CHAPTER I

INTRODUCTION

"Runoff" is the term usually employed to distinguish the flow of water running off the land's surface during and shortly after rainfall, it represents the output from the catchment in a given unit of time. For given precipitation, when the evaporation, initial loss, infiltration, and detention storage requirements are satisfied, the excess precipitation moves over the land surfaces to reach smaller channels. This portion of runoff is called overland flow. It travels all the time over the surface as overland flow and through the channels as open-channel flow and reaches the catchment outlet. Which is called surface runoff.

Runoff from agricultural land can carry excess nutrients, such as nitrogen and phosphorus into streams, lakes, and groundwater supplies. These excess nutrients have the potential to degrade water quality. As it flows over the land surface, stormwater picks up potential pollutants that may include sediment, bacteria (from animal and human waste), and pesticides. Accurate estimation of runoff depth and volume is an important task for proper watershed management, such as the design of drains, canals & other channels. Runoff estimation is also useful for the design of storage for irrigation. So, it is very important to measure runoff from agricultural land.

Runoff plots are used to measure surface runoff under controlled conditions. It is difficult to monitor runoff inflow to the collection tank during night time. So, there is a need to develop a smart system for the measurement of runoff using concept of IoT (Internet of Things). Ultrasonic sensors with a microcontroller can be used as a depth measuring device in runoff tanks. These sensors record the raw data and communicate with the microcontroller to generate the actual depth using various functions. The processed data can be sent to the Wi-Fi modules by communication protocols to provide remote access to data. This Wi-Fi module works as an internet gateway and sends sensor data to the webpage. The webpage is used for data visualizations and data storing purposes. These data can be further used for analysis.

1.1 RAINFALL AND RUNOFF

Rainfall is known as the main contributor to the generation of surface runoff. Therefore there is a significant and unique relationship between rainfall and surface runoff by the basic principle of hydrologic cycle, when rain falls, the first drops of water are intercepted by the leaves and stems of the vegetation. This is usually referred to as interception storage. Once they reach the ground surface, the water will infiltrate through the soil until it reaches a stage where the rate of rainfall intensity exceeds the infiltration capacity of the soil. The infiltration capacity of soil may vary depending on the soil texture and structure. Soil composed of a high percentage of sand allows water to infiltrate through it quite rapidly because it has large, well-connected pore spaces. Soils dominated by clay have low infiltration rates due to their smaller sized pore spaces. However, there is less total pore space in a unit volume of coarse and sandy soil than that of soil composed mostly of clay. (Ritter, 2006).

Runoff occurs when part of the land is saturated or impervious. Basically, there are two types of concepts that are responsible for runoff generation. These are the infiltration-excess runoff and the saturation excess runoff. In the infiltration excess runoff concept, it is assumed that soil surface. The second type of runoff generation also occurs where the soil surface is saturated and any further rainfall, even at low intensities, generates runoff that contributes to stream-flow.

Apart from rainfall characteristics such as intensity, duration, and distribution, there are other specific factors which have a direct bearing on the occurrence and volume of runoff. The most common factor is soil type. Due to the variation of runoff generation, different studies have been conducted according to particular soil conditions. Another factor that can affect runoff production is vegetation. An area which is densely covered with vegetation produces less runoff than bare ground while the amount of rain lost to interception storage on the foliage depends on the kind of vegetation and its growth stage. Vegetation has a significant effect on the infiltration capacity of the soil. A dense vegetation cover shields the soil from the intense raindrop impact which eventually will cause a breakdown of the soil aggregate as well as soil dispersion with the consequence of driving fine soil particles into the upper soil pores. This results in clogging of the pores, formation of a thin but dense and compacted layer at the surface which highly reduces the infiltration capacity.

1.2 IoT

Anyone who has heard this term for the first time must be eager to know what is internet of things (IoT). Internet of Things is a network of physical devices connected with one another for the exchange of data and information through sensors and actuators. These actuators and sensors are embedded on to these physical devices which make this exchange of data with each other possible. In layman language, IoT means letting the devices to connect to the internet to make our life comfortable. The 'things' here refer to internet of things physical devices like chips, cameras, sensors or such devices.

In the near future, IoT is going to be an important part of our life. Through this IoT, distant or remote objects can be controlled by this network. The idea of smart homes is quite prevalent these days. This idea of smart homes is based on the Internet of Things (IoT). But IoT is not limited to just smart homes as there are many other applications of IoT which will be discussed later in this post.

Internet of Things (IoT) covers a distinct number of network protocols, domains, and applications. With IoT, there will be more advanced communication between the devices with better connectivity and better services. The embedded devices will provide enhanced automation in almost every area starting from homes to cities. These devices gather important information by using the latest technologies and then transfer this information to other devices.

1.2.1 IoT architecture and working

The architecture of IoT is also known as four-stage architecture. IoT architecture can be dividing into four stages. Stage 1 includes the sensors and the actuators. Stage 2 includes the aggregation systems and analog-to-digital converter. In stage 3, processing of the data is done by some technology. In stage 4, the data is moved to the data center systems.

Stage 1

In the very first stage, the raw data is collected by the sensors from the surrounding environment or from an object and is converted into the useful data. An

actuator acts according to the changes in the physical environment. The sensors and actuators are used in almost every area ranging from industries to healthcare. IoT devices have a limiting power. The data can be processed by the sensors.

Stage 2

In the second stage, there comes an internet gateway. The data is in analog form collected by the sensors. It is converted into a digital format using data acquisition systems (DAS) for future processing. The DAS performs analog to digital conversions along with data aggregation. The Internet gateway receives this aggregated and digitized data and provides routing for it over the wireless or wired network. The analog data is converted to digital one as large volumes of data are created by the analog streams. The analog data requires specialized software for processing based on timings and structures.

Stage 3

The data enters the third stage after digitization and aggregation for more processing. This processing is performed by the IT systems through detailed analysis. These IT systems may be at off-site or at on-site.

Stage 4

It is the final stage the data is stored at the data centers and cloud. The data doesn't require immediate feedback and requires more detailed processing. This data is transferred to data centers which have more advanced IT systems to perform in-depth analysis. This type of processing particularly takes place on the location.

1.3 POWER RESOURCES

Nowadays, due to the decreasing amount of renewable energy resources, the last ten years become more important for per watt cost of solar energy devices. It is definitely set to become economical in the coming years and growing as better technology in terms of both cost and applications. Everyday earth receives sunlight above (1366 W/m^2 approx.). This is an unlimited source of energy which is available at no cost. The major benefit of solar energy over other conventional power generators is

that the sunlight can be directly converted into solar energy with the use of the smallest photovoltaic (PV) solar cells. There have been a large number of research activities to combine the Sun's energy process by developing solar cells/panels/modules with high converting form. The most advantages of solar energy are that it is free reachable to common people and available in large quantities of supply compared to that of the price of various fossil fuels and oils in the past ten years. Moreover, solar energy requires considerably lower manpower expenses over conventional energy production technology.

1.4 OBJECTIVES

The objectives of this study are as follows:

1) To develop the IoT based smart automatic runoff measurement
2) To evaluate the performance of developed smart automatic runoff measurement system
3) To develop the computer program to communicate and store data on cloud through IoT and WiFi module