2021 年臺灣國際科學展覽會
優勝作品專輯

作品編號　**200025**

參展科別　**環境工程**

作品名稱　**Detect the Defect**

國　　家　**Egypt**

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Abstract.

"When the Well is Dry, we will know the Worth of Water." Most of Egypt and the world suffers from water and petrol shortage. With the current consumption rate, two-thirds of the world's population may face water shortages by 2025. These are water pollution, overpopulation, and agriculture, leading to wastewater from landfills and pipes that seep into the ground and may pollute the water, making it unfit for human consumption and waste more water. Besides, some accidents happen to water distribution and irrigation systems, causing a significant loss in water. According to the ministry of water resources, in 2016, the need for freshwater is 67 billion cubic meters. On the other hand, Egypt receives only 55 billion cubic meters (2.6 billion cubic meters of them evaporate during runoff).

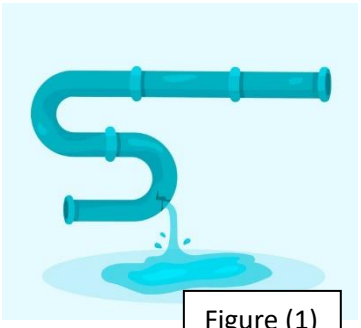


Figure (1)

Also, one of the wasting water methods in modern irrigation systems is water leakage from pipes as the water transmission and distribution lose about 31% of the produced water due to pipe leakage. Besides, every day more than 3.3 billion liters of treated water – 20 percent of the nation's supply and 234 million liters a day more than a decade ago – are lost through leaking pipes in England and Wales. Many reasons lead to leakage in pipes like water pressure, clogs, and corrosion. The leakage in pipes does not exist in the lines of water only. Also, the pipes in a petrol can cause dangerous accidents like the accident in the Bahira government that led to the death of 6 people and made 19 in a dangerous state.

Our project designed a system that can detect fluid leakage and deal with it fast to prevent the wasting of fluid by using sensors and electronic circuits. Our system provides us with information about the fluid (like the amount of the flowing fluid and its speed). Therefore, if there is a difference in the reads, we understand that there is a leakage in this region, and the system will automatically stop the fluid flowing through the pipes. the system will locate all the leakage sites and send them to the mobile app with the amount wasted and the actions taken.

Scientific Base.

We worked to prevent the leakage in pipes so, we build our project on a related scientific base and equations. We used the scientific equation to measure the volume flow rate of water leakage [leakage volume flow rate(**QL**) = A(v2-v1)] when A is the area of the pipe and v2 is the velocity of water through the second sensor, and v1 is the velocity of water through the first sensor, we can write this equation in another way [**QL** = **Q2**- **Q1**] when **Q2** and **Q1** is the volume rate through the second and first sensor, respectively. This equation is based on a continuity equation, a local form of conservation laws shown in figure (2).

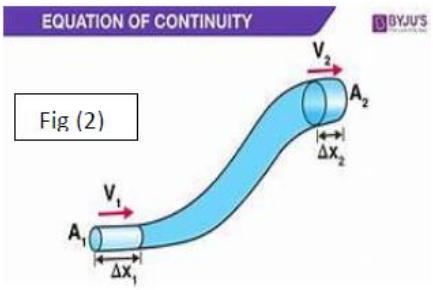
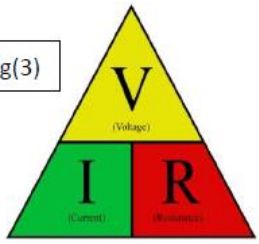


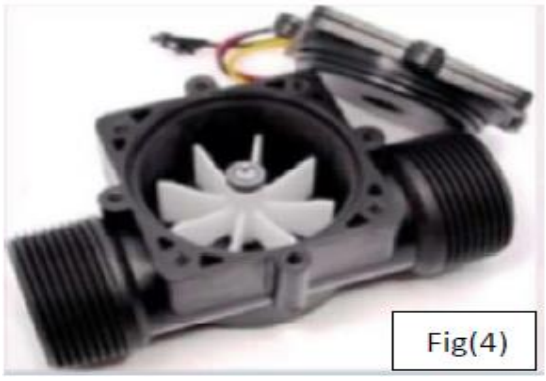
Fig (2)

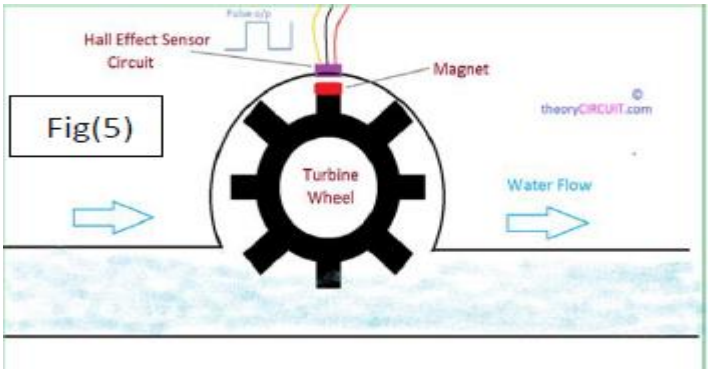
We used Ohm's law (R= $\boldsymbol{V/I}$) as shown in figure (3) when working with the circuit to prevent any errors that would damage the component, be sure that it would work stably, and measure the resistance of some components due to the sensitivity of the sensors used.



Fig(3)

We will use the water flow sensors as shown in figure (4,5) (distributed along with specific parts in the pipe) which according to pulse's time and the cross-sectional area, we will be able to get the velocity and the volume flow rate. We will then use the equation shown above [**QL** = **Q2**- **Q1**] to conclude if there is a leaking or not and will be capable to measure the value of wasted volume. If QL = 0, then there is no leakage, but if QL > 0, then there is a leakage.


Fig(4)



Fig(5)

Table (1)

Materials

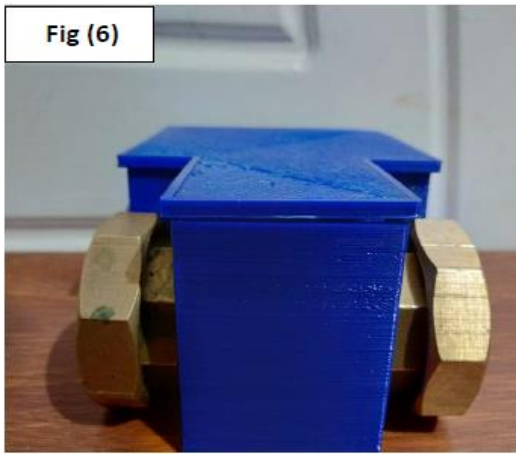
Node Mcu		
Water flow sensor		
Battery		

Methods.

In the begging, we search about the problem and its consequences, and its reasons. This problem is the leakage in the fluids' pipes (like water and Petrol) which leads to many crises. So, we worked to prevent the leakage in pipes and save the wasted amount of water and petrol.

- First, we connected the two flow sensors with the pipe from the two sides.
- we designed the box that will hold the sensor, the Node MCU and the battery and save them then we printed the design on 3D printer, as shown in figure (6)

Fig (6)



- We connected the hardware (the sensor and the Node mcu) and powered them with the battery and repeated the same process with the second sensor.
- After that, we write the code on the PC using the Arduino IDE and uploaded it to the Node mcu.
- Finally, we made a mobile app to collect all data from the system and send it to the user and connected it with the hardware with the online database.

Test plan.

We tested our prototype to make sure that it is workable.

Efficiency test:

we finished our prototype, operated the system, and made a leak in the pipes. After that, we compared the flow rate before and after the leakage to ensure it works well.

Accuracy test:

We pumped water in the system and calculated the volume of water in liters and the time in which water passed through the system, and then we got the flow rate in liters per time. After that, we compared the result to the sensor reading to get the difference between them.

Fig (7)

Environmental test:

We tested the impacts of our prototype on the environment.

Mobile app test:

We test the mobile app to be sure that the app receives all data from the system and tell the user about the system's state.

Results.

We tested our prototype to make sure that it is workable.

Efficiency test:

we compared the flow rate before the leakage to that after the leakage to ensure it works well. As shown in table (2)

Accuracy test: We pumped water in the system and calculated the volume of water in liters and how water passed through the system, then we got the flow rate in liters per time. As shown in table (3)

After that, we compared the result to the sensor reading to get the difference between them and the frequency-velocity ratio. (as shown in fig 8)

Environmental test: We tested the impacts of our prototype on the environment.

Mobile app test: We try the mobile app to be sure that the app receives all data from the system and tells the user about its state.

Table (2)

No. of trials	Trial 1	Trial 2	Trial 3
Water volume	0.450 L	0.450 L	0.450 L
Time	0.267 min.	0.200 min.	0.350 min
Calculated the flow rate	1.685 L/min	2.250 L/min.	1.286 L/min
Sensor flow rate	1.717 L/min.	2.209 L/min.	1.259 L/min.
Accuracy	98.1%	98.2%	97.9%

Table(3)

Water flow rate	Leaking flow rate	Work or not Work
2500±50 ml/min	1200±24 ml/min	Worked stably
2500±50 ml/min	1000±20 ml/min	Worked stably
2500±50 ml/min	500±10 ml/min	Worked stably
2500±50 ml/min	200±6 ml/min	Worked

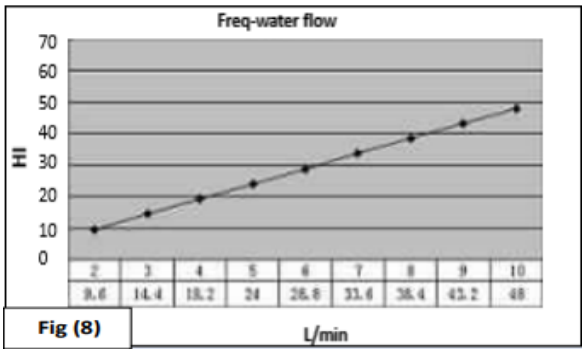


Fig (8)

Applications.

In our project, we prevent leakage in pipes to prevent the waste of water or petrol. It can be used in various fields.

• In irrigation, we can use our prototype to detect the leakage in pipes of water and prevent water waste specially in the deserts. It can help us decrease the amount of water that wastes every year, which can reach 31% of the produced water due to pipe leakage.

• In another hand, we can use our project in the pipes of petrol to prevent petrol waste because the leakage of petrol has a dangerous consequence and can cause a scary accident.

• Our project can be used to avoid the leakage in the natural gas pipes, using pressure sensor instead of the flow sensor.

Conclusions.

Our project aimed to prevent leakage in pipes of fluids (water and petrol). We designed an integrated system that controls most of the leakage in tubes as it contributes to avoiding the waste that happens during the distribution of water and petrol. It consists of pipes, two flow sensors and Node MCU. We tested our prototype to be sure that it works efficiently and achieves the desired goal. Also, we found that the relative sensor error was about 2%, which is a minimal error. Our prototype was eco-friendly as it did not have any negative impacts on the environment.

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For helping and support us

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This research offered an idea of water leakage detection from pipes to prevent wasting of water. This is an interesting idea, however, further experimental data were needed for more accuracy.