Water Accumulation- Navigation & Drainage Controller

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Abstract. In today's time, even in the modern cities, there are not many efficient drainage systems that can clear the accumulated liquid waste on roads and dispose it no time. There are traditional styled drains which often get blocked with impurities/other blockades. Major problem due to this is in the rainy season wherein accumulated rainwater leads to hour-long traffic jams. There is no way a person can pre-plan as to where all he/she can expect water clogging and where not. The proposed concept is to install a device at various places (roads, grounds, pitches, campus etc.) where water and other wastes could be accumulated during drain overflows, rains etc., The device would automate the process of clearing water clogged areas efficiently and quickly. Additionally, the data about water clogged areas can also be accessed on a mobile application enabling the user to check which locations are currently experiencing water clogging or any other drainage issue.s

Keywords: Smart Drains, Water Clogging Navigation, Water Accumulation, Drainage Overflow Control.

1 Introduction

Metropolitan cities have been a center of attraction for many people in various countries across the World. It's always a desire for many people to move to a metro city. In today's time, metropolitan cities usually have a very dense population as people tend to move to metro cities in order to improve their standard of living. This has resulted into construction of more and more residential societies, corporate offices, institutions, parking etc. However, all this has led to a decrease in sufficient space to escape for sewage, rainwater and other wastes which gets accumulated on the surface of roads leading to water clogging, water erosion, water prone diseases, accidents etc. The proper drainage of water clogged roads is still not a very efficient process in the current times. The existing mechanism of drainage is time consuming and inefficient as there is no automation in the process and no monitoring mechanism is used. It's difficult to track which areas are currently facing water clogging and which are free from it.

2. Problem Statement

2.1. Motivation and Objective

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Water clogging on roads, grounds, pitches is a common problem during monsoons which can lead to hour-long traffic jams, water prone diseases and road accidents. The objective of this project is to create an automated way of disposing accumulated surface water on roads, grounds, pitches etc. In this way we can control the amount of water collected on roads during monsoon season, waste water collected on roads, and other forms of surface water accumulation.Moreover, using this we can also track the areas which are affected by water clogging, water quality, and other metrics through a GPS enabled mobile application and some sensors. The existing drains often get blocked even if there is a slight increase in water level or impurities, and then it takes manual labor to unblock them and restart the drainage mechanism.

2.2 Existing method

There are many existing automated systems for cleaning drains but they do not include disposing accumulated water or track its location and metrics. Apart from these automated cleaning systems, there are stationary drains made of Concrete, Stainless Steel, and PVC etc. They work mainly on the principle of Drainage Gradient. Drainage Gradient is the combined slope of Cross Slope (surface of road) and Longitudinal Slope(hilliness).

2.3 Proposed method

The proposed solution consists of Water Suction Pumps and Ultrasonic Sensors. When the Ultrasonic sensor detects a certain Water Level, suction pumps get activated and water is disposed to a storage tank for further purification of the contaminated water. The GPS module attached sends the water level data to the Cloud and the information is broadcasted to various users of the mobile application to inform them of the water level and quality metrics of that particular area. The pumps and the water quality sensors are controlled through a microcontroller.

3. Design, Materials and Working Methodology

The sketch of the portable device to be installed at various places for Drainage Control i.e., WA-ND Controller device was sketched on a 3-D Modelling Software as shown in the figure below. The portable device is made up of ABS Plastic and is no bigger than an alarm clock. It contains the microcontroller and other sensors which gather and transfer data to the Cloud.

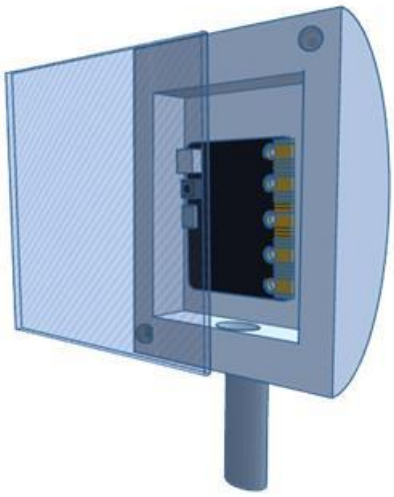


Fig. 1.1 Prototype of the WA-ND Controller device

A. Components Description

The primary components involved in the fabrication of this device are

[1] DC Mini Vacuum Suction Pump

A 12V DC suction motor is used to pull water using atmospheric pressure. There are two such motors for increasing efficiency i.e., both the motors work in parallel so that even if one motor fails to operate, the other can do the required task and there is no major blockage. Each suction motor is attached to a plastic pipe (for the prototype) to transport water.

[2] Ultrasonic Sensor HC-SR04

An Ultrasonic sensor is used to measure distance. It works by sending an ultrasound and receiving an echo which comes back from striking an object. Using the Ultrasonic Sensor, we can measure the water level with respect to the surface (road, ground, pitch etc.)

Note: For the prototype, a relatively low power ultrasonic sensor is used which can be replaced with a powerful one for accuracy.

[3] 12V DC Stepper Motor

A Stepper motor is used to divide a full rotation into a number of equal parts. It lies at the core of this device as it ensures that the object/substance detected by the Ultrasonic sensor is actually waste water/sewage.

[4] L293D Motor Driver IC

The L293D driver IC is used to control 2 DC Motors simultaneously.

[5] Neo-6M GPS Module

GPS module is used to determine 3-D coordinates of the object i.e., the latitude, longitude, and altitude.

[6] Arduino UNO

Arduino is a low-cost programmable microcontroller which lies at the heart of the device to bind everything together and supply power to the components.

[7] Various Quality Sensors-

Temperature Sensor, humidity sensor, and PH Sensor.

4. Calculating distance

The stepper motor along with the Ultrasonic sensor is used to calculate the affected distance of water accumulation. Fig 1.2 shows the implementation of the arrangement. The ultrasonic sensor is rotated at a specific angle ɵ in the clockwise direction and again in the anti-clockwise direction.

The altitude h is a constant determined at the time of installing the device.

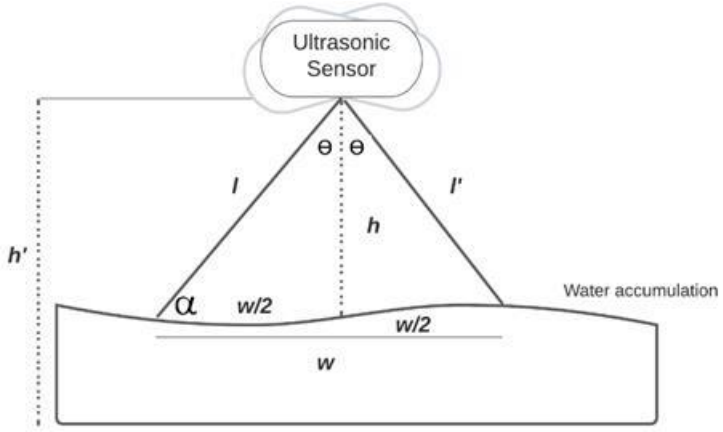


Fig. 1.2 Calculation of distance of the water accumulated region

h' is the distance between the ultrasonic sensor and the ground level.

Always, h < h'

l is the distance between the start of the region and the device as calculated by the Ultrasonic sensor.

ɵ is the angle of incidence of the ultrasonic waves

For covering a considerable region, we take it to be 60 degrees,

Taking h, ɵ, h' as constant, we can calculate was follows

$\cos\theta = 2 \times (w/2h)$ ---- i)

$\cos\theta = w/h)$ ---- ii

$w = h \times \cos\theta$ ---- iii)

Knowing w we can decide whether the water level is even or not.

Let, $\Delta l = (l - l')$

If $|\Delta l| \sim 0$, we can assume that the ultrasonic waves bounced from the same surface.

Also, if $\Delta w = (w - w')$ and $\Delta w \sim 0$ ⟦; w⟧^'→ actual width

It can be confirmed that the calculated width w and actual width w' are same and hence the region detected is a uniform region which could be water.

In order for the Suction Pumps to start working, we need to make sure that the accumulation detected is of a certain level L, which can be calculated as follows,

L=h^'-h

Now, if L is greater than or equal to a certain threshold δ, where, 10cm≤δ≤h'

Once all the conditions are met, the Suction Mechanism starts working and depending on the water level (L), a certain amount of power supply is given to the suction pumps.

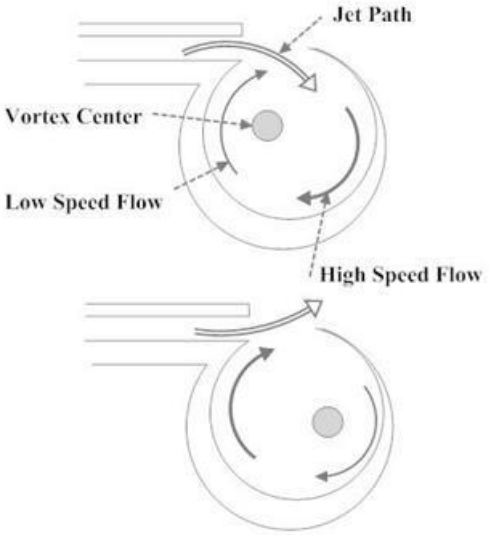
Sending Location Data

If the calculated volume of water accumulation is higher than normal threshold value, while the pumps are set to work, the GPS module and other water quality sensors gather data and send to the server. The server receives the data and broadcasts it as a notification to all the users of the mobile application. This way, users can track the water accumulation data in Real-time.

5. Working Principles

This device works mainly on the following principle-

Forced Vortex Flow- When a fluid is rotated about a vertical axis at a constant speed, such that every particle has the same angular velocity, motion is known as the forced vortex.



6. Conclusion

The literature in this paper highlighted the process of improving efficiency of drainage systems by transforming the traditional method of drainage into IC controlled automated drainage system with navigation information. Research proved that this device can be widely used in various fields, roads, highways and other open spaces prone to water accumulation. This device can be manufactured in a cost-effective way and its installation is very convenient. This device can be converted into a more powerful version, wherein more powerful pumps and sensors can be used to provide more accurate results.

References

[1] Ajay Sharma, Ankur Singh, Mahipal Singh "Automated Drainage System" International Journal of Engineering Research & Technology (IJERT) http://www.ijert.org ISSN: 2278-0181

.[2] NDUBUISI C. Daniels, "Drainage System Cleaner A Solution to Environmental Hazards", International Refereed Journal of Engineering and Science (IRJES)ISSN (Online) 2319-183X, (Print) 2319-1821Volume 3, Issue 3(March 2014), PP.54-60.

[3] Costello, Mark. (2000). Design, Fabrication, and Testing of a Portable Suction Pump.

[4] Design and fabrication of automatic drainage waste removal equipment. By- Mahesh ShirsSadaskar, Kiran Wayal, Sneha Shinde, Pooja saragar.