IoT Based Hydrodynamic Cavitation for Controlling Water Pollution

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***Abstract* - This study brings out the information about IoT based hydrodynamic cavitation process for water monitoring and control approach, where the data is collected on real time basis. The techniques studied includes, hydrodynamic cavitation, automation using IoT, web page designing. The issue presents generation of disinfectants and stingy smell in water, which has been solved by the project of Hydrodynamic Cavitation using ozonation which has to be controlled manually. Based on this standard we propose a smart water treatment model combining Internet of Things technologies with chemical procedure.**

***keywords* - Internet of Things, Hydrodynamic Cavitation, Ozonation, Water Treatment**

I. INTRODUCTION

This work proposes automation to the system which is a real time project, carried out at Rankala. A variety of physical and chemical techniques are used for water disinfection including chlorination, ozonation and ultraviolet light. These techniques can be combined with hydrodynamic cavitation for water purification. The project implemented at Rankala uses hydrodynamic cavitation process using ozonation. This system is used to reduce the greenish colour and stingy smell of water. Number of oxygen generators are used for generating oxygen which is then converted to ozone through ozonator. The pressure of ozone is reduced and is brought to vapor form, this forms cavitation bubbles. When the pressure is brought back to normal pressure, these vaporous bubbles collapse with a bang to generate intense pressure and temperature at the point of collapse. Such increase in temperature kills bacteria and disinfectants present in water. As temperature rises in this process a cold water cylinder is wrapped around the ozone pipe to reduce the temperature. This is then mixed with water which has been pumped in. This system is manually operated. Thus, to make it more convenient we are adding IoT based controlling and monitoring system, which can be accessed from anywhere around the world unless and until it is connected to the internet. We are creating a prototype of this real time system. Also, this system can be used in future to control water pollution in other places.

A. Hydrodynamic cavitation

The techniques for water disinfections includes hydrodynamic cavitation, acoustic cavitation and treatment with chemicals such as ozone and hydrogen peroxide. A variety of physical and chemical techniques are used for water purification which includes chlorination, ozonation and ultraviolet light. Cavitation is a physical process associated with formation, growth and collapse of vapor or gas filled cavities (bubbles) within the body of a liquid due to variations of local pressure. Cavitation will only occur if the local pressure decreases to some point below the saturated vapor pressure of the liquid. When the pressure is brought back to normal pressure, these vaporous bubbles collapse with each other to generate intense pressure and temperature at the point of collapse. Thus, the process of bubble generation, and the subsequent growth and collapse of the cavitation bubbles, results in very high energy densities, local temperatures and local pressures at the surface of the bubbles for a very short time. Such intense conditions bring about several physical, chemical and biological transformations.

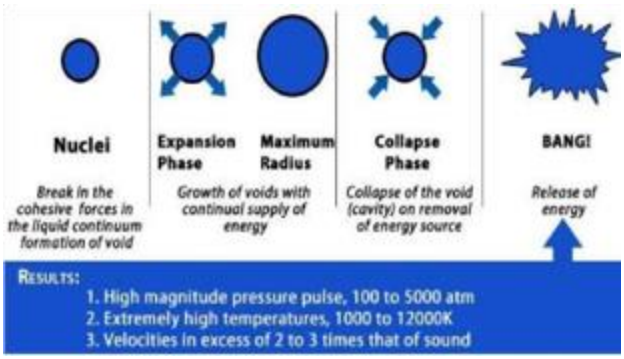

Fig. 1

B. Internet of Things (IoT)

It is a concept that describes the idea of everyday physical objects being connected to the internet. It is becoming a well known concept in everyday life in society. IoT has gained a great attention, since it has become vital and convenient technology. IoT represents devices or sensors which are connected to the Internet via wired and wireless network structure. Electronic devices are connected, monitored and controlled through IoT. These devices collect useful data with the help of technologies such as RFID, Wi-Fi, Bluetooth, ZigBee and flow the data between other devices. Examples of IoT are, controlling television, fan, any other home applications or appliances, Intelligent shopping system, Traffic Management system, Automobile Vehicle, Environmental Monitoring, Health, Parking, Security.

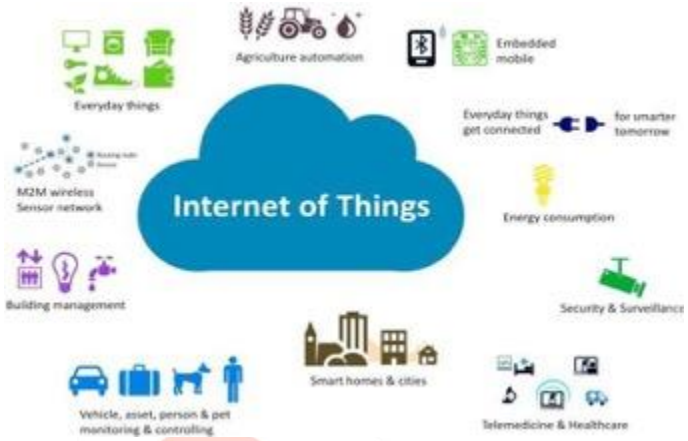

Fig. 2

II. PREVIOUS WORK

[1] K.K.Jyoti and A.B.Pandit.

The authors have described three types of techniques for water disinfections in this paper which includes hydrodynamic cavitation, acoustic cavitation and treatment with chemicals such as ozone and hydrogen peroxide. They have mentioned in their experimental studies that the diffusion technique of ozone for 2mg/l O3 was chosen as the bubbles, results in very high energy densities, local temperatures and local pressures at the surface of the bubbles for a very short time. Such intense conditions bring about several physical, chemical & biological transformations concentration for the study and observed that the percentage reduction in total coliforms for 15 mins was 60% and for 60 min was 94%.

[2] A.R.Warade, R.W.Gaikwad, et.al.

In this paper authors have proposed a system of hydrodynamic cavitation for treatment of wastewater. Hydrodynamic Cavitation can be described as formation, growth and collapse of cavities releasing large amount of energy. It has been found that hydrodynamic cavitation is capable of oxidizing organic pollutants.

[3] Rajeev Piyare and Seong Ro Lee.

The authors have specified a system which can be controlled through a web page using IoT. They have mentioned basic principle of Internet of Things (IoT) as connecting everyday object like smartphone, sensors, etc. to internet where devices are linked together to form communication between things and people. They have also suggested that the system can be controlled using any android based smartphone with built in support Wi-Fi, if Wi-Fi connection is not available.

Rankala water purification plant, to treat polluted water is set up at Rankala, which is run by Municipal Corporation of Kolhapur. Several people have contributed ₹ 25 Lakh to set up Hydrodynamic Cavitation technology which is developed by renowned scientist and Prof. G. D. Yadav. The set up was built in June 2015 on temporary trial basis which was later made permanent by Kolhapur Municipal Corporation. The ozone generator machine is installed for the purification of water. The plant consists of ozone generator machine. The generated ozone which is used for hydrodynamic cavitation process is mixed with water which reduces harmful pollutants in water by increasing the amount of dissolved oxygen in water. It can treat one million liters of water per hour without using any chemical. It also reduces the stingy smell and growth of algae in water. The results were observed and the officials concluded that the quality of water has improved and the fish count in water has increased.

III. PROPOSED WORK

A. Block Diagram

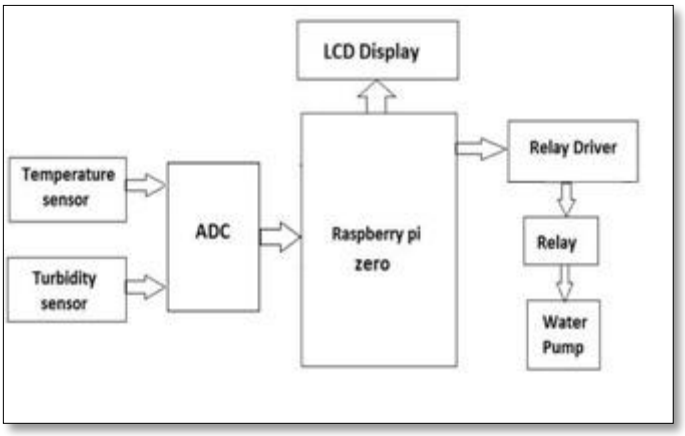

Fig. 3

- *Raspberry Pi zero:*

The Raspberry Pi is a credit-card sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word processing, browsing the internet, and playing games. A Raspberry Pi Zero has smaller size with reduced input/output (I/O) and general purpose input/output (GPIO) capabilities. In model Pi Zero, the USB port is connected directly to the system to the chip.

- *Turbidity Sensor:*

The turbidity sensor detects water quality by measuring the levels of turbidity. It uses light to detect suspended particles in water by measuring the light transmittance and scattering rate, which changes with the amount of total suspended solids (TSS) in water. As the TTS increases, the liquid turbidity level increases. This sensor provides analog and digital signal output modes.

- *Temperature Sensor:*

LM35 is a temperature sensor that outputs an analog signal which is proportional to instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. The advantage of lm35 over thermistor is it does not require any external calibration.

- *LCD Display:*

Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, etc. The 16x4 intelligent alphanumeric display is capable of displaying 1604 different characters and symbols. A 16x4 LCD means it can display 16 characters per line and there are 4 such lines. In this LCD each character is displayed in 5x8 dots including cursor.

- *ADC:*

MCP3204/3208 devices are successive approximation 12-bit Analog-to-Digital (A/D) converters with on-board sample and hold circuitry. The MCP3204 is programmable to provide two pseudo differential input pairs or four single ended inputs. Communication with the devices is accomplished using a simple serial interface compatible with the SPI protocol. The devices are capable of conversion rates of up to 100 ksps.

- *Relay:*

A relay is a special type of switch that turns on and off by an electromagnet. A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts. When a current flows through the coil an electro-magnetic field is set up. The field attracts an iron armature, whose other end pushes the contacts together, completing the circuit, which will turn on the relay.

- *Pump:*

A pump is a device that moves fluids, by mechanical action. Pumps operate by some mechanism and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, which come in many sizes, from microscopic for use in medical applications to large industrial pumps.

B. Working

By using Raspberry Pi board, proposed system focuses on controlling and monitoring of water quality. In this system, when the power supply is turned on, the turbidity sensor at the input, will check its turbidity and display quality of water on LCD as well as on web page. Through our system we are going to show the mechanism of flow of ozone, which is used in real time project to prevent greenish colour and stingy smell of water. As it is expensive and harmful for human health, ozone is not being used in our project. Our actual mechanism is for purification of water which is done by pumping the water into the candle filter which purifies the water. On the other hand, we are showing the prototype of mechanism of hydrodynamic cavitation using ozonation. The filtered water is then sent out and its quality is measured by the turbidity sensor at the output. The temperature sensor is used for monitoring temperature of chiller, which is a part of ozonation process. We are showing one kind of alert, that if the temperature rises above the threshold level an alert is generated. This process is controlled through a web page, where the authorized person can control and monitor the system. The web page is designed where the user needs to provide its user ID and password to log in. After the user has logged in, user can get information about the quality of water and temperature of

chiller. The user can turn on/off the relays and shut down the system by this web page as well as manually. The temperature alert generated will be shown as a pop up message on web page as well as a message will be sent to the user on the predefined user's mobile number.

IV. CONCLUSION

From the studies carried out in this work, it can be observed that Hydrodynamic Cavitation using Ozonation technique monitors and controls the treatment of disinfectants in water with modern technique of Internet of Things. Maximum number of disadvantages and circumstances are taken under consideration and are over come in this study.

V. RESULT

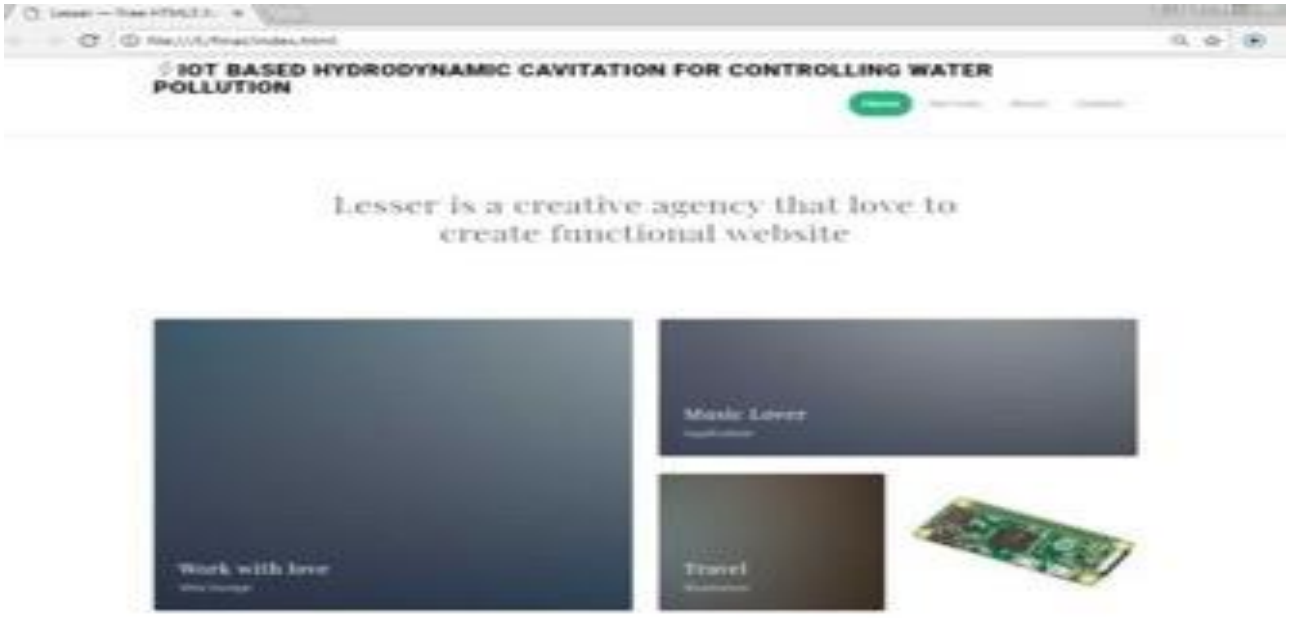

Fig .4

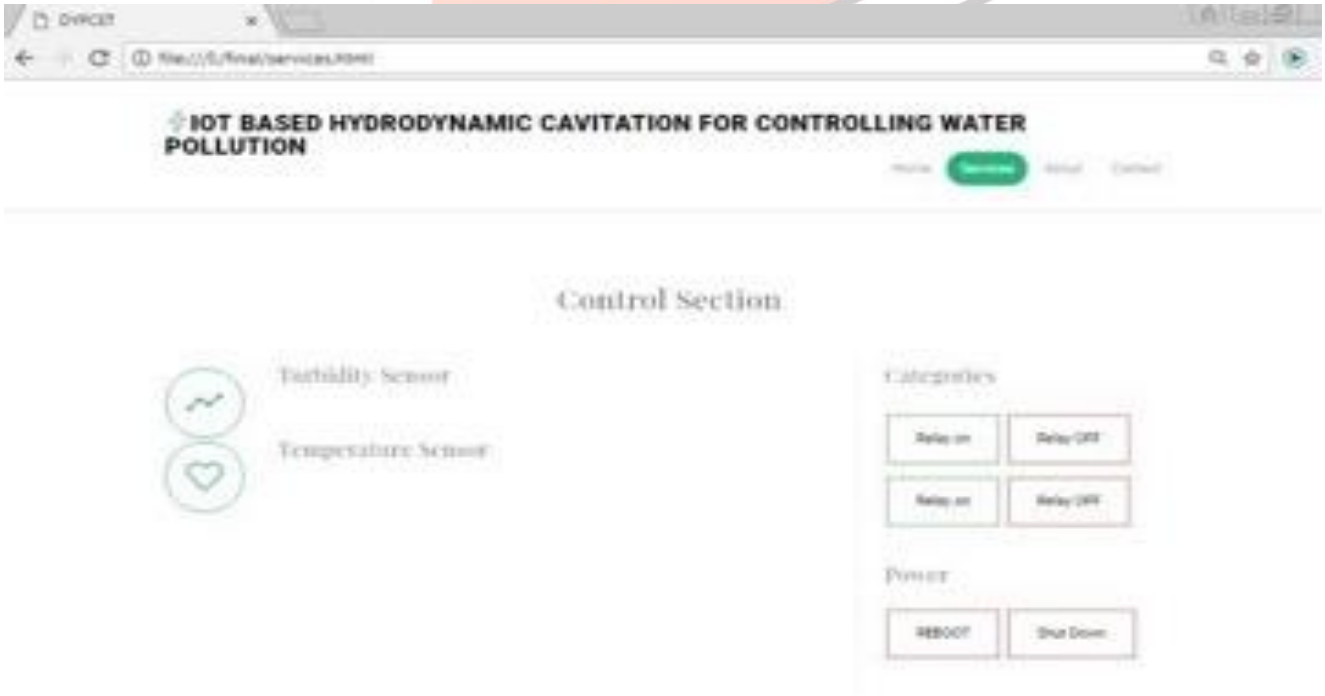

Fig. 5

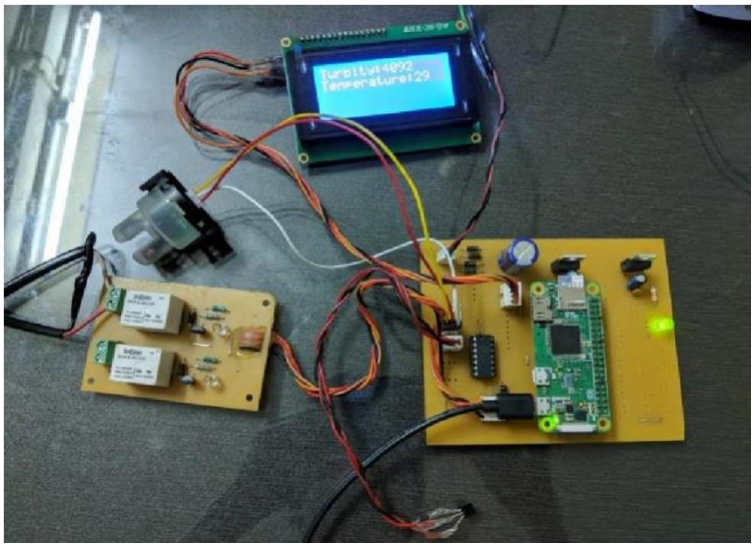

Fig. 6

VI. REFERANCES

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