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Sensor Study: A Review of their Precision and Reliability

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Abstract: This review paper is all about aquaponics and its implementation using IoT. The motivation for this literature study is to provide insights into the usage of various sensors in the system. This includes studying of turbidity in different solutions with comparison and different values of pH. Sensors are the heart of IoT-based projects and their accuracy needs to be at par for the smooth functioning of the system on they have been implemented. This information on some sensors can be compiled and studied further to also resolve the challenges in farming.

Keywords: Aquaponics, IoT, pH, and Turbidity

I. INTRODUCTION

Our world has come to have to a point where we need to take stern actions if we want Life to thrive peacefully in the future. This era is all about sustainable alternatives to almost everything – fuel, food, technology, fashion – everyone is aiming to meet the needs of the present & also preserving resources for the future. The first thing which comes to mind is keeping up with the food stock with the growing population. Thus, the traditional agricultural sector too needs some sustainable alternatives as the overuse of chemical fertilizers is affecting the world in different ways.

Aquaponics could be such an alternative & the future of sustainable farming. It is a combination of aquaculture and hydroponics. Aquaculture is breeding, rearing, and harvesting aquatic life [fish, shellfish, algae] and on the other hand, hydroponics means growing /cultivating plants in a soilless environment. Mixing these two techniques gives birth to a food production system where there is the symbiotic cultivation of plants and aquatic animals in a recirculating environment.

This aquaponics system could be made more efficient with the help of IoT (Internet of Things). IoT in general terms means controlling or monitoring everyday things with the use of the internet. Connecting everyday objects with the internet, this monitoring can be done with the help of various sensors.

For our project – Aquaponics using IoT, we are using various sensors to check different aspects of the system like the pH of water, its turbidity and the temperature and humidity of the surrounding, etc.

II. IMPLEMENTATION

To bring this Aquaponics project to life using IoT, we need to take into account the hardware and software tools that need to be used to implement this IOT integrated system owing to the feasibility and outcome of the system.

First comes the micro-controller and Wi-Fi module that has been used to put data over the internet. We have decided to work on Arduino Uno as the micro-controller and used Node MCU as the Wi-Fi module which together suffices as the hardware environment of the project. Owing to the open-source compatibility and needed hardware interfaces, we have done the programming of these on the Arduino IDE.

Although software tools and environment are not the prime focus of this paper, we have chosen Firebase for the Real-Time database, and for the front-end technologies, we have decided to use React and CSS.

Last but not the least, the key components of the project are the various sensors which will provide us the necessary values to make this monitoring system a success. We have taken a few different sensors which are connected to the Arduino Uno Board which will measure various aspects of the project components such as pH value, turbidity, water level, temperature, and humidity. The detailed description of sensors and connection diagrams with the Arduino is as follows:

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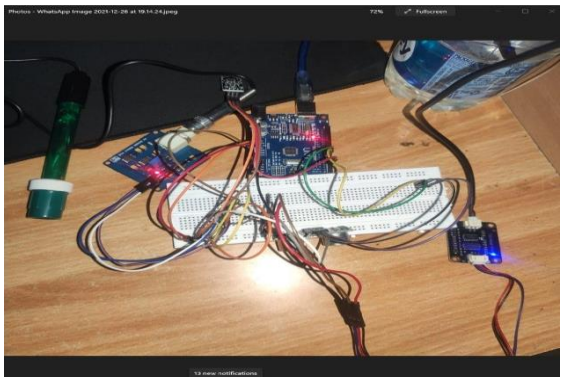

Fig:1 Various Sensors

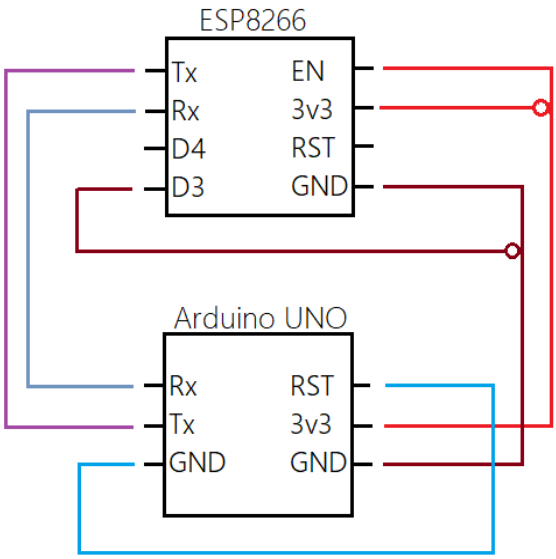

Fig: 2 Pin diagram for Arduino UNO microcontroller and Wi-Fi module NodeMCU ESP8266

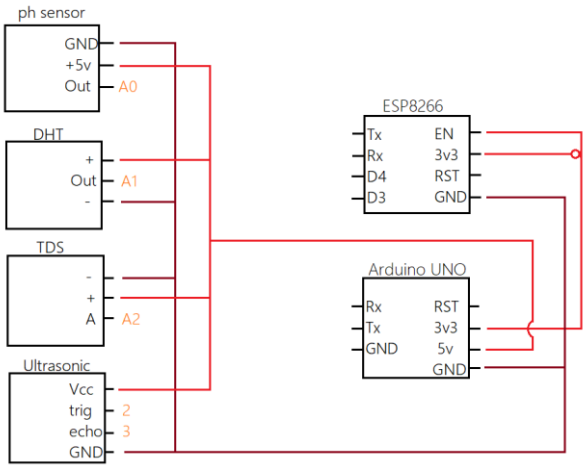

Fig:3 Connection of Sensors with Hardware Environment.

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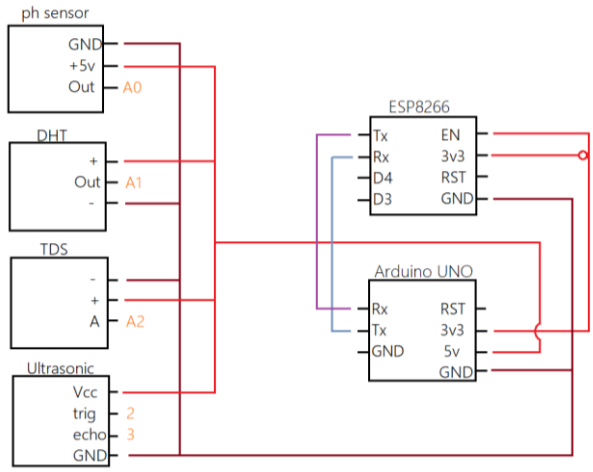

Fig: 4 Connection for Transmitting and Receiving Data from Sensors.

As the system we wanted to work on requires all these sensors, we decided to test them on various samples and environments and compared them to the standard values available for which below are our findings:

pH Sensor

pH measurement is done to check whether a given solution is acidic or basic. The ‘p’ in the term "pH" is derived from the word “potenz” which is a German word that means power, and the ‘H’ represents Hydrogen. Thus, the pH means 'power of Hydrogen’ .Hence, pH is a measure of Hydrogen ion concentration i.e., its acidity or alkalinity in a solution.

How is pH measured?

- Rough measurements can be made using litmus paper.
- Another and more accurate means of measurement is using primary standards to calibrate a glass electrode and pH meter.
- The second way includes the usage of various sensors.

We used Laboratory pH sensors. After evaluating various liquid samples, we drew the following results:

TABLE I: PH VALUE OF DIFFERENT SOLUTIONS

	Solution	Standard pH Range	pH value
1	Handwash	8-10	8.3
2	Grape juice	3.0-4.0	3.1
3	Isopropyl Alcohol	8	8.1
4	Lime juice	2.1-2.2	2.2
5	Milk	6.7-6.9	6.4
6	Soyabean Oil	7.8-7.9	7.9
7	Tap Water	6.5-8.5	7.4
8	Vinegar	2.5-2.7	2.7

TDS Sensor (Total dissolved Solids):

It is a small hand-held device that tells how much dissolved solid is present in the solution. The solution contains various salts and minerals which increase the conductivity of the solution. This conductivity of the solution is measured by TDS Sensor.

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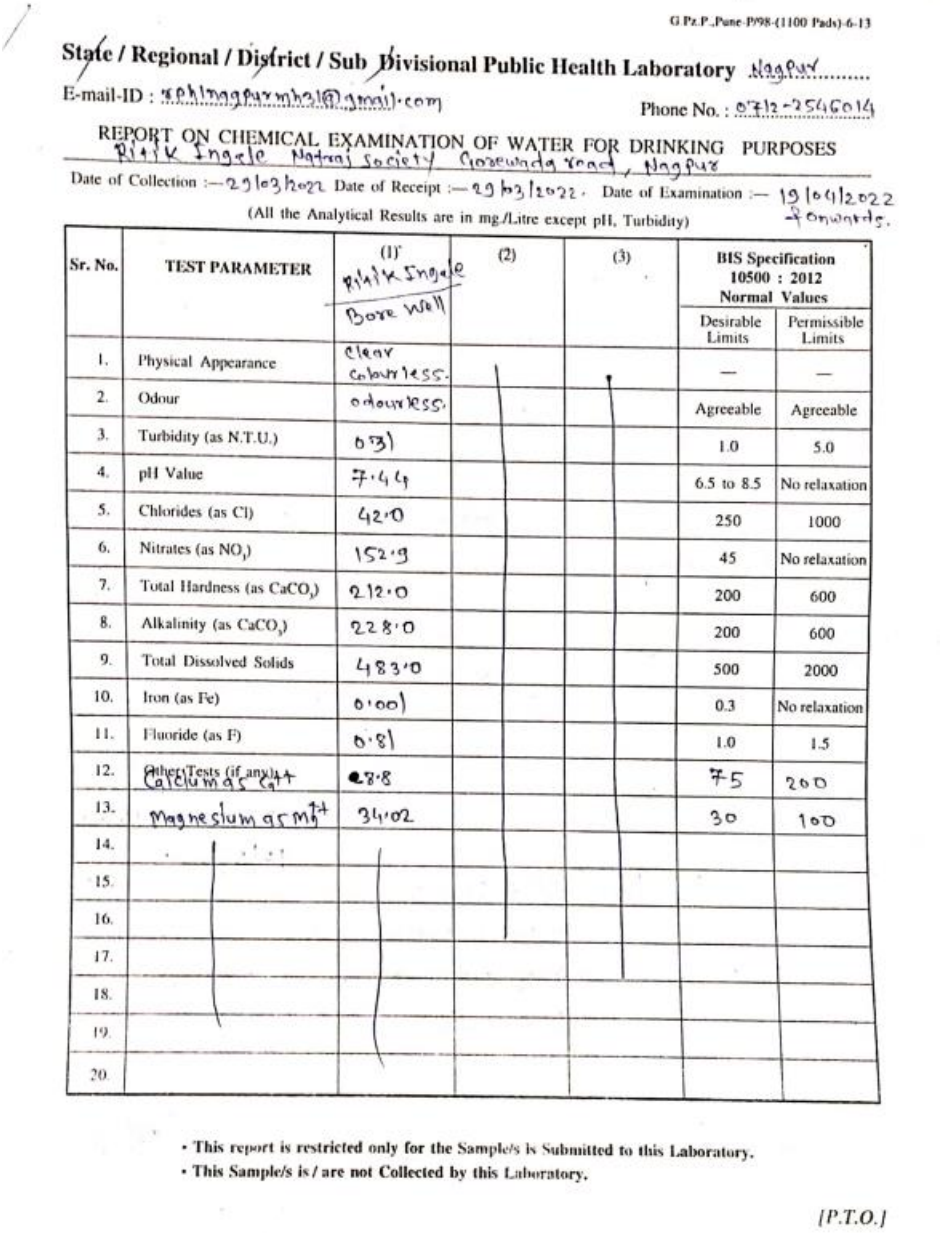
TABLE II TDS VALUE OF DIFFERENT SOLUTION

	Specimen	Standard TDS value (ppm)		Observation Value (ppm)
1	House-hold water	50-150	acceptable	Drinking water:387 Tap water:665
		150-350	good	
		350-500	fair	
		500-900	poor	
		900+	unacceptable	
2	Oil	0		0

We took the water samples of tap water, drinking water, and water from a bore-well to the RPHL office and got the following results:



G.Pz.P.,Pune-P/98-(1100 Pads)-6-13

State / Regional / District / Sub Divisional Public Health Laboratory Nagpur

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REPORT ON CHEMICAL EXAMINATION OF WATER FOR DRINKING PURPOSES

Date of Collection :—29/03/2022 Date of Receipt :—29/03/2022. Date of Examination :— 19/04/2022 Onwards.

(All the Analytical Results are in mg./Litre except pH, Turbidity)

Sr. No.	TEST PARAMETER	(1) Bore well	(2)	(3)	BIS Specification 10500 : 2012 Normal Values	
					Desirable Limits	Permissible Limits
1.	Physical Appearance	Clear Colourless.			—	—
2.	Odour	odourless			Agreeable	Agreeable
3.	Turbidity (as N.T.U.)	0.31			1.0	5.0
4.	pH Value	7.44			6.5 to 8.5	No relaxation
5.	Chlorides (as Cl)	42.0			250	1000
6.	Nitrates (as NO_3)	152.9			45	No relaxation
7.	Total Hardness (as $CaCO_3$)	212.0			200	600
8.	Alkalinity (as $CaCO_3$)	228.0			200	600
9.	Total Dissolved Solids	483.0			500	2000
10.	Iron (as Fe)	0.001			0.3	No relaxation
11.	Fluoride (as F)	0.81			1.0	1.5
12.	Other Tests (if any) Calcium as Ca^{++}	28.8			75	200
13.	Magnesium as Mg^{++}	34.02			30	100
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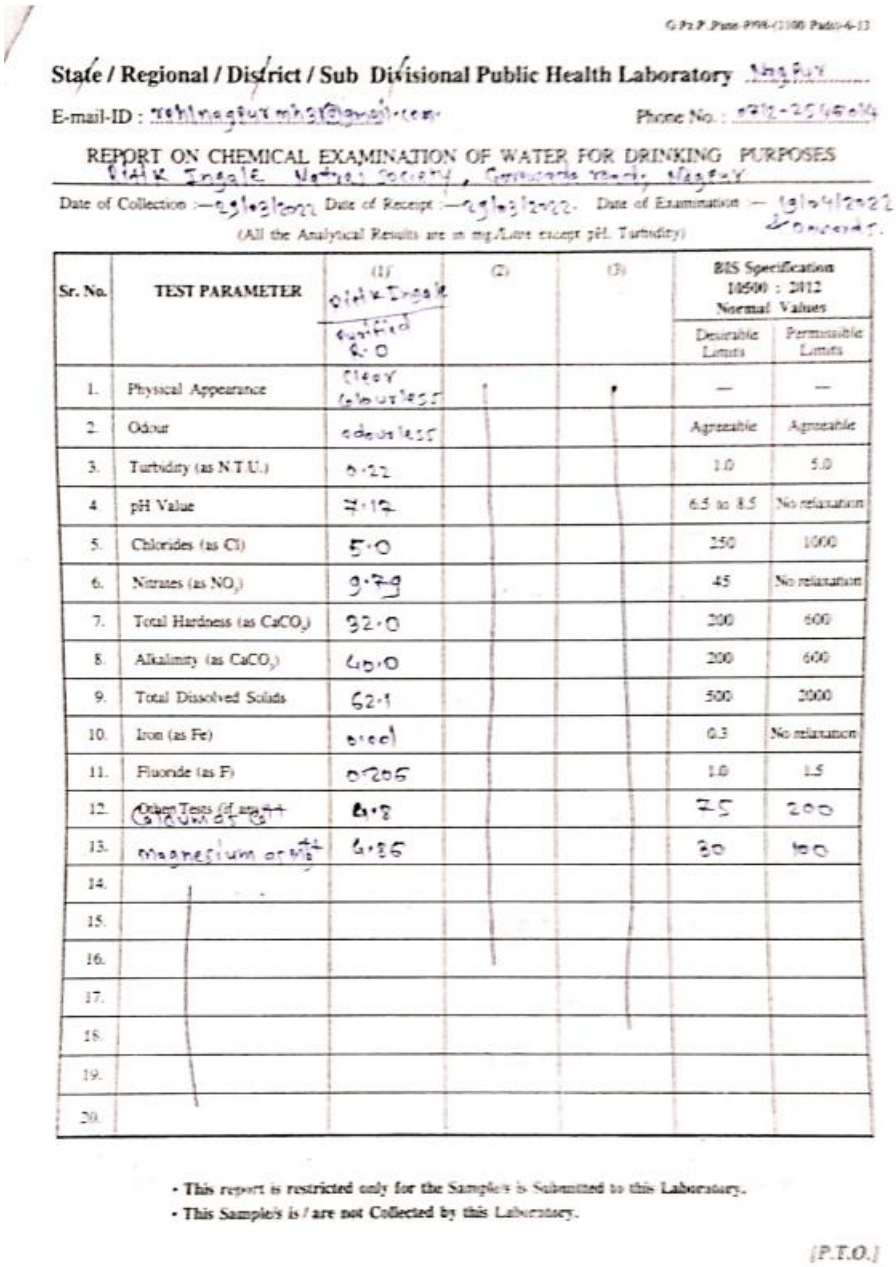

State / Regional / District / Sub Divisional Public Health Laboratory Nagpur

E-mail-ID : [illegible] Phone No. : [illegible]

REPORT ON CHEMICAL EXAMINATION OF WATER FOR DRINKING PURPOSES

Ritik Ingale Nehru Society, Gumthala road, Nagpur

Date of Collection :—29/03/2022 Date of Receipt :—29/03/2022. Date of Examination :— 19/04/2022 onwards.

(All the Analytical Results are in mg/Litre except pH, Turbidity)

Sr. No.	TEST PARAMETER	(1) Ritik Ingale Purified R.O	(2)	(3)	BIS Specification 10500 : 2012 Normal Values	
					Desirable Limits	Permissible Limits
1.	Physical Appearance	Clear colourless			—	—
2.	Odour	odourless			Agreeable	Agreeable
3.	Turbidity (as N.T.U.)	0·22			1.0	5.0
4.	pH Value	7·12			6.5 to 8.5	No relaxation
5.	Chlorides (as Cl)	5·0			250	1000
6.	Nitrates (as NO_3)	9·79			45	No relaxation
7.	Total Hardness (as $CaCO_3$)	32·0			200	600
8.	Alkalinity (as $CaCO_3$)	40·0			200	600
9.	Total Dissolved Solids	62·1			500	2000
10.	Iron (as Fe)	nil			0.3	No relaxation
11.	Fluoride (as F)	0·205			1.0	1.5
12.	Other Tests (if any) Calcium as Ca^{++}	6·8			75	200
13.	Magnesium as Mg^{++}	4·86			30	100
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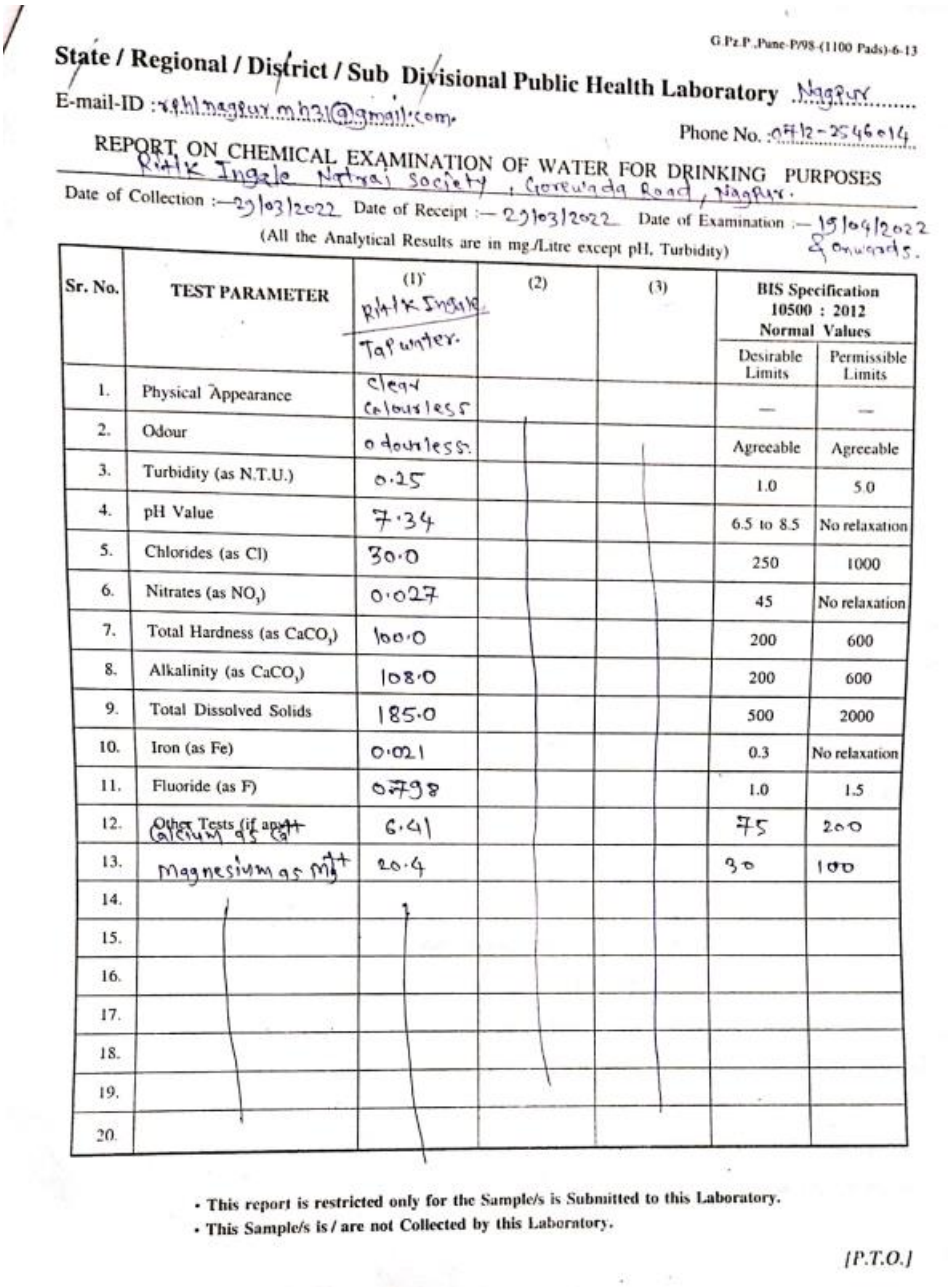

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Ritik Ingale Netraj Society, Gorewada Road, Nagpur.

Date of Collection :— 29/03/2022 Date of Receipt :— 29/03/2022 Date of Examination :— 19/04/2022 & onwards.

(All the Analytical Results are in mg./Litre except pH, Turbidity)

Sr. No.	TEST PARAMETER	(1) Ritik Ingale Tap water.	(2)	(3)	BIS Specification 10500 : 2012 Normal Values	
					Desirable Limits	Permissible Limits
1.	Physical Appearance	Clear Colourless			—	—
2.	Odour	odourless.			Agreeable	Agreeable
3.	Turbidity (as N.T.U.)	0.25			1.0	5.0
4.	pH Value	7.34			6.5 to 8.5	No relaxation
5.	Chlorides (as Cl)	30.0			250	1000
6.	Nitrates (as NO_3)	0.027			45	No relaxation
7.	Total Hardness (as $CaCO_3$)	100.0			200	600
8.	Alkalinity (as $CaCO_3$)	108.0			200	600
9.	Total Dissolved Solids	185.0			500	2000
10.	Iron (as Fe)	0.021			0.3	No relaxation
11.	Fluoride (as F)	0.798			1.0	1.5
12.	Other Tests (if any) Calcium as Ca^{++}	6.41			75	200
13.	Magnesium as Mg^{++}	20.4			30	100
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dht11 Sensor:

dht11 is an ultra-low-cost digital temperature and humidity sensor. dht11 Sensor is used for detecting temperature and humility of the Surrounding it can be used with microcontroller such as Arduino uno etc. It is available as sensor or module.

Ultra-Sonic Sensors:

Ultrasonic Sensor is a device which measures the distance of an object using ultrasonic sound waves. It sends and receive pulses using transducer.

III. CONCLUSION

With the growing use of IOT Technologies sensors are playing an even more important role in monitoring certain aspects at various fields. These sensor values can be made into a data set and compile to study further many different things like which crop grows best in which pH range or what factors affect the change in pH and turbidity or what could be the safe values and how could they be achieved.

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