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Designing a Smart and Safe Drainage System using Artificial Intelligence

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***Abstract*— In the contemporary world, especially in underdeveloped and developing countries, the drainage system has been a major issue. There has been constant overflow, breakage of pipes and a lot of tragic incidents, such as small kids getting caught and suffocated to death inside manholes. All these problems can be solved by making an efficient drainage system with certain safety measures. Due to the advent of new technologies like Machine Learning and IOT, creating an enhanced drainage system is now possible. We can make our drainage system efficient, smart and safe, as compared to the traditional system available today. In this paper we have designed few ways to improve the existing drainage system. With these improvements our drainage system will be easy to maintain, less pollution will occur and a lot of lives can be saved.**

Keywords—Smart, safe, drainage, artificial intelligence

I. INTRODUCTION

The main objective of our paper is to redesign the existing drainage system and make it smart and efficient, by using Machine Learning and IOT. We will be using various datasets to make various analyses on land and on the waste disposed, in addition we will be using various sensors to analyze the rate at which waste is being disposed in an area and control the valves and also device a way to detect people within a manhole. We will try to implement the following ideas in our project, depending upon the population density of the area we can make an analysis and increase the width and number of pipes used in a particular area. Secondly, we can change the valves and redirect the flow of waste from one disposal area to another to avoid accumulation of excess waste in a particular disposal area and also open all the valves in case of heavy rainfall, to avoid overflow. We can also add small cameras in manholes to detect if someone has fallen into the pipeline and send immediate notification to the local municipality. This can be enhanced by adding a water level detector connected to a buzzer and LEDs near the manhole to indicate its presence, when its completely covered by water.

II. LITERATURE SURVEY

We have well developed roads, buildings, schools and many others than can go on the list, but when it comes to drainage system especially in developing countries, they are still using the old drainage systems which does not work effectively for floods, disposal, heavy rains etc. we had gone through some of these improvements to come up with the new project.

A. Underground Drainage Monitoring system using IOT [1] they proposed a smart drainage system where this system will send a message to municipality if the drainage is blocked or in the case of emitting harmful gases using IOT, this is a good project, but there are no safety measures included.

B. Underground Drainage Blockage Monitoring and Detection System Using IOT [2] describes a design used to detect leakage in the drainage system which consists of used water, it is a quite efficient system, though this paper does not discuss other issues related to the drainage system and how to overcome them.

C. Drainage overflow monitoring system using IoT (DOMS) [5], we got an idea of how the waste levels can be identified and reported to the municipality via SMS, this a good system but it involves complexity and it only monitors and reports the issue. Manual labor is required to fix any errors.

D. Face recognition using deep multi-pose representations [8], gave us an insight on how CNN in deep learning can be used to detect a face and this can be implemented in various applications, we can implement a deep learning model to detect a human and differentiate it from other objects in the manhole.

E. Microcontroller Based Automated Water Level Sensing and Controlling [11], the have proposed a water level detection system using microcontroller, this a sophisticated system with many advantages, we got an idea of using a water level detection based on this, but as this cannot be

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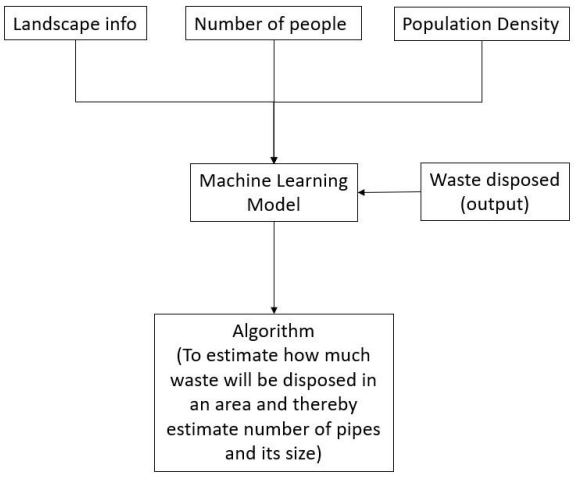
implemented in each and every manhole a simple transistor water level detection was chosen.

F. Research and development of control system in digital valve electric actuator [12], gave us an insight on how electric valves can work and how it is better than a manual valve, this can be implemented in our project to avoid manual labor. Other references were also referred for the better understanding and to get a better insight on how things work.

III. PROPOSED ARCHITECTURE

Analysis of area and population density:

Block Diagram:



Landscape info: This includes height above sea level, type of soil present, area type like a plateau or costal region etc.

Number of people: This is the total population of that particular place, at that particular time.

Population Density: It is the total population of a particular place divided by the area of that place.

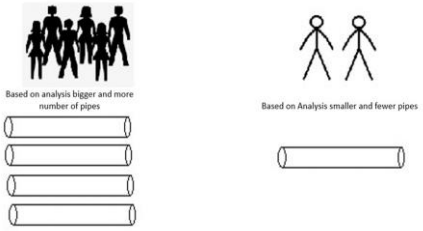
Waste disposed: The total waste previously disposed that area over a particular span for example 3 months. This will be the output for training the machine learning model.

Machine learning model: All the above inputs are given to train the machine learning model.

Algorithm: This will be the result of the trained model, to estimate how much waste will be disposed in an area and help us decide how much pipes should be laid and what should be its width.

Implementation:

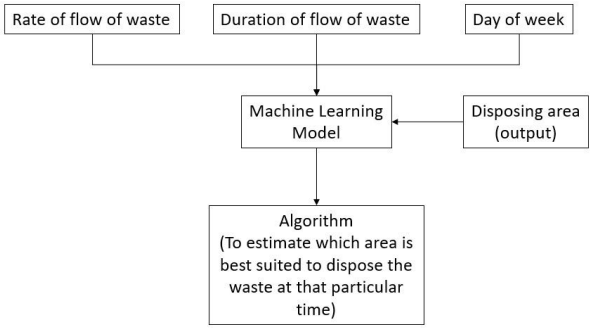
We can collect various data pertaining to the areas landscape, population density, number of people and 'waste disposed' to train a machine learning model based on various algorithm like 'KNN' and 'Linear regression' to predict the amount of waste that will be disposed in a particular area, with this data we estimate the required size and number of pipes that is required for a particular area and in what orientation they should be placed. This will be useful and efficient as areas with high population density will need larger and a greater number of pipes, whereas areas with lower population density will require smaller and fewer pipes. This will be highly beneficial when creating satellite cities or while developing rural areas. This method is more pragmatic, instead of just having the same size and number of pipes for each area.



The government can take a survey and also collect data from the previous surveys to create a dataset to make predictions on the amount of waste that will be disposed of in each particular area. Based on this they can redesign or lay out new pipelines depending on the area's needs, this will especially be useful when creating satellite cities and developing rural areas.

Choosing the disposal area efficiently:

Block Diagram:



Rate of flow of waste: We will be detecting at what rate the waste is flowing in the pipes using a velocity water sensor.

Duration of flow: We will be using a timer to check for what duration the waste has been flowing.

Day of the week: To know at which day how much waste has been disposed in an area.

Disposal area: These are the various areas the waste can be disposed

Machine learning model: All the above inputs are given to train the machine learning model.

Algorithm: This will be the result of the trained model, it will be used to determine where the waste can be disposed at that particular time, to avoid accumulation of excess waste at a particular place.

Implementation:

We can calculate and make a dataset of the rate of flow, duration of flow, day of the week and different disposal areas available. Using this we can train a machine learning model to

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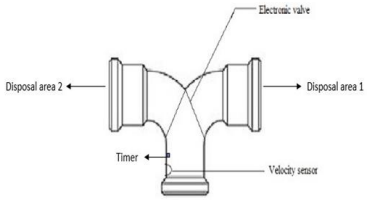
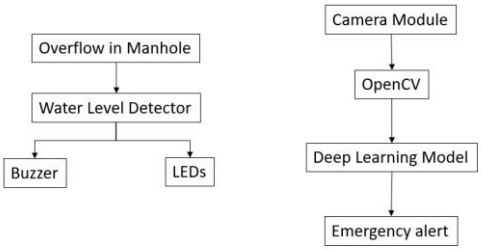
analyze which area is suited for disposing the waste at that particular time and the flow can be redirected to another location by changing the valves automatically. The flow of waste can be detected using a water velocity sensor like 'YF-S201' and attach a timer to get the duration of flow. We can send these values to a computer consisting of the Machine learning model to continuously compute the amount of waste being disposed of in that site, once it crosses the threshold the valves are electronically closed and redirected to a different disposal site. In case of a heavy rainfall the computer will open up all the valves to avoid overflowing of waste.



Government can fix a water velocity sensor and a timer at the end of each pipe, to determine the amount of waste flowing into a disposal area, based on all these data a machine learning model can be created to efficiently switch between disposal areas, so that one place doesn't get highly contaminated, thereby avoiding floods and pollution to some extent.

Detecting humans in manholes and warning about its presence:

Block Diagram:



Overflow in Manhole: When the is heavy rainfall, or a pipe has been broken and due to other factors, a manhole will overflow.

Water Level Detector: It is used to detect the water level in the manhole, a water level detector can be made using simple transistors like BC547 combined with resistors.

Buzzer and LEDs: The buzzer and LEDs are used to indicate that there is manhole at that place as it cannot be seed during heavy rainfalls. They are triggered using the water level detector.

Camera Module: This is used to monitor the manhole.

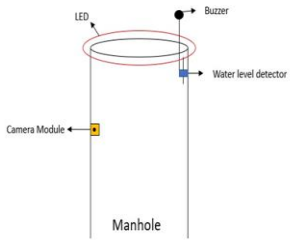
OpenCV: it is used to detect humans within the man hole.

Deep Learning Model: It is used to verify if the object detected is a human or some other object.

Emergency Alert : If the object detected is a human, there will be immediate notification and alarm will be raised in the municipality.

Implementation:

We can attach affordable camera modules like 'OV7670' in manholes then train a Deep learning model to detect and differentiate people from other objects within a manhole and send an emergency notification to the municipality if someone is in trouble. In addition, we can add a water level detector to trigger a buzzer and series of LEDs around it. Once the manhole overflows, the people walking or riding around that area will hear the buzzer and see the LEDs and avoid going that side.



V. CONCLUSION

This paper has been made, considering the drawbacks in the present drainage system. A simple drainage system has been designed, which is easy to implement and is way more efficient, eco-friendly and safe, when compared to the present traditional drainage system, and which is cost efficient to implement. With the help of Machine Learning we can make efficient use of our resources and lay down pipes as per the requirements of the area, which will be more economical and error free as it is based on the landscapes. This is especially very beneficial when it comes to rural areas and during the construction of satellite cities. Pollution can be controlled significantly by efficiently disposing waste to a numerous other area based on analysis, moreover overflowing can also be avoided. In addition, the safety levels can be increased significantly, there will be a huge decrease in the number of deaths, due to manholes and people will be aware of its presence during heavy rainfall. Overall, we will be implementing a smart drainage system with the use of Artificial Intelligence, capable of monitoring and disposing waste efficiently and also create a higher level of safety.

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