AQUA OPTIMIZER DEVICE (AOD)

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ABSTRACT

Aqua Optimizer is a device which has been designed to help people with using water in various background, including home use, especially in bathing. Three steps are defined for the device, each step indicates the amount of water consumed by the water in which the green, yellow and red lights are respectively lit when the water is being used, and if the user exceeds the limits then the device will cut off the stream and eventually prevents it from wasting the water.

1 Introduction

Water it is one of our most precious resources but our water supplies a limited. 97.5 % of the earth's water is salty and only 2.5 % is fresh water but over two third of this fresh water is locked in the polar ice caps and glaciers. This leaves only 0.5 % in our lakes for agricultural, industrial and personal use.

Based on the news agency the quality of this water is under threat. According to the world health organization, only 0.007% of the world, total water supply is safe for consumption and this amount of water needs to be shared by the more than 7 billion people on the planet. Water scarcity is the lack of fresh water resources to meet water demand. It affects every continent and was listed in 2019 by the World Economic Forum as one of the largest global risks in terms of potential impact over the next decade[1].

A water crisis is a situation where the available potable, unpolluted water within a region is less than that region's demand and based on the information nowadays two-thirds of the global population (4 billion people) live under conditions of severe water scarcity at least 1 month of the year. Half a billion people in the world face severe water scarcity all year round. Half of the world's largest cities experience water scarcity [2].

It also occurs where water seems abundant but where resources are over-committed, such as when there is over development of hydraulic infrastructure for irrigation. Symptoms of physical water scarcity include environmental degradation and declining groundwater. While the concept of water stress is relatively new, it is the difficulty of obtaining sources of fresh water for use during a period of time and may result in further depletion and deterioration of available water resources[3].

Water shortages may be caused by climate change, such as altered weather patterns including droughts or floods, increased pollution, and increased human demand and overuse of water. Therefore, challenges rise up more rapidly without solution. Two in 5 people are affected by water scarcity. It is a water crisis because it starts with water but water effects everything. Education, health, poverty and specially women and children. Well population growth increases demands for water , food and, energy. Meanwhile Rivers dry up and no longer reach the sea.

As clearly stated in researches by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity and two third of the world's population could be living under stressed conditions [4]. So the main reason of this research is designing a device as Aqua Optimizer to help people with using water in various background, including home use, especially in bathing.

Three phases are define in this device and each phase indicates the status of water consumed by the users thus the green, yellow and red lights will respectively turn on in order to manage the consumption in which the red lights flashing means it might be using too much water and accordingly our device will cut off the water flow and actually prevent it from wasting the water.

2 Modeling

Aqua means water and optimizing means make the best or most effective use of (a situation or resource). Our device is divided in two major parts: first part is the Warning box, which includes LEDs, Printed circuit board and adopter, which has to connect to an electrical outlet for running the device and the second part, is Tube section, which includes the sensors (Fig. 1).

Fig. 1: The schematic of our Aqua Optimizing

At the beginning of the tube section, we have a sensor called flow meter, in which there is a turbine wheel inside that and there are some magnets upon the wheel. According to the volume flow rate every time that turbine wheel rotates it means a pulse. So after the water flowed through the tube section, our microcontroller will start counting the pulses and then the order to illuminate the LEDs.

Five phases are launched and united on this device. Each of them bring a specific kind of order and concept. In this way, the first phase that turns on is due to start Run; it means that the device is working.

The second phase is green and in fact, it condemns that the amount of water consumption is scanty and low. This step has been provided for users to realize that they can continue using water on those moments.

The third phase is the warning, which has Yellow lights, so that you will find your water consumption has reached its normal range or you are at the middle of your standard usage and you should probably leave.

The next phase is high water consumption with Red lights that illustrates indication quote of warning that you have used too much water. On those moments, your water usage and consumption are riding out of the standards and you must leave the bathroom immediately after.

The last phase is stream interrupting. At the end of the High water stage, Red lights are going to flash, and after flashing, the device will cut off the water flow and eventually prevent it from wasting water .

The stages related to light phase are clear in figure (2).

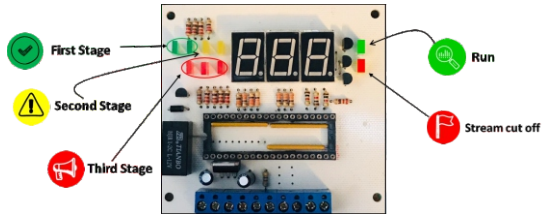

Fig. 2: Light phase stages in Aqua Optimizer

3 Materials and Methodology

The features and options of Aqua optimizer:

1)This invention expands the Contractual use of water in several steps with lights flashing and LEDs so that users can realize at what phase of water consumption they are! In addition, they could be able to schedule their consumption with water in order to take advantage while using water.

2)This product has the ability to cutoff the water flow, so Red lights flashing mean after over-use of the water it will cut off the water stream so the water is not going to being wasted by the users.

3)We installed the Restart button into AODs options by over thinking so that if there is anyone in an emergency, they could repeat this process by pressing the button and go through another course of water stream.

4)We can vary our defined limits for the lights related to any situation. For example, the standard water consumption for bathing in each country may vary, so we put an option to change the limits

5)There is a genuinely great access to connect AOD device into your home, tube section is near the waterspout and the warning box can be connected anywhere with the tag or the dealer because it is lightweight and water proof.

6)We use some panels which are seven segment most of the people are familiar with that as we can observe in streets in traffic lights counter that shows some number. this panel in AOD shows how much water you have used from the beginning of opening tap.

7)Leak of the valves and pipes in many cases can lead to a lot of water loss, but when AOD is connected to your spout water, no drop of water can escape from the head shower.

8)AOD is not used solely for bathing, but wherever a stream of flow is passing away. For example, washing the dishes or like in traditional agriculture, when farmers open the faucet and leave it, the device can be stand according to standard value and limits which we are going to define for and when it reaches the high level of consumption it will cut off the stream and there is no one to press the restart button. It is done by inserting a microcontroller which is the connector between AOD and our computer .

4 Theory

We code AOD with C++ and also two related physics theories , Bernoulli's principle in fluid dynamics and volume flow rate are used in AOD calculations .

Bernoulli's principle in fluid dynamics (Eq.1) , states that an increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy and the volumetric flow rate (Eq.2) is the volume of fluid which passes per unit time [5].

The flow rate in different pulses is found in table (1) [6].

$$\rho gh + \frac{1}{2}\rho v^2 + p = \text{constant} \quad (1)$$

$\rho =$ *Density*

g = Gravity acceleration

h = Height (length)

v = Velocity

P= pressure

$$Q = A \times V \quad (2)$$

$Q = quantity\ flow\ rate$

$V = average\ velocity$

$A = cross\ sectional\ area$

Table 1: The flow rate in different pulses

Flow ($\frac{L}{H}$)	Frequency (Hz)
120	16
240	32.5
360	49.3
480	65.5
600	82
720	90.2

Figure (3) shows the schematic of AOD and also figure (4) Position of each component in the whole system in.

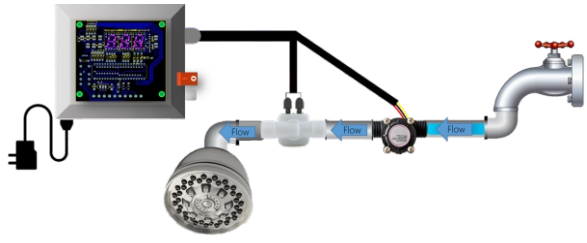

Fig.3: AOD experimental setup and calibration

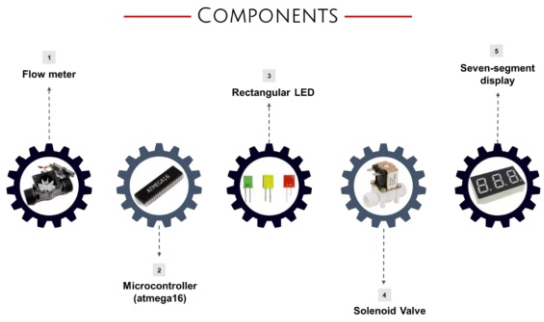

Fig.4: The components of AOD

5 Calibration

It is observed in different pressures, you are able to catch the flow with different pressures in different times without changes in AOD's function so as the experimental results, the pressure of the flow has no effect on AOD. (Fig.5 and 6)

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Fig. 5: Three different pressures in AOD's function

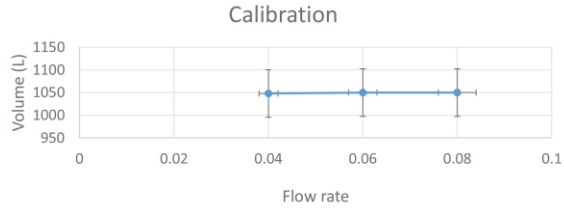

Fig.6: Volume versus flow rate in AOD

About the calibration Process, we can refer to the data sheet of the components as it is observed from the equation in 1 pulse/s the amount of flow rate is about 0.002 lit/s so in each frequency 1 litre of water stream should be about 500 pulses . Comparing theory and the experimental results shows only 20 pulses error in AOD (Fig.7).

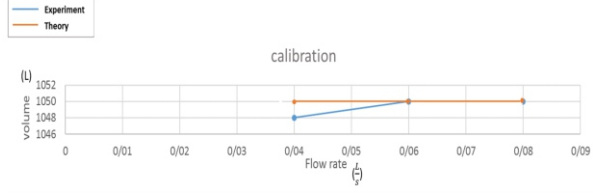

Fig.7: Comparing theory and experiment in AOD

Washing dishes and washing the head are compared with and without AOD. The comparison of water consumption by using this device(blue line) and without it (Red line) in washing the head shows water is saving (Fig. 8) and due to the result of our experiments, we are saving 41% of consuming water with AOD. It happens again in washing dishes (Fig. 9) and again we are saving 45% of consuming water while washing the dishes with AOD.

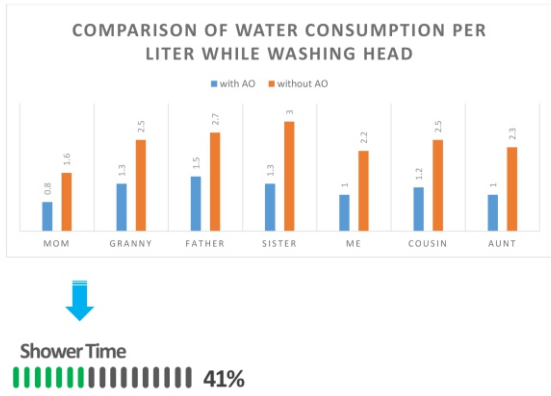

Fig.8: The comparison of water consumption with AOD (blue line) and without AOD (Red line) in washing the head

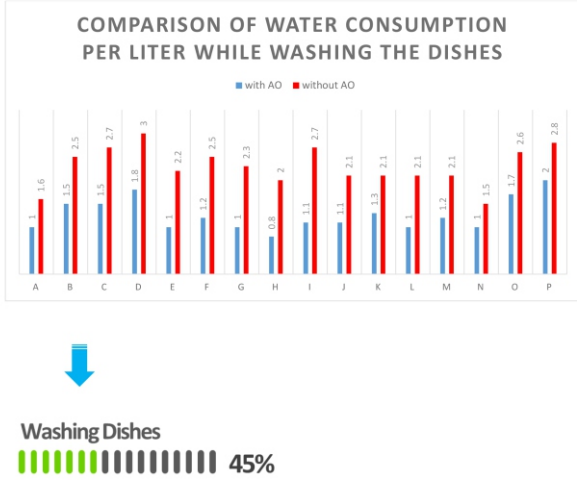

Fig.9: The comparison of water consumption with AOD (blue line) and without AOD (Red line) in washing the dishes

By using this device, we are saving and managing our water, time and other natural resources such as electricity, but the most important part is that we are making appropriate and perfect behaviour through our nature .

6 Conclusions

AOD helps people for a better consuming of water and save more green energy, which means more money and better nature. According to the results we can save water by AOD in all different types of usage such as washing dishes or shower (Fig. 10).

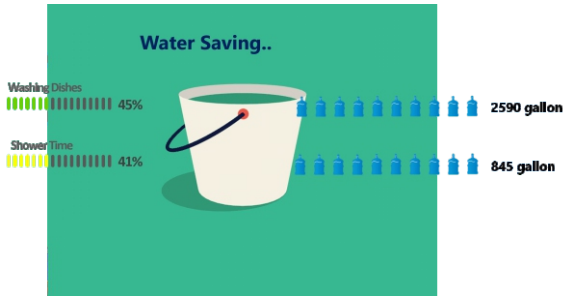

Fig.10: Saving water by AOD

Now we will talk about the future option:

1) There are different ways to warn and alert users. This warning can be a vibration, a beep-sounding alert, or simple and imaginable form of consumption (Fig. 11).

Fig. 11: Different ways of alarming

2) We can improve our device by sending Emails to let you manage your water consumption. To see your past and current consumption monthly , daily and even hourly and comparing your consumption to previous period of usage (Fig.12).

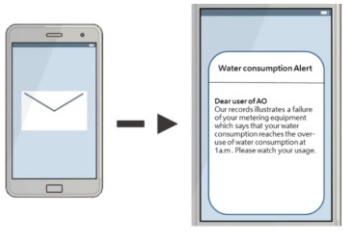

Fig. 12: Ways to improve AOD

3) However, the best option for those who do not pay attention to the warning is that, after the red light, the water pressure will gradually reduce until the moment of flow completely cutoff and you are not able to consume water after that for a certain time.

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