JoFRISE 2 (1) (2024)
Journal of Frontier Research in Science and Engineering
https://journal.riau-edutech.com/index.php/jofrise
Publisher :
Andester Riau Edutech
Pusat Inovasi Pendidikan dan Teknologi
ISSN : 0000-0000

Development of a Discharge Measuring Tool using an Arduino Uno-based WaterFlow Sensor as a Fluid Learning Media

Igah Mawarni Futri [1*] , Ernidawati[1], Muhammad Sahal[1]

[1] *Physics Education, Faculty of Teacher Training and Education, Riau University*

*Corresponding author's email: igah.mawarni0424@student.unri.ac.id

Submitted: 30/12/2023
Revised: 04/01/2024
Accepted: 04/01/2024
Published: 11/03/2024
Vol. 2
No. 1

ABSTRACT

The development of a water flow measuring device using an Arduino-based WaterFlow sensor can provide a comprehensive learning experience that encourages students to think innovatively. Develop students' practical skills in designing, assembling and testing water flow measuring devices so that students not only learn theory but can also practice the application of fluid theory. This research uses the Research and Development method. This is a research method used to produce certain products and test the effectiveness of these products. In this research, the data analysis technique used is analysis to determine the cross-sectional area of the pipe and the volume of water that can be detected by this water disposal device and also to determine the maximum time required to fill the water reservoir, so that we can find out what influences the detection of discharge. water.

Keywords: *Fluid, Discharge Meter, Learning Media*

1 Introduction

Science includes a collection of knowledge and methods for obtaining and applying that knowledge. In the educational context, physics is considered a conceptual subject and requires high-level thinking skills to be understood. However, many students face difficulties in understanding various physics concepts (Entino, Hariyono, and Lestari., 2021) . Conditions where students' understanding does not match the correct physics concepts according to scientists are known as misconceptions. Misconceptions can arise due to students' daily experiences when interacting with the surrounding environment (Permata, et al., 2022) . It is important for physics learning to be carried out seriously, but still provide an interesting and fun atmosphere for students, so that the learning material can be more easily understood. Even though the lecture method is often used in the learning process, many students still have difficulty understanding the material, especially in the context of applying the Continuity equation to dynamic fluids and static fluids(Ali and Irawan 2023). Considering the significance of understanding fluid material in physics subjects, it is necessary to use learning media. This media can be designed to convey messages to students and create a better learning environment (Af'idah, Manaksia, and Fitriyah., 2023) .

In the learning process, the dynamic fluid concept is an aspect that has relevance to students' daily lives. Therefore, the existence of a learning media is very important as a solution to bring this concept closer to students. (Nisrina Najikhah, Akhdinirwanto, and Ashari., 2021) . Making a tool to calculate water discharge as a fluid learning medium is definitely not far from the law of continuity, this law explains the relationship between speed and cross-sectional area. This law of continuity is also related to water discharge, which determines water discharge by multiplying the flow velocity by the cross-sectional area. Learning media in the form of teaching aids are instruments that can be displayed in the teaching and learning process, acting as a tool to clarify the concepts of the material being studied (Herfana et al. 2021). With teaching aids, students tend to be more motivated in the learning process, and find it easier to understand concepts and improve their analytical skills because they can see trials or experiments directly (Wahyuningsih, Hakim, and Ashari, 2019) .

How to Cite :
Futri, I.G, Ernidawati & Sahal, M.(2024). Development of Discharge Measuring Tool Using an Arduino Uno-Based Waterflow Sensor as a Fluid Learning Media. *Journal of Frontier Research in Science and Engineering(JoFRISE)*, 2(1), 1-6.

Props as a tool to demonstrate in the learning process, The basic principle in preparing educational teaching aids refers to the use of the five senses in obtaining information. By involving all the five senses in the learning process, it is hoped that students' understanding of the subject matter can increase. The focus of this teaching aid is to divert as much sensory attention as possible to an object, with the aim of facilitating students' perception of the material being taught (Dahniar, 2022) .

Technological advances have provided a significant impetus in the development of measurement systems. Many measuring instruments that were previously manual have now switched to digital systems. This provides advantages in terms of ease of reading measurement results, and the accuracy is higher compared to manual measuring instruments because the results are displayed in numerical form (Rohman, 2009) . Of the various measuring instruments available, one of them is a water discharge measuring instrument (Ramadhan, Sumaryo, and Priramadhi., 2019) . In an agricultural context, an efficient irrigation system is needed. Irrigation is an effort to channel water to agricultural land, both paddy fields and fields, through channels that are arranged regularly. The aim is to regulate water distribution well, and dispose of excess water effectively, so that water can be utilized optimally (Yusuf, 2019) . The next problem is that when we channel water to agricultural land, we definitely need to measure the discharge to manage irrigation so that it matches the capacity required on the land. Researchers are trying to develop a water discharge measuring tool by using the Water Flow sensor as a learning instrument about fluids, and it is hoped that it can be applied in irrigation management in the agricultural sector (Saktioto et al. 2020). This tool operates automatically by detecting water flow via the Water Flow sensor. This system uses a water flow sensor as an input sensor to calculate water and uses a buzzer to alarm excessive water use (Wijayanto, Triyanto, and Ilhamsyah., 2016). Other components involved in this tool involve an Arduino Uno microcontroller as the control center and an LCD screen as a sensor output to display the results of the recorded water flow readings.

2 Research methodology

In this research, researchers used the *Research and Development method* developed by Brog and Gall (1989). *Research and Development* (R&D) is a research method used to produce certain products and test the effectiveness of these products (Assyauqi, 2020) . Through development, it is hoped that the product will provide benefits in optimizing learning activities and physics experiments in the laboratory(Irawan, Hanto, and Widiyatmoko 2023).

2. 1 Design of a Water Flow Measuring Tool using an Arduino Uno Based *Water Flow Sensor*
The arrangement of electronic components is assembled based on a scheme as in Figure 1 below :

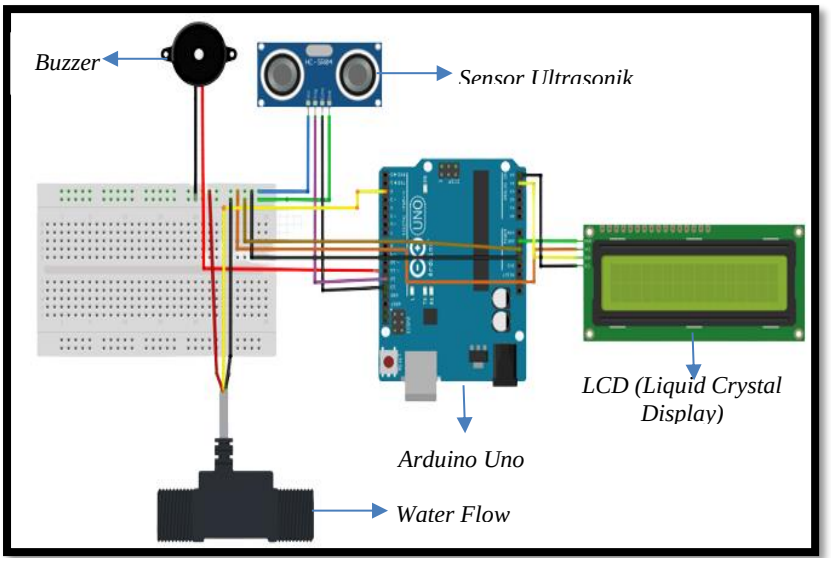


Figure 1. Schematic of the electronic component circuit for the water flow counter

The connection arrangement for this water flow meter is as follows: a.) Arduino can be connected at 5V to the positive pin of the breadboard, GND to the negative pin of the breadboard; b) The Waterflow Sensor can be connected to the yellow cable to pin 2 of the Arduino, the black cable to the negative breadboard pin, the red cable to the positive breadboard pin; c) LCD I2C: SCL to pin A5 Arduino, SDA to pin A4 Arduino, VCC to breadboard pin positive and GDA to GDA Arduino; d) Ultrasonic Sensor: VCC to breadboard pin positive, GND to breadboard pin negative, ECHO to pin 13 Arduino, TRIG to pin 12 Arduino; e) Buzzer: red cable to pin 11 of Arduino and black cable to breadboard pin negative
The tool development design is as shown in Figure 2.

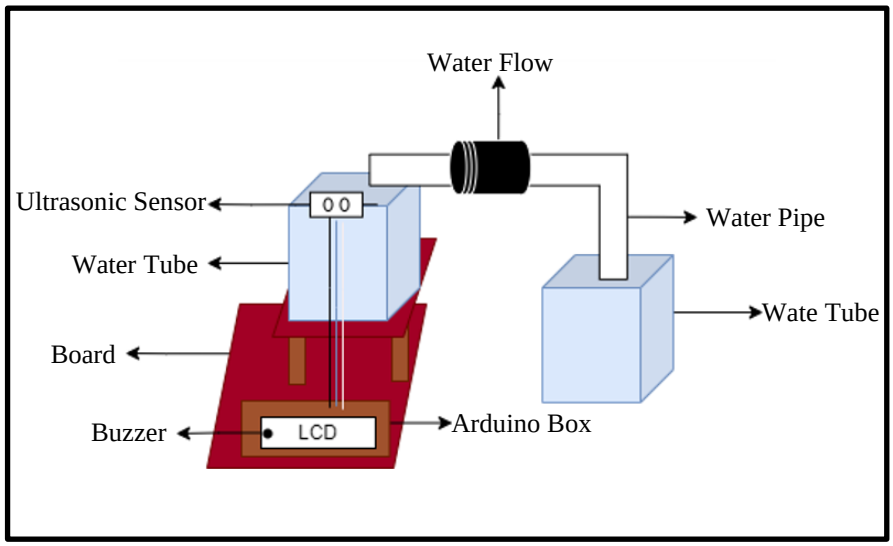
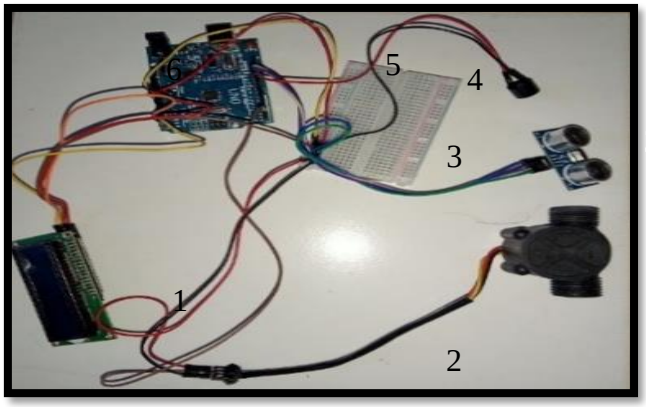


Figure 2. Tool development design

3. Results and Discussion

3.1 Results of Development of a Water Flow Measuring Tool using WaterFlow Based on Arduino Uno as a Fluid Learning Media.

A water flow measurement tool using an Arduino Uno-based water flow sensor is a system designed to measure the flow rate or water discharge using a special sensor that can detect water movement. Arduino Uno functions as a microcontroller that controls system operations, reads data from sensors, and displays or stores the information(Delviandri and Irawan 2023). A water flow measuring device is a device whose circuit is composed of simple components such as Arduino Uno, *Water Flow sensor* , ultrasonic sensor, buzzer and the jumper is assembled into an automatic tool for calculating water discharge. The following is a picture of a series of water flow measurement tools using an Arduino Uno-based *Water Flow sensor* that has been developed and a picture of the tool that has been installed into the water reservoir.



1. LCD , 2. Waterflow sensor, 3. Ultrasonic sensor, 4. Buzzer, 5. Breadbord, 6. Arduino Uno.

Figure 3. A series of water discharge measurement tools using a *Water Flow sensor*

1. Tool box (Lcd , Buzzer, Beardboard, Arduino Uno), 2. Aquarium water pump and water reservoir, 3. Pipe 3,2 $cm^2$and 1.6 cm^2, 4. Water Flow Sensor, 5. Water reservoir and Ultrasonic sensor

Figure 4. Water discharge measurement tool using a *Water Flow sensor*

a. Results data

Based on the description above, the author has experimented with a water discharge measurement tool using an Arduino Uno-based *Water Flow sensor* by observing the incoming water over a period of time, with the same cross-sectional area in water tubes of different volumes to see how the incoming water discharges.

Table 1. Water discharge measurement results with different cross-sectional areas

Cross section	Time (second)	Water Volume (ml)	Water discharge (M/s)	Flow Speed (cm^2/s)
A1 ($\mathbf{3,2\ cm^2}$)	20	6156	25	7.8
	40	6156	23	7.2
	50	6156	20	6.3
	60	6156	20	6.3
	Average		**22**	**6.9**
A2 ($\mathbf{1,6\ cm^2}$)	20	6156	17	10.6
	40	6156	14	8.75
	50	6156	14	8.75
	60	6156	14	8.75
	Average		**14.75**	**9.2**

The data in Table 1 shows that at a larger cross-sectional area the resulting discharge is greater but the flow velocity is smaller and vice versa for a smaller cross-sectional area the resulting water discharge is small but the flow velocity is greater. Meanwhile, the water discharge at each cross-section changes, but it is not significant due to changes in water volume as the water depth becomes shallower. From Table 1, it can be seen that testing of the discharge measuring device using *Water Flow* was successfully carried out 4 times at different times. Thus, it indicates that the system in the form of an LCD, buzzer and *Water Flow sensor* has successfully operated.

A water discharge measuring device using Arduino Uno is a circuit composed of several simple components which are assembled into an automatic water discharge measuring device. The components in this water flow measuring device include Arduino Uno, *Water flow sensor* , *Ultrasonic Sensor* , I2C LCD, *Buzzer* , *male to male jumper* and *male to female jumper* , water pump, cellphone adapter. The main controller of this device is the Arduino Uno, where the Arduino will be active if it is connected to an electric current which will then supply a voltage of 5v to *the Water Flow* , ultrasonic sensor, I2C LCD and buzzer. After that, if the water rator is on and flowing water, *Water Flow* starts working and calculates the incoming water flow, then the read water flow appears on the LCD screen. If the water approaches the ultrasonic sensor about 10 cm, the buzzer will automatically sound indicating the water is full. When experiments were carried out using the tool that had been made, it could be seen that the tool was functioning well. This is proven by the data produced in Table 1.

The experimental work steps used an automatic discharge measuring device using Arduino Uno, namely by using 2 pipes that have different cross-sectional areas and also using a water tube with a volume of 6156 ml. For the first trial, use a cross-sectional area with dimensions $3{,}2\ cm^2$and a water tube with a water volume of 6156 ml. After the circuit is installed neatly, connect the device to the PLN voltage via a socket, then after the device is on, the water will flow through the pipe to the water reservoir, turn on the stopwatch to count. time. Collect data by varying time, pipe cross-sectional area and water volume, then calculate how much water flows in.

Based on Table 1, measuring the flow rate using the cross-sectional area of the pipe: $3{,}2\ \mathrm{cm}^2$with a water volume of 6156 ml, the water flow rate at 20 seconds was 25 L/s, the longer it took until 60 seconds, the result was 20 L/s with an average water flow rate of 22 L/s. and flow rate 6.9 cm^2/s. Measuring the water discharge using the cross-sectional area of the pipe: 1.6 $cm^2$with a water volume of 6156 ml, the water discharge at 20 seconds was 26 L/s, the longer it took until 60 seconds, the result was 14 L/s with an average water discharge of 14.75 L/s. s and a flow speed of $9cm^2/s$

The results of the dynamics study regarding the relationship between cross-sectional area and flow velocity can be seen in the description above. Figure 5 shows that the larger the cross-sectional area, the smaller the flow speed. Vice versa, if the cross-sectional area is smaller, the flow speed will be greater. Thus it can be concluded that the cross-sectional area is inversely proportional to the flow speed. This is in accordance with the research results, theory and formula stated by (Aini, 2018) that the cross-sectional area is inversely proportional to the flow velocity $(A \sim \frac{1}{V})$.

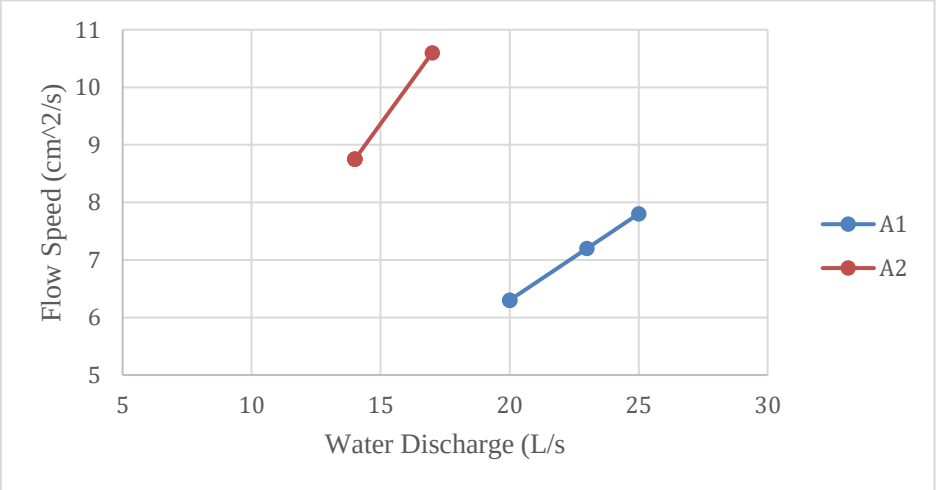


Figure.5 Graph of the relationship between cross-sectional area and flow velocity

4. Conclusion

Based on the results of this research, it can be concluded that the design of a water flow measurement tool using an Arduino Uno-based *water flow sensor* as a fluid learning medium can be made according to design. The water discharge is always the same at each cross-section. This is in accordance with the principle of continuity which states that the amount of flow per unit of time is always the same at each cross-section $Q_1 = Q_2$, but in this experiment there was a change but it was not significant, this was because the volume of water used was getting closer to the bottom, so the results were It was found to have an effect, the flow speed from the research results is inversely proportional to the cross-sectional area. This is in accordance with the water discharge theory which states that the cross-sectional area is inversely proportional to the flow speed $(A \sim \frac{1}{V})$.

In general, the design of the discharge measuring device consists of Arduino Uno, *Water flow sensor* , *Ultrasonic Sensor* , I2C LCD, *Buzzer* , *male to male jumper* and *male to female jumper* , water pump, cellphone adapter. Then, making a water discharge measuring device consists of three stages, namely making a series of water discharge measuring devices, making a support from wood to hold the water and assembling the water pipe according to the design.

Reference

Af'idah, Noer Af'idah, Oktaffi Arinna Manasikana, and Lina Arifah Fitriyah. 2023. "Kepraktisan Dan Efektivitas Alat Peraga Tuas Sebagai Media Pembelajaran Ipa Untuk Siswa Smp Kelas Viii." *Jurnal Pendidikan Fisika* 11(1): 55.

Aini, Dina Fadilah. 2018. "KAJIAN DINAMIKA FLUIDA PADA ALIRAN AIR TERJUN TANCAK KEMBAR BONDOWOSO SEBAGAI RANCANGAN HANDOUT FISIKA." *SEMINAR NASIONAL PENDIDIKAN FISIKA 2018* 3: 56–62.

Ali, Jalil, and Dedi Irawan. 2023. "Investigation of Optical Properties of Fiber Bragg Grating (FBG)." 1: 28–34.

Assyauqi, Moh. Iqbal. 2020. "Model Penelitian Pengembangan Borg and Gall."

Dahniar. 2022. "Penggunaan Alat Peraga Dalam Pembelajaran." *Jurnal Aktualisasi Pendidikan Islam* 19: 20–32.

Delviandri, Rahmi, and Dedi Irawan. 2023. "Development of Light On / Off Controller Simple Using LDR Sensor-Based Relay and Arduino Uno on Physics Learning Electromagnetic Material." 1: 1–7.

Entino, Rohman, Eko Hariyono, and Nurita Apridiana Lestari. 2021. "Analisis Miskonsepsi Peserta Didik Sekolah Menengah Atas Pada Materi Fisika." *PENDIPA Journal of Science Education* 6(1): 177–82.

Herfana, Poppy, Muhammad Nasir, Dedi Irawan, and Nur Islami. 2021. "Development of 3D Physics Learning Media Using Augmented Reality for First-Year Junior High School Students Development of 3D Physics Learning Media Using Augmented Reality for First-Year Junior High School Students."

Irawan, Dedi, Dwi Hanto, and Bambang Widiyatmoko. 2023. "An Optimum Design of Tapered Optical Fiber as a Cell Sensor Based on Surface Plasmon Resonance." 1: 8–12.

Nisrina Najikhah, Raden Wakhid Akhdinirwanto, and Ashari Ashari. 2021. "Perancangan Alat Peraga Kincir Air Berbasis Android Dalam Pembelajaran Fluida Dinamis." *Jurnal Inovasi Pendidikan Sains (JIPS)* 2(1): 9–17.

Permata, Hilda, Julia Maysarah Rosha, Dadi Rusdiana, and Irma R. 2022. "PENGUKURAN DEBIT FLUIDA MENGGUNAKAN SENSOR FLOW BERBASIS ARDUINO PADA MATERI FLUIDA DINAMIS Pendidikan Fisika Pascasarjana Universitas Pendidikan Indonesia." *Jurnal Ikatan Alumni Fisika Universitas Negeri Medan* 8(1): 29–33.

Ramadhan, Achmad Brahmantio, Sony Sumaryo, and Rizki Ardianto Priramadhi. 2019. "DESAIN DAN IMPLEMENTASI PENGUKURAN DEBIT AIR MENGGUNAKAN SENSOR WATER FLOW BERBASIS IoT DESIGN AND IMPLEMENTATION OF WATER DISCHARGE MEASUREMENTS USING An IoT-BASED WATER FLOW SENSOR." *e-Proceeding of Engineering* 6(2): 2623–30.

Rohman, Fathor. 2009. "PROTOTYPE ALAT PENGUKUR KECEPATAN ALIRAN DAN DEBIT AIR (FLOWMETER) DENGAN TAMPILAN DIGITAL." (021).

Saktioto, Toto et al. 2020. "Birefringence and Polarization Mode Dispersion Phenomena of Commercial Optical Fiber in Telecommunication Networks Birefringence and Polarization Mode Dispersion Phenomena of Commercial Optical Fiber in Telecommunication Networks." (October).

Wahyuningsih, Fita Tri, Yusro Al Hakim, and Ashari. 2019. "Pengembangan Alat Peraga Pengukur Debit Air Menggunakan Sensor Flow Berbasis Arduino Sebagai Media Pembelajaran Fluida." *RADIASI : Jurnal Berkala Pendidikan Fisika* 12: 38–45.

Wijayanto, Dadan, Dedi Triyanto, and Ilhamsyah. 2016. "Pengganti Meteran Manual Karena Dapat Mengontrol Penggunaan Air Yang." *Coding, Sistem Komputer Untan* 4(3): 109–18.

Yusuf, Khaidir. 2019. "PERANCANGAN ALAT PENGUKUR DEBIT AIR BERBASIS ARDUINO UNO SEBAGAI ANTISIPASI PEMBOROSAN AIR DI SEKTOR PERTANIAN." *Jurnal Energi Elektrik* 8(1).