A

DISSERTATION REPORT

ON

DAM & WEATHER PARAMETERS MONITORING SYSTEM

SUBMITTED TO THE SAVITRIBAI PHULE UNIVERSITY OF PUNE, IN THE PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE AWARD OF THE DEGREE

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(VLSI & EMBEDDED SYSTEMS)

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CERTIFICATE

This is to certify that the Dissertation Report entitled

"DAM & WEATHER PARAMETERS MONITORING SYSTEM"

Submitted By

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Is a Bonafide work carried out by HIM under the guidance of PROF. D. E. UPASANIand it is approved for the partial fulfillment of the requirement of the SAVITRIBAI PHULE PUNE UNIVERSITY for the award of

The MASTER OF ENGINEERING (E&TC)
(VLSI & EMBEDDED SYSTEMS)

This Dissertation Report has not been earlier submitted to other Institute or University for the award of any degree or diploma.

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List of Figures

List of Tables

Contents

Nomenclature and Abbreviation

ADC	Analog to Digital Converter	
AH	Absolute Humidity	$(grams/m^3)$
CSV	Comma Separated Values	
DWPMS	Dam & Weather Parameters Monitoring System	
GDP	Gross Domestic Product	
GUI	Graphical User Interface	
IoT	Internet of Things	
M2M	Machine to Machine Communication	
RFID	Radio Frequency Identification	
RH	Relative Humidity	(%)
RTDS	Real Time Decision Support	
RTDSS	Real Time Decision Support System	
RTD	Resistance Temperature Dependant	
SCADA	Supervisory Control and Data Acquisition	
SHIS	Smart Home Information System	
DB	Database	

Abstract

Authentic time dam and weather parameters monitoring are today's need. The nowadays dam authority is facing problems related to the dam and weather parameter monitoring. Up to now most of the smaller dams are manually monitored and sending data with normal ways, this manual observation and transmission results in a time lag, between the data observed in dam site and decision taking level. This sometimes causes loss of beneficial real time data. Researchers want observed data to be readily available for research purpose as well as monitor the authentic time changes in various parameters. Common people, mainly farmers are unaware about these parameters like rainfall, Dam water level and gate status. This project will help to reduce these problems faced by Dam authority, researchers as well as common people (farmers). The concept of this system is to develop a web portal which will monitor and give authentic time parameters related to Dam and weather conditions. It also provides facility of downloading CSV file of recorded parameters readings. GUI Software developed in this system will provide two types of facility Autopilot mode and Manual mode. At back end of the software it takes parameter information from the related sensors and dumps it into the database. The dumped data can be used for maintaining a database and further decision making. This proposed scheme basically works on Internet of Things (IoT), so that data sharing can be possible utilizing web data base.

Index Terms: Dam parameters, GUI, Internet of Things (IoT), monitoring system, weather parameters, web-portal.

Chapter 1

INTRODUCTION

Water and Weather are playing a vital role in our daily lives, these are important factors that can not be neglected. The Economy of India is the seventh-largest in the world, the agricultural sector is the largest employer in India's economy but contributes to a declining share of its GDP (17% in 2013-14). Hence to cater that dams are built. Dams can fulfill these need, as they are source of water and hydro-electric power.

Now a days dam authority facing problems regarding the dam and weather parameters monitoring as most of small dam till using manual data observation and transmission. Older transmission system make much more difference in decision making.

Dam researchers want to monitor dam data continuously to observe the changes in parameters. They want centralize database so they can perform operation on well collected and organize data. For research purpose in India centralize database not available up to now. Presently researchers request to dam authority for data. It means that data availability is major problem for them.

Normal people like farmers also unaware about these parameters like water level, gate opening, amount of rainfall, temperature, humidity; so they are facing many problems. Due to heavy rainfall, the water level of dam increases suddenly due to which the Dam authority have to open the gates to prevent the dam from the risk of uncertainty issues. Also due to this the people living in nearby villages have to face a serious problem like flood in their farms. When back water of dam increases above its threshold level(danger level) it may cause damage to farms, villages, industries located nearby and lastly the lives of the people living nearby.

Manual data observation and transmission results in a considerable time lag, between data observed in field and its communication to decision making level which sometime leaves little time, so there may be a possibility of losing a real time data. The proposed scheme will help to reduce such problems.

This system will help to reduce these problems which faced by Dam authority, researchers as well as common people like farmers.

The conception about this system is to develop a web portal which will monitor and provide authentic time parameters related to Dam and weather like water level, rain fall, dam gate position, temperature, humidity etc.

In observation part the smart controller provides facility of dumping sensor observation values directly into database with specific time interval. It provides the facility of SMS for providing data. Also the system has an alarm which will give alerts and will help in knowing critical conditions.

As it is basically based on Internet data sharing with the help of web database, like weather parameters for Meteorological department, dam parameters to government authority etc, the Government of India wants to monitor the real time water level of reservoirs. Hence this work will help in Digital India Mission.

1.1 Relevance

This system will make easy monitoring of Dam and Weather parameters. Which will help to Dam authority, Dam researchers and normal people. Real Time Decision Support (RTDS) will help for various decision making related to parameters.

1.2 Objectives

Following are the objectives of this project:

- To monitor & Analyse Dam Parameters
  - Dam authority
  - Dam researchers
  - Normal People
- To monitor & Analyse weather Parameters
- To develop GUI software
- To provide Real Time Decision Support (RTDS)
- To data sharing with remote systems
- To develop finished Product
- To Publish Paper in good Journals

Chapter 2

LITERATURE REVIEW

The term “Internet of Things” was first documented by a British visionary, Kevin Ashton, in 1999. Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a Smart Grid. [1]

Kevin Ashton wrote article in RFID journal that He could be wrong, but he fairly sure the phrase ”Internet of Things” started life as the title of a presentation he made at Procter and Gamble in 1999. Linking the new idea of RFID in P and G’s supply chain to the then-red-hot topic of the Internet was more than just a good way to get executive attention. It summed up an important insight one that 10 years later, after the Internet of Things has become the title of everything from an article in Scientific American to the name of a European Union conference, is still often misunderstood. [1]

H. Li and X. Xing discloses the architecture of an internet of things (IOT). The architecture includes multiple levels of IOT service platforms, also discloses a method for implementing an IOT service. The method includes the steps of the superordinate IOT service platform providing management for one or more of subordinate IOT service platform, special service platform and service gateway, wherein the management includes one or more of registration, login, logout, data synchronization. With this the deployed industries or special service platforms can be integrated into a unified architecture, thus lightening the burden of the IOT service platforms. [2]

D. A. Bagade proposed plan under "Maha krishna" for real time data acquisition and reservoir operation in Maharashtra. In that proposed Real Time Decision Support System (RTDSS) with SCADA network for data connectivity and covers the Automated rainfall station, Automated full climate station, Automated discharge measurement, Web portal giving the total current data about discharge, water lavel, rainfall about reservoir. [3]

M. Wang et al. proposed a smart control system base on the technologies of internet of things has been proposed to solve how to manage and control these increasing various appliances efficiently and conveniently so as to achieve more comfortable, security and healthy space at home. To manage all appliances in a smart home, he develop a smart home information system (SHIS) with web technologies. [4]

B. Kang et al. proposes an IoT-based monitoring system using a tri-level context making model for context-aware services in smart homes as data acquisition and information analysis through various sensors will play a crucial role. The necessary technology is one that collects and analyzes much different information around us through various sensors. [5]

Table 2.1: Literature Survey

Contributors	**Parameter**	**Significance**
Kevin Ashton	IoT	advanced connectivity of devices, systems, and services that goes beyond M2M communications and covers a variety of protocols, domains, and applications
H. Li and X. Xing	IoT	Architecture of an internet of things
D. A. Bagade	RTDSS	SCADA network for data connectivity Web Technologies
M. Wang et al.	Smart Control System	smart home information system (SHIS) with web technologies
B. Kang et al.	Tri-level Model	It is technology that collects and analyzes much different information around us through various sensors.

Chapter 3

COMPONENT SELECTION

3.1 Introduction

3.1.1 Good Sensor

The two most important characteristic of a sensor are:

- **Precision -** The ideal sensor will always produce the same output for the same input.[6]
- **Resolution -** A good sensor will be able to reliably detect small changes in the measured parameter.[6]

3.1.2 Affects of Precision

- **Noise -** All measurement systems are subject to random noise to some degree. Measurement systems with a low Signal to Noise Ratio will have problems making repeatable measurements. In the diagrams above, the sensor on the right shows much better precision than the noisy one on the left.[6]
- **Hysteresis -** Some types of sensors also exhibit hysteresis. The sensor will tend to read low with an increasing signal and high with a decreasing signal as shown in the graph below. Hysteresis is a common problem with many pressure sensors.[6]

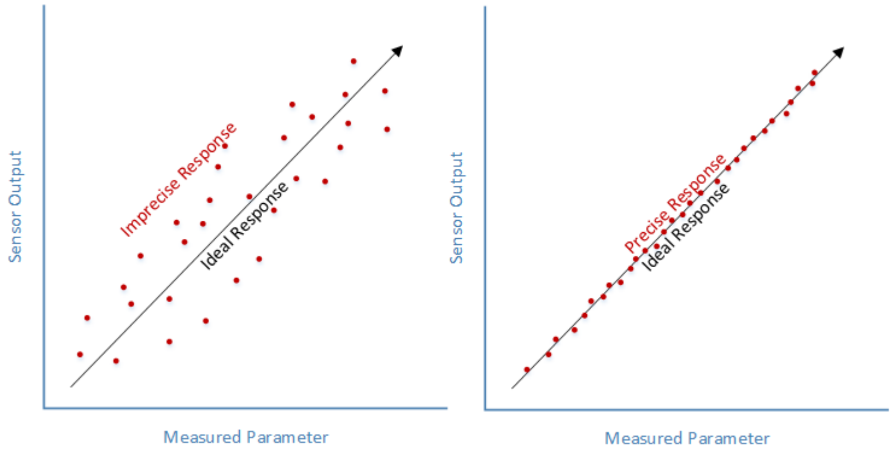

Figure 3.1: Sensor Precision

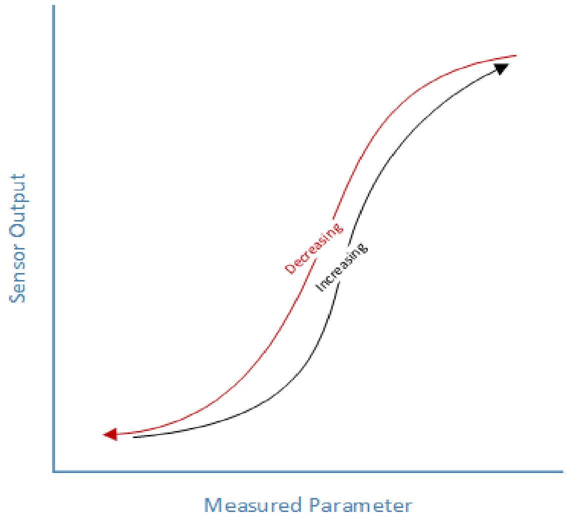

Figure 3.2: Sensors Hysteresis

3.1.3 Other Important Qualities In a Sensor

Precision and resolution are the real 'must have' qualities. But there are a couple of other 'nice-to-have' qualities:

- **Linearity -** A sensor whose output is directly proportional to the input is said to be linear. This eliminates the need to do any complex curve-fitting and simplifies the calibration process.

- **Speed -** All else being equal, a sensor that can produce precise readings faster is a good thing to have.

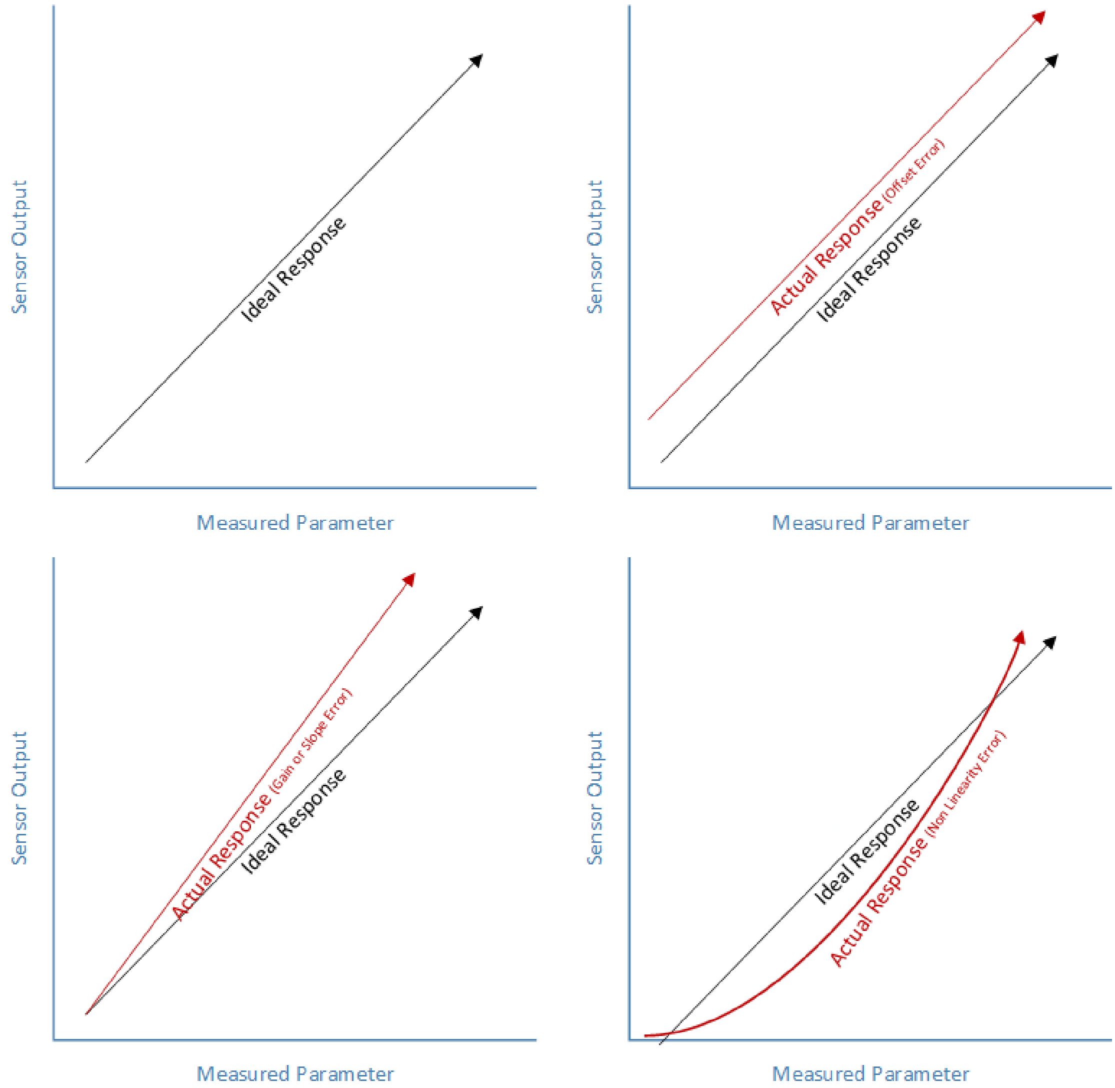

Figure 3.3: Sensors Errors

Accuracy is a combination of precision, resolution and calibration. If you have a sensor that gives you repeatable measurements with good resolution, you can calibrate it for accuracy.[6]

Digital sensors are calibrated at the factory to some extend but, digital sensors are still subject to manufacturing and operating condition variability. For critical measurements, you need to calibrate the total system.[6]

3.2 Raspberry Pi

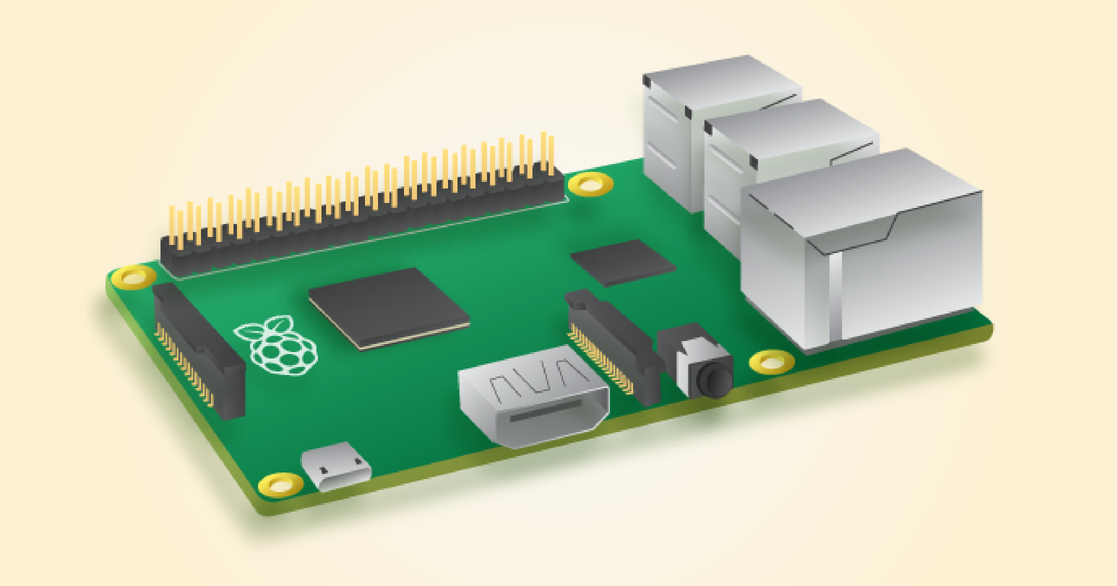

Figure 3.4: Raspberry Pi 2 Model B.

The Raspberry Pi is a low cost, **credit-card sized computer** that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you had expect a desktop computer to do, from browsing the Internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.[7]

The Raspberry Pi Foundation is a registered educational charity (**registration number 1129409**) based in the UK. Foundation's goal is to advance the education of adults and children, particularly in the field of computers, computer science and related subjects.

Table 3.1: Available Raspberry Pi Models

Attribute	Model A	Model A+	Model B	Model B+	2 Model B
SoC	Broadcom BCM2835	Broadcom BCM2835	Broadcom BCM2835	Broadcom BCM2835	Broadcom BCM2835
CPU	700MHz ARM1176JZF-S	700MHz ARM1176JZF-S	700MHz ARM1176JZF-S	700MHz ARM1176JZF-S	900MHz Quad-core ARM Cortex-A7
GPU	Video Core IV	Video Core IV	Video Core IV	Video Core IV	Video Core IV
RAM	256 Mb	256 Mb	512 Mb	512 Mb	1 Gb
USB	1	1	2	4	4
Video	RCA, HDMI	Jack, HDMI	RCA, HDMI	Jack, HDMI	Jack, HDMI
Audio	Jack, HDMI	Jack, HDMI	Jack, HDMI	Jack, HDMI	Jack, HDMI
Boot	SD	MicroSD	SD	MicroSD	MicroSD

3.3 Temperature Sensors

There are mainly three type of temperature sensors as fallow:

1. Thermocouple
2. RTD
3. Thermistor

3.3.1 Thermocouple

A Thermocouple is a sensor used to measure temperature. Thermocouples consist of two wire legs made from different metals. The wires legs are welded together at one end, creating a junction. This junction is where the temperature is measured. When the junction experiences a change in temperature, a voltage is created. The voltage can then use to calculate the temperature.

3.3.2 RTD

Resistance Temperature Detectors (RTDs) are sensors that measure temperature by correlating the resistance of the RTD element with temperature. Most RTD elements consist of a length of fine coiled wire wrapped around a ceramic or glass core.

3.3.3 Thermistor

Thermistors are special solid temperature sensors that behave like temperature-sensitive electrical resistors. No surprise then that their name is a contraction of "thermal" and "resistor".

3.3.4 Comparison

From above comparison of the main type of sensor **RTD** is best solution for our project as it has a excellent Interchange ability, good long term stability, high accuracy and maintaining linearity with medium output sensitivity.

Table 3.2: Temperature sensors comparison

Attribute	**Thermocouple**	**RTD**	**Thermistor**
Cost	Low	High	Low
Temperature Range	Very wide -350°F - +3200°F	Wide -400°F - +1200°F	Short to medium -100°F - +500°F
Interchange ability	Good	Excellent	Poor to fair
Long-term Stability	Poor to fair	Good	Poor
Accuracy	Medium	High	Medium
Repeatability	Poor to fair	Excellent	Fair to good
Sensitivity (output)	Low	Medium	Very high
Response	Medium to fast	Medium	Medium to fast
Linearity	Fair	Good	Poor
Self Heating	No	Very low	High
Point (end) Sensitive	Excellent	Fair	Good
Lead Effect	High	Medium	Low
Size/Packaging	Small to large	small to medium	Small to medium

3.4 Humidity Sensor

According to the measurement units, humidity sensors are divided into two types:

1. Relative humidity(RH)sensors
2. Absolute humidity(moisture) sensors

3.4.1 Relative humidity Sensors

Principle is Ratio of mass(vapour) to mass(saturated vapour) or ratio of actual vapor pressure to saturation vapor pressure.

$$RH = \frac{Mass(vapour)}{Mass(Saturatedvapor)}$$

It is measure in percentage (%)

3.4.2 Absolute humidity sensors

Principle is Ratio of mass(vapor) to volume.

$$AH = \frac{Mass(vapour)}{Volume}$$

It is measure in $grams/m^3$

Table 3.3: Available Temperature and Humidity Packages Comparison for experimental setup

Attribute	Sensors							
	LM35	**HR202L**	**DS18B20**	**DHT22**	**HTS221**	**RHT03**	**AM2001**	**LMT87**
Type	Temp	Humi	Temp	Temp/humi	Temp/humi	Temp/humi	Humi	Temp
Range	-55°C - 150°C	20-90% RH	-10°C - 85°C	-40°C - 80°C 0% - 100% RH	-40°C - 120°C 0% - 100% RH	-40°C - 80°C 0% - 100% RH	0% - 100% RH	-50°C - 150°C
Accuracy	± 0.4°C	±5% RH	±0.5°C	±0.5°C & ±2% RH	±0.5°C & ±4.5%RH	±0.5°C & ±2% RH	±3% RH	±0.3°C
Resolution	0.5°C	-	0.5°C-0.0625°C	0.1°C 0.1%RH	0.016°C 0.004%RH	0.1°C 0.1%RH	0.1% RH	0.5°C
Availability	Easily available	Easily available	Easily available	Easily available	Harder to find	Harder to find	Harder to find	Harder to find
Calibration	Celcius	Relative Humidity	Celcius	Celcius & RH	Celcius & RH	Celcius & RH	Relative Humidity	Celcius
Cost (appx)	100/-	165/-	100/-	535/-	220/-	660/-	400/-	100/-
Power	5V DC	1.5V AC	3-5.5V DC	3-5V DC	1.7-3.6V DC	3.3-6V DC	5V DC	5V DC
Output	Variation in voltage	Varitaion in impedence	Digital binary output	Digital binary output	Digital binary output	Digital binary output	Variation in voltage	Variation in voltage
Interfacing	ADC	ADC	Complex digital	Complex digital	SPI and I2C	Complex digital	ADC	ADC

3.5 Rain Gauge

A rain gauge (also known as an udometer, pluviometer, or an ombrometer) is a type of instrument used by meteorologists and hydrologists to gather and measure the amount of liquid precipitation over a set period of time.[8]

Types of rain gauges are:

1. Optical rain gauge
2. Weighing gauges
3. Tipping bucket gauges
4. Simple buried pit collectors

3.5.1 Tipping bucket gauges

The tipping bucket rain gauge consists of a funnel that collects and channels the precipitation into a small seesaw-like container. After a pre-set amount of precipitation falls, the lever tips, dumping the collected water and sending an electrical signal. An old-style recording device may consist of a pen mounted on an arm attached to a geared wheel that moves once with each signal sent from the collector.[8]

Figure:3.5 shows the modern tipping rain gauge. Modern tipping rain gauges consist of a plastic collector balanced over a pivot. When it tips, it actuates a switch (such as a reed switch) which is then electronically recorded or transmitted to a remote collection station.

3.5.2 Optical rain gauge

These have a row of collection funnels. In an enclosed space below each is a laser diode and a photo transistor detector. When enough water is collected to make a single drop, it drops from the bottom, falling into the laser beam path. The sensor is set at right angles to the laser so that enough light is scattered to be detected as

Figure 3.5: Tipping Bucket rain gauge.

a sudden flash of light. The flashes from these photo detectors are then read and transmitted or recorded.[8]

Figure 3.6: Optical rain gauge.

3.5.3 Measurement

Most rain gauges generally measure the precipitation in millimetres equivalent to litres per square metre. The level of rainfall is sometimes reported as inches or centimetres.

Rain gauge amounts are read either manually or by automatic weather station (AWS). The frequency of readings will depend on the requirements of the collection agency.[8]

3.6 Water Level Sensor

Wide spectrum of water level sensors is available in the market and commonly, they are classified on basis of:

- Sensing points
- Measuring method

3.6.1 Sensing Points

1. **Single Point Sensors:**
   These sensors are used where water level is to be sensed only at single location.

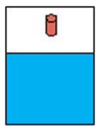

Figure 3.7: Single Point Sensors.

2. **Multi-point Sensors:**
   These sensors are used where water level is to be sensed at number of locations single location.

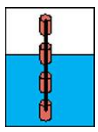

Figure 3.8: Multi-point Sensors.

3. **Continuous Sensors:**
   These sensors are used where water level at all locations is to sensed

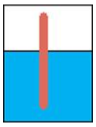

Figure 3.9: Continuous Sensors.

3.6.2 Measuring method

1. **Pressure Based Sensors**
   Pressure is defined as the force per unit area. The pressure at any depth, in a static fluid is equal to the weight of the liquid acting on a unit area at that depth plus the pressure acting on the surface of the liquid. It relies on the principle that the difference between two pressures is equal to the height of the liquid multiplied by specific gravity.[9]

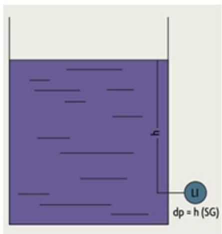

Figure 3.10: Pressure Based Sensors.

2. **Ultrasonic Based Sensors**
   Ultrasonic level instruments operate on the basic time-of-flight principle using sound waves to determine liquid/solid/slurries level. Ultrasonic Level sensors comprises of two elements; a high efficiency transducer and, an associated electronic transceiver. Complete return trip time between transmitted ultrasonic pulse and reflected echo is measured to determine the water level. The frequency range for ultrasonic methods is in the range of 15 to 200 kHz.[9]

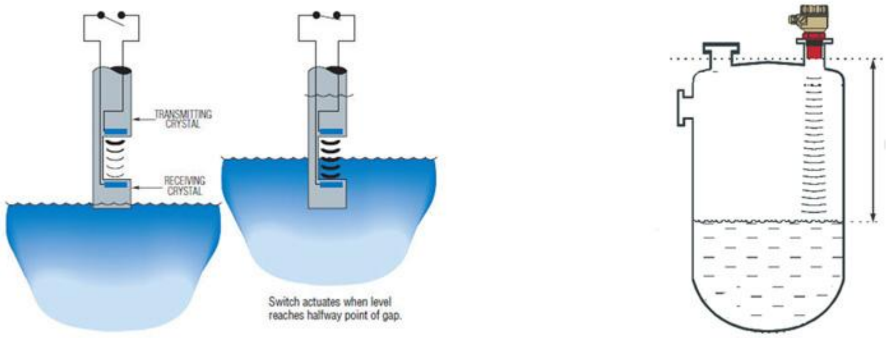

Figure 3.11: Ultrasonic Based Sensors.

Table 3.4: Available Ultrasonic Level Sensor package comparison for experimental setup

Attribute	**HC-SR-04**	**US-100**
Technology	Ultrasonic	Ultrasonic
Min Range	2 cm	2 cm
Max Range	4 m	4 m
Resolution	3 mm	1 mm
Measuring angle	Lees than 15 degree	lees than 15 degree
Frequency	40 KHz	40 KHz
Availability	More	Less

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Appendix A

LIST OF PUBLICATIONS