino Controller Panel that we designed and developed for this tool has turbidity sensor to measure the turbidity of water. The power button is pressed to allow the LCD and LED lights to be automated turned on while the turbidity sensor is ready to read.

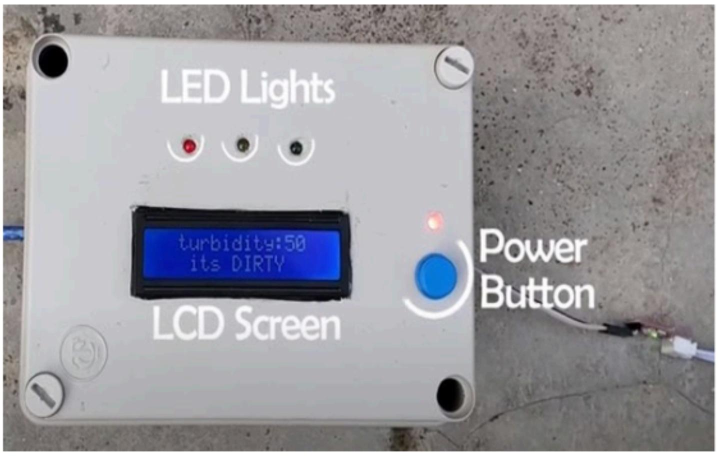

Fig. 6 *Arduino controller panel*

Second, as shown in Fig. 7, there are two bottles containing dirty water which is one bottle with river stones and the other bottle without river stones. The Arduino controller Panel is used to read by turbidity sensor to check the turbidity of water. Third, as shown in Fig. 8, the bottle with river stone added the potassium alum as our goal to test alum with river stone and without river stone. The Arduino controller Panel is also used which is a turbidity sensor to check the turbidity of water.

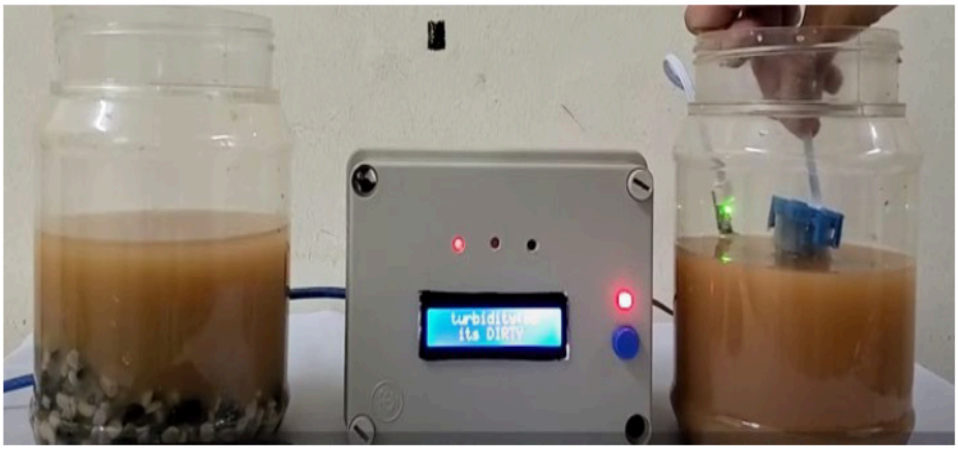

Fig. 7 *Dirty water with and without river stone*

Fig. 8 *Both bottles added potassium alum*

Lastly, the turbidity sensor is tested for each hour until water is indicated status of turbidity cleared for both bottles, as shown in Figure 9, final test.

Fig. 9 *Final test*

5. Result and Discussion

Table 2 shows the result between Turbidity with and without River stones. The bottle is defined as dirty at the initial value. In hour 1, one bottle with river stone becomes cloudy whereas the other bottle is still dirty. In hour 2, the result of the bottle with river stone is slightly clear while the other bottle becomes cloudy. In hour 3, the bottle with river stone becomes clear while the other bottle is still slightly cloudy. In hour 4, the result of the bottle with river stone is clear while another bottle is slightly clear. In the last hour, the bottle with river stone shows very clear while the other bottle changes to clear status.

Table 2 *Turbidity result value*

Hour/s	Bottle with River Stone	Bottle without River Stone
0	Dirty	Dirty
1	Cloudy	Dirty
2	Slightly Clear	Cloudy
3	Clear	Cloudy
4	Clear	Slightly Clear
5	Very Clear	Clear

Based on the result above, the value of without river stone has slightly slow decrease instead of with river stone has rapidly decrease for each hour. It shows that Potassium Alum with stone river is very useful to decrease turbidity of water value. The function of the river stone is to trap the dirt and debris that has settled down from the recontamination water.

6. Related Work

Fowdar et al. [7] investigated the transformation and fate of nitrogen in biofilters planted with various climbing and ornamental plant species. They examined the amount of nitrogen removed through the coupled processes of nitrification and denitrification. Their findings revealed that in planted biofilter systems, the nitrification-denitrification pathway accounted for only a minor fraction (0-15%) of the added 15N removal. All biofilter designs effectively reduced dissolved organic nitrogen (DON) and ammonium levels, indicating efficient mineralization and nitrification rates. However, in biofilter designs exhibiting poor overall nitrogen removal performance, the effluent was enriched with nitrate, suggesting limited denitrification rates as a potential bottleneck.

Rakesh & Manjunath [8] investigated a greywater treatment system employing river sand and polypropylene Pall rings as filter media. The methodology involved designing, fabricating, and installing a greywater treatment model on the premises of the National Institute of Education (NIE) campus. The performance of this system was monitored over an extended period. Weekly sampling of greywater was conducted, and the collected samples were analyzed for various water quality parameters, including pH, total dissolved solids (TDS), total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), turbidity, and nutrient levels. The findings suggested that the treated greywater could be suitable for gardening and toilet flushing purposes. However, further treatment processes would be necessary for reusing the treated greywater in other domestic applications within urban households.

The study reported by Usha & Anslin [9] presents a greywater recycling system designed for cleaning and flushing applications. The proposed system comprises several key components, including a piping system for water transport, a diversion system for separating greywater from other wastewater streams, a filtration unit, and a storage system for the treated greywater. The filtration media employed in this study consisted of alum and biosand. Additionally, the researchers utilized an Arduino Mega microcontroller to automate and control the various processes involved in the greywater recycling system.

Prabhu et al. [10] focused on recycling wastewater through an aerobic treatment process. The researchers employed various sensors and components to monitor and control the water quality during the treatment. Specifically, they utilized a pH sensor, turbidity sensor, and a level sensor to continuously track the water quality parameters. Additionally, a solenoid valve was integrated into the system to regulate the water flow. The study also involved measuring the water quality at different stages of the treatment process, with the data will be displayed on the Blynk app for monitoring and analysis. The findings indicated that the treated water could be suitable for applications such as gardening, toilet flushing, and car cleaning.

Hong et al. [11] studied an Arduino-based sensor system for monitoring the quality of water as aimed of their study. They employed a prototype including the attached sensors with a microcontroller. The prototype is tested weekly, and the result of their study found that the system developed is reliable. However, the prototype or system developed required human assistance and resulted in data inaccuracies.

7. Conclusion and Future Work

Most flood victims find it tough to recycle their floodwater and find it challenging to use it to meet critical needs. Additionally, the existing application to provide clean water consumes time and it is very hard for the user in urgent cases. The methodology to develop this tool is the ADDIE model. Thus, a smart indicator called ArduPoSt using Arduino with potassium alum and river stone is developed to show the status of water's Turbidity. This product is tested with two samples, potassium with and without river stone to measure the accuracy of turbidity of water. The result of this was found that the turbidity of potassium with river stone was more accurate and faster. In our future works, we hope can provide more additional features to allow users more interact with our tool specifically in interface design with mobile applications.

Acknowledgement

We would to thanks to Fakulti Teknologi Maklumat dan Komunikasi (FTMK) and Universiti Teknikal Malaysia Melaka (UTeM) for their support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Noorrezam Yusop, Wahba Kamaluddin, Ali Hussaini, Nur Ezyanie Safie;* ***data collection:*** *Wahba Kamaluddin, Ali Hussaini;* ***analysis and interpretation of results:*** *Noorrezam Yusop, Nur Ezyanie Safie;* ***draft manuscript preparation:*** *Noorrezam Yusop, Nur Ezyanie Safie. All authors reviewed the results and approved the final version of the manuscript.*

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