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Automated Water Meter: Prediction of Bill for Water Conservation

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Abstract - *The need for water is increasing everyday with increase in population and thus conservation of water resources become one of the most important aspects in order to meet the needs of ever-growing population. Managing and keeping track of the resources and frameworks by using labour-intensive and traditional processes are becoming more tedious due to growing urbanization and population. The proposed smart city solution for conservation and managing of water resources are Automated Water Meters. These smart meters not only help in managing the water resources but also play a major role in conservation of water. This paper discusses the existing approaches adopted to create Automated Water Meter. In addition, it includes how some of these approaches are helping to reduce the water consumption as well as manual work involved in getting meter readings.*

Key Words: **Automated Water Meter (AWM), Conservation of Water, Smart City, Smart Meters, Urbanization.**

1. INTRODUCTION

The world is continually trying to acquire new technologies in order to enhance the quality of living. The quality of life can be ensured by automating technologies which in turn increases accuracy and efficiency [3]. Automating technologies by reducing human intervention gives rise to urbanization and making of smart cities. Smart cities are created using smart technologies that are used to connect various devices together using technologies such as IOT, sensors, Wireless Network, Cloud, etc [4]. One such smart device adding to the urbanization and smart city technology includes Automated Water Meters (AWM).

India depends on manual water-metering system to supervise water consumption and distribution. The long-established and conventional water management systems have always been a delicate task especially with managing varying customers. This standard method involves human error and is not efficient. To increase the accuracy and efficiency and to decrease the manual intervention AWM can be used which is cost efficient in the long run and is ascendable [5].

In order to enhance the efficiency of metering systems, researchers have proposed various models of smart meters using technologies like IOT and Machine Learning.

Internet of Things (IOT) plays a major role in development and making of smart cities. It is defined as a technology that connects two or more devices together over the internet and these devices can be controlled at anytime, from anywhere and by anyone. It can also be defined as, communication of two or more devices over the internet [8]. A few important and efficient implementations of IOT are,

- Smart Home
- Wearables
- Smart City
- Smart Grids
- Industrial Internet
- Connected Car
- Smart Retail
- Smart Farming
- Connected Health
- Smart Supply Chain

Machine Learning, as the word suggests is the learning process of the machines which is carried out through previous training data and experiences. The training is carried out through a set of scientific algorithms and models. The availability of huge amounts of data have made the usage of machine learning algorithms and models increasingly popular and simple. As a result machine learning has been playing one of the major roles in development of smart cities. The structure of deployment of machine learning algorithm is given in figure1.

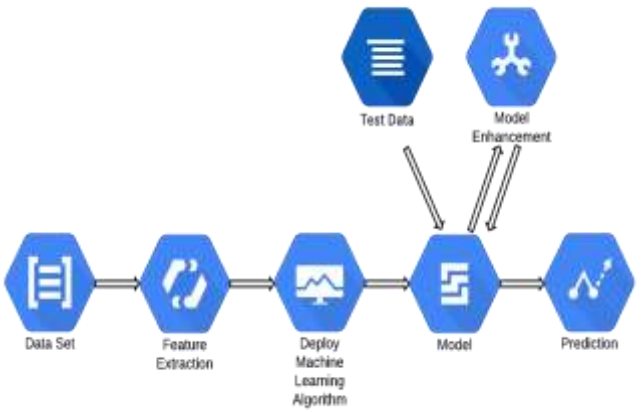

Fig-1: Structure of deployment of Machine Learning Algorithm

Machine Learning is used to solve a lot of problems in actuality such as,

- Traffic Alerts
- Social Media
- Transportation's and Commuting
- Products Recommendation
- Virtual Personal Assistants
- Self Driving Cars
- Dynamic Pricing
- Google Translate
- Online Video Streaming
- Fraud Detection

2. TECHNOLOGY USED

Various types of machine learning algorithms are: Supervised learning, Unsupervised learning, Semi-supervised learning and Reinforcement learning.

Supervised learning means to administer the learning process. Here, we train the machine with a data set that is mapped to a correct result using models such as classification and regression. In classification, the machine is expected to classify the data based on various categories and in regression the machine groups the output data based on real values.[6].

Unsupervised learning is a learning process that is independent of the training data. Two types of models available are clustering and association models. Unlike supervised learning, the machines are not trained using labels thus they are expected to sort the information based on similarities, patterns and differences. Clustering models are used when similar patterns are observed and association models are used to identify similarities in large amounts of data [6].

In Reinforcement learning we do not train the machines with labels instead we provide experiences as input and thus it is a continuous learning process. Based on the experienced data, model tries to find the best solution for the given input. If the user is satisfied with the output, then the model will be rewarded accordingly else the model will be punished. The output that has obtained highest amount of rewards will be marked as the ideal solution [6].

Techniques of Supervised Machine Learning Algorithms are [5]:

- Super Vector Machines;
- Multi-class Classification;
- Decision Tress;
- K-NN;
- Support Vector Machine (SVM);

AWM system requires continuous analyzation and prediction of the water meter model. This involves the usage of regression algorithms. The various regression algorithms available are Linear Regression; Polynomial Regression; Stepwise Regression; Ridge Regression; Lasso Regression; ElasticNet Regression; Logistic Regression.

Logistic regression, a regression model is a strong meticulous approach which is a supervised classification algorithm. This algorithm is used when the resultant is binary. Regression is one of the most commonly used mechanism for applied statistics and discrete data analysis. This model is used to categorize and predict the probability using the sigmoid function. It is also used to describe the data and to explain the relationship between the dependant and /or independent variables [9].

3. LITERATURE SURVEY

According to the literature survey, researchers have proposed varying techniques for the implementation of the smart meters. Each of these techniques try to solve the problem of manual water meters from different perspectives.

Novel smart water meter mainly concentrates on the issue of connectivity in poor cellular network coverage areas by providing a solution for both online and offline methods of connectivity. The model proposed by them consists of a unit called Electronic Interface Module (EIM) that coexists with the existing water meter which is responsible for transferring data to a smart-phone over a wireless

network. The smart phone app gives details regarding the water consumption and billing cycles. By implementing this method they were able to save 14% of water consumption [3].

Another paper proposed an open source system that could be tweaked according to the requirement's of the service provider. This system mainly concentrated on solving the issues of leakage detection and it also helped in managing the water usage. Thus by implementing this system one could gain better control over the usage of water and it would be cost effective because of the open source tools used for monitoring. However the communication between the devices connected a smaller area and thus many households could not use the same system [5].

A paper was proposed using Convolutional Neural Networks (CNN) for Automatic Water Meter reading. This system consists of two stages counter recognition and counter detection. Data Augmentation methods was used to train the CNN models. This system mainly concentrated on accuracy of digit detection and recognition from the meters. After training the model with approximately 2000 images and accuracy rate of 97.30% was observed in digit recognition. However, this system proposed improves the

reading unit of the smart metering system where as it does not state any changes with respect to further processes [7].

A set of researchers proposed a smart metering system consisting of four units namely, Reading Unit, Communication and Leakage Detection Unit, Data Receiving Unit, and Billing Unit [10]. All of these units are interdependent and carry out different processes. The reading unit reads the data from the meter and the data read is made accessible on the micro-controller for transmission. Communication and leakage detection unit makes sure that no data is lost and it detects the leakage based on the total amount of water that is coming in and going out. Data receiving and processing unit consists of a computer application that is responsible for processing of the received data. Billing unit is responsible for the calculation of the water bill for a fixed time interval [10].

4. EVALUATION

Table 1 gives the pros and cons of various smart metering systems.

Table 1: Table 1: Evaluation of different smart metering systems

5. CONCLUSION

As discussed in this paper, AWM is a solution for smart meters that not only enthuses the consumer to conserve water but also allows the consumer to have a better control over the usage of water by providing the predicted usage report for a fixed time interval. It also helps in reducing the human errors and increase the efficiency by automating the bill generation process.

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SL.NO	TECHNIQUE	PROS	CONS
1.	Novel smart water meter proposed Electronic Interface Module (EIM)[3]	It provides high transmission quality.It is easy to integrate GSM with other wireless networks an it is cost effective.	License is a must.It requires repeaters to be installed to cover a larger network area.Higher version devices must be used in order to increase the data rate capability.
2.	Smart water meter system for user centric consumption measurement proposed printed circuit board(PCB)[5]	In PCB boards the failures can be easily identified and rectified. The faulty components can be replaced without any hassle. It also helps to reduce labour costs ad increase repeatability, accuracy and quality. Overall it provides high quality and reliability.	High amperage can ruin the PCB, there is also an difficulty level to revise multiple times. Technology changes so rapidly that, within a year the component can become obsolete and expensive to restore.
3.	Automatic Water Meter using reading proposed Convolutional Neural Networks (CNN), FAST-YOLO, CRNN CR-NET and Multi-Task Learning. [7]	One of the main advantages of YOLO (You Only Look Once) is its speed of detecting 45 frames per second, which is said to be more effective. This method is best suited for processing in real time. It is said to be more efficient because of its generalizability.	No other device was found to be faster than YOLO in object detection but a few disadvantages of YOLO was that it resulted in lower Mean Average Precision (MAP) and localization error.
4.	Detection and control of water leakage using flow conservation,Micro-controller [10]	This process helps in easy and wireless transmission of data using Micro-Controllers. It is easy to interface additional ports.	Harder to implement. This might be compared as a complex structure because of dependency between processes.

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