Smart Water Management System At Home

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Abstract - It is essential for water providers and the urban water supply industries have to understand how water is used in residential settings. The project Artificial Intelligence Based Smart Water Management System discusses the innovative Information and Communications Technology (ICT) approaches to practice the tapped water-saving habit in house. At the domestic level, this is attained by the expansion of a decision provision method to provide good awareness among the family members about their daily water consumption in a significant way and do assessment and promote water consumption reduction. The proposed AI system will control and monitor the flow of water from overhead tank to various utility areas like Kitchen, Bathroom, and Dress Wash and also for Garden in House. The water distribution is controlled by Smart Water Distributor which distributes the water at different locations of the house based on its need. Using Deep Belief Network technique of AI, the threshold level of each location is compared with the current flow level of the sensor. These flow control sensors will update the flow periodically to the intelligent monitor system. The intelligent monitor system will analyze the sensor data with the current water limit of each distribution as well as the data from the water level sensor of the underground tank. Similarly, the high-rate pressure sensor will periodically update the pressure over the pipe. Based on the variation ratio of water availability Vs Demand ratio and reduction in pressure level, the Intelligent Monitoring system will alarm the house holders about the shortage and leakage of water. By the way the proposed system will regulate the usage of water and avoids the waste stage of water through leakage. This will also help the society and the government bodies to resolve the problem of water demand.

Keywords - Artificial Intelligence, Water, Intelligent Meter, Sensor, Society, Deep Belief Network.

1. Introduction
Water is the main resource for human life and is to be handled with at most care. Water scarcity basically affects the regular routine of human life. Basic alert system on water usage will highly helpful for the people to effectively use the water. The proposed smart water management system will play a key role in smart home. It is a scarce resource which has to be monitored efficiently, and also measures have to be taken for efficient supply and distribution[1]. There are three categories of water, White water is refined or chlorinated water from resources like Kitchen, Bathroom, and Dress Wash and also for Garden in House. The water distribution is controlled by Smart Water Distributor which distributes the water at different locations of the house based on its need. Using Deep Belief Network technique of AI, the threshold level of each location is compared with the current flow level of the sensor. These flow control sensors will update the flow periodically to the intelligent monitor system. The intelligent monitor system will analyze the sensor data with the current water limit of each distribution as well as the data from the water level sensor of the underground tank. Similarly, the high-rate pressure sensor will periodically update the pressure over the pipe. Based on the variation ratio of water availability Vs Demand ratio and reduction in pressure level, the Intelligent Monitoring system will alarm the house holders about the shortage and leakage of water. By the way the proposed system will regulate the usage of water and avoids the wastage stage of water through leakage. This will also help the society and the government bodies to resolve the problem of water demand.

2. Water conservation in indian constitution
India gets a normal precipitation of around 1170mm which Relates to a yearly precipitation of around 4000 BCM (Billion Cubic Meter) including snowfall. Nonetheless, there is significant variety in precipitation both transiently and spatially. Almost 75% of this i.e., 3000BCM happens during the storm season restricted to 3 to multi month (June to September) in a year [8-10]. After representing vanishing the normal yearly water accessibility in the Country has been surveyed as 1869 BCM. It has been assessed that attributable to geographical, hydrological and different imperatives, the utilisable water is 1123 BCM which involves 690 BCM of surface water 433 BCM of replenishable ground water assets. According to most recent appraisal made by the CWC in 2010 the live stockpiling limit of finished ventures is 253.388 BCM. According to appraisal directed by CPCB in 2015, the sewage age limit with regards to Urban Population of India for the year is assessed to be 62,000 MLD roughly against sewage treatment limit of 23,277 MLD with 816 STPs (Sewage Treatment Plants) [11-13].

Consistently during summer, India has all the earmarks of being on the water emergency indeed regardless of seeing plentiful downpours the earlier year. As of late, Bengaluru's exacerbating water hardships made it to the features, with unnerving measurements notice that India's IT capital would go the Cape Town way if preventive move isn't made immediately [14-16]. As JA Carney wrote in her 1845 sonnet, little drops of rain water grow into a mighty stream. But if corrective measures are not taken timely, it will lead to a catastrophic situation. As of 2016, parts of India have experienced a prolonged drought, which has damaged crops and livestock. The government has taken several initiatives to address water scarcity, such as the National Water Mission and the Rajiv Gandhi Mission for Deep Ground Water Exploration and Development. However, these efforts need to be complemented with innovative technologies and policies to ensure sustainable water use.

In conclusion, smart water management systems have the potential to revolutionize the way water is used and conserved in urban settings. By leveraging artificial intelligence and information and communications technology, these systems can help residents and industries to make informed decisions about water usage, ultimately leading to more efficient and sustainable water management.
water and its distribution range at each location. Similarly, the unwanted leakage of water should be properly identified early and should be blocked right away [18].

Table 1: Water resources and quantity

<table>
<thead>
<tr>
<th>Water Resources</th>
<th>Quantity (Billion Cubic Metre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual Precipitation</td>
<td>4000 BCM</td>
</tr>
<tr>
<td>Avg. precipitation during Monsoon (Jun-Sept)</td>
<td>3000 BCM</td>
</tr>
<tr>
<td>Natural Runoff</td>
<td>1986.5 BCM</td>
</tr>
<tr>
<td>Estimated utilisable surface water resources</td>
<td>690 BCM</td>
</tr>
<tr>
<td>Total utilisable ground water resources</td>
<td>433 BCM</td>
</tr>
<tr>
<td>Total annual utilisable water resources</td>
<td>1123 BCM</td>
</tr>
<tr>
<td>Per capita water availability</td>
<td>1720.29 cm</td>
</tr>
</tbody>
</table>

3. Standard utilization of water

According to the measurements the water usage of individual every day is determined as below (Figure 1). Average individual uses 101.5 gallons of water every day. In this, a full tub is around 36 gallons, 18-24 gallons for flushes, 20 gallons for showers, 15 gallons for dish washer, 2.5 gallons for cleanliness. Also, there are other random employments of water in the house which might be critical, contingent upon the level of water protection by the Household [19-20]. Such utilization incorporates family spills from funneling, latrines and different apparatuses, dribbling fixtures and the hosing of walkways, carports, carports and structures.

Fig. 1 : Standard Water Utilization Chart at Home

Household includes household leaks from piping, toilets and other appliances, dripping faucets and the hosing of sidewalks, driveways, garages and buildings.

4. Water Environment Carrying Capacity

The current circumstance is of shortage of regular assets getting more genuine with populace blast. To understand the maintainable utilization of local assets, individuals start to decide to utilize natural conveying limit which is one of the most impressive and compelling instrument to consider eco-ecological conveying limit and evaluate provincial economical turn of events. As far as water assets, with the expanding lack of water assets and the irritation of water contamination issues, the exploration of field and metropolitan water climate conveying limit has pulled in the consideration of researchers [21]. With the constant improvement of the degree of human social efficiency, the expanding populace and the further advancement of urbanization, the human interest for water assets is developing quickly, and the issue of water lack further confines human turn of events. Simultaneously, individuals don't focus on the security of water climate with the advancement of the economy, bringing about a ton of water contamination, which greatly affects the endurance, development and improvement of people and different organisms [22]. Water climate conveying limit is characterized as the biggest populace and financial scale that the water climate can uphold in a particular area for some timeframe without clear unfriendly impact on the nearby water climate. Water climate conveying limit research begins from the connection between the water climate, macroeconomic, populace, social and different variables, which basically mirrors the persuasive connection among climate and human exercises, to give a logical premise to the organized advancement of populace, society, economy and environment and it very well might be alluded as an unpredictable capacity with water, climate, populace, economy, innovation, strategy, space, time concerned. Hence, it additionally implies that neighborhood water assets can continue and support the all-out populace, economy and ecological scale under the reason of the balanced turn of events and usage of water assets adequately at home.

Therefore, it also means that local water resources can sustain and support the total population, economy and environmental scale under the premise of the rational development and utilization of water resources effectively at home.

5. Standard increase in need of water

In 2020, the worldwide interest for water is assessed to be around 5.5 cubic kilometers. As indicated by the source, agribusiness water efficiency is assessed to increment at 0.8 percent per annum, and modern water use at around 0.5 percent a year.

6. Nature-Based Solutions (NBS) for Water

NBS utilize or limit regular cycles to upgrade water accessibility (e.g., soil dampness maintenance, groundwater recharge) & to improve water quality (e.g., characteristic and built wetlands, riparian cradle strips), and lessen hazards related with water-related calamities and environmental change (e.g., floodplain reclamation, green roofs). The worldwide interest for water has been expanding at a pace of about 1% every year over the previous a long time as a component of populace development, monetary turn of events and changing utilization designs, among different variables, and it will keep on becoming altogether over the predictable future. Modern and homegrown interest for water will expand a lot quicker than horticultural interest, despite the fact that agribusiness will remain the biggest client generally speaking. By far most of the development popular for water will happen in nations with creating or arising
economies. Simultaneously, the worldwide water cycle is intensifying because of environmental change, with wetter locales by and large turning out to be wetter and drier areas getting considerably drier. So, to beat the interest of water in not-so-distant future, the shrewd water the board situation is basic right from an individual.

7. Smart Water Management
Water is one of the significant assets for human existence. The sensational change in atmosphere and expansion in the populace made water deficient. As the utilization of water is expanding, water the board turns into a major test for both the public authority and water providers. The cutting-edge innovations of processing,

8. Smart Water Flow Control at Home

![Diagram of Smart Water Management System at Home](image)

The proposed system as shown in Figure 2 specifies the structure of Smart Water Management System using Deep Belief Network techniques applicable at home. It consist of Intelligent Water Meters(IWMs)and smart sensors, Smart water distributor, Intelligent Monitor(IM) communicating through WIFI. The Artificial Intelligence based data analytics can be implemented to analyze the usage and leakage of water effectively. The system collects water level from the water tank using water level sensors($S_1$, $S_2$) and tube pressure using high rate Pressure Sensor ($S_P$) and also the quantity of flow from Intelligent Water Meters. Then the collected information is transmitted to a centralized Intelligent Monitor(IM) using Raspberry Pi and its Wi-Fi Module and the analyzed result can be viewed through a web interface and display unit. The meters(IWMs) are intelligent since they are not only measure the values but also communicate the measured value periodically to the AI based Intelligent Monitor(IM). The Intelligent Meter1(IM1) measures the water intake from public source to the under tank of the house. Then the water to overhead water tank every day is controlled and measured by the Intelligent Meter(IM2) and from there through Smart Water Distributor, the water is distributed to various location of the house like Kitchen, Bathroom, Washing and also to Garden. The Smart Water Distributor(SWD) collects the measured water level from various intelligent meter and compare it with the threshold value as shown in Table 1 for each utilization. When the utilization nears the threshold limit, then the warning message is given by the intelligent monitor. Thus the smart
water management system will monitor the usage of water at home and an alert will be given to the members of the house. So that people at home will start utilize the water in a controlled way. This will tremendously reduce the water demand per day. In turn, the overall water need of a city can be reduced.

9. Artificial Intelligence to Automate Smart Water Monitor (SWM)

Artificial Intelligence consciousness is professed to be a proper answer for some specialized issues where it is difficult to build up an exact model related with before expectation frameworks. In the assessment issues neural organizations demonstrated great outcomes for the previously mentioned situation.

**Deep Belief Network as an Analyzer**

As Deep Belief Networks (DBN) name shows, it is multi-layered conviction organizations. Each layer is Restricted Boltzmann Machine and they are stacked each other to develop DBN. The proposed model functions as follows. The initial step of preparing savvy water the board DBN is to gain proficiency with a layer of highlights like edge level of water need, available amount of water, pressure level of water pipe from the obvious units, utilizing Greedy Learning calculation.

The intelligent water distributor will distribute the water based on the threshold value as mentioned in the Figure 4 above. Threshold value is the one which is used to indicate us the limit of usage of water. Threshold value for leakage, gardening, house cleaning and washing clothes is 1. Value 2 is fixed for utensils cleaning and bathing.

### Table 2: Threshold Level of Water at Various Utility Areas

<table>
<thead>
<tr>
<th>Water Usage at Home</th>
<th>Threshold value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leakage</td>
<td>1</td>
</tr>
<tr>
<td>Gardening</td>
<td>1</td>
</tr>
<tr>
<td>Drinking</td>
<td>4</td>
</tr>
<tr>
<td>Cooking</td>
<td>3</td>
</tr>
<tr>
<td>Utensils washing</td>
<td>1</td>
</tr>
<tr>
<td>Washing clothes</td>
<td>1</td>
</tr>
<tr>
<td>Toilet</td>
<td>3</td>
</tr>
<tr>
<td>Bathing</td>
<td>2</td>
</tr>
</tbody>
</table>

Value 3 is fixed for toilet, cooking and 4 for Drinking. If the usage of water quantity crosses these threshold values, an alert will be given indicating that the quantity of water is beyond the fixed threshold value. Then the Intelligent Water Meters (IWMK, IWMB, IWMW, IWMG) will measure the flow of water to Kitchen, Bathing, Washing and Garden. It sends the measured value to AI based Intelligent Monitor (IM) periodically. The IM will feed the water threshold level (Table 1) and current level of water (Table 2) at each distribution and Table 3 gives testing data.

### Table 3: Testing Data (Periodically)

<table>
<thead>
<tr>
<th>Time (24 Hrs)</th>
<th>S3-K (100)</th>
<th>S4-B (500)</th>
<th>S5-W (500)</th>
<th>S6-G (100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>95</td>
<td>490</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>08</td>
<td>80</td>
<td>450</td>
<td>500</td>
<td>40</td>
</tr>
<tr>
<td>10</td>
<td>75</td>
<td>200</td>
<td>500</td>
<td>40</td>
</tr>
<tr>
<td>12</td>
<td>60</td>
<td>200</td>
<td>350</td>
<td>40</td>
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<tr>
<td>14</td>
<td>50</td>
<td>180</td>
<td>350</td>
<td>40</td>
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<tr>
<td>16</td>
<td>50</td>
<td>180</td>
<td>150</td>
<td>40</td>
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<td>18</td>
<td>50</td>
<td>180</td>
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<td>20</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>22</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>24</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>ALERT</td>
</tr>
</tbody>
</table>

In this 80% of the input is considered for training and 20% is considered for testing the outcome. As such the Deep Belief Network is trained and tested with the inputs. As a result of this intelligent training the DBN returns the alert message about remaining water level in underground tank, overhead tank and also in the line of distribution respectively to various utility places of house [22-25].
Analysis of Leakage

The high Pressure Sensor(Sp) will send the pressure details over the water tube periodically. It sends the measured value to Intelligent Monitor(IM). Then the IM analyses the variation of pressure level of water and predicts the possibility of leakage.

10. Result and discussion

Due to the follow up of smart water management system the effective water consumerism habits can be improved. The level of water usage at various utility places of house is tremendously decreased as shown in Figure 5 below.

![Figure 5: Water consumption before and after the smart system](image)

Traditional System-70% were used for Bathing, 80% for toilet, 50% for washing clothes, 30% for house cleaning, 60% for utensils washing, 40% for cooking, 60% for drinking, 40% for gardening and 30% got leaked out from faucet. The proposed Artificial Intelligent based Smart Water Management System reduces the percentage of usage as 30% for bathing purpose, 50% for toilet, 25% for washing clothes, 15% for house cleaning, 30% for utensils washing, 15% for cooking, 40% for drinking, 10% for gardening and 8% got leaked out from Machines which uses water like air conditioner and from faucet. By this framework individuals can be educated regarding the water shortage, its related issues and any wrong water use propensities or practices; at that point they can be guided through fitting course towards more successful methods of water utilization.

11. Conclusion And Future Work

The proposed AI based keen water executive framework teaches the significance of water management to individuals. Through this the public will be trained to use the water in a calculative way for their needs. In addition they will be free from the stress of periodic confirmation of availability of water at home. The advanced alert system will help people to do necessary arrangement for refilling the water before getting drain completely. This smart water management system will be very much helpful during the summer season when the scarcity of water is high. This proposed model will help the society and government to overcome the problem of water scarcity in future. As a part of future work the Cloud based water management system and SMS alert system will be enhanced in order to do remote alerts and ring up the water suppliers for future need.

References

[2]. Roslyn Brain Utah State University Jeremy Lynch Utah State University Kelly Kopp Utah State University, Defining Terms: Greywater, Blackwater and Clearwater, 1-2015
[6]. YanlualiHongwenXiuYuexiangWangh briberyYangYang, Evaluation of water environmental carrying capacity of city in Huaihe River Basin based on the AHP method: A case in Hua’an City, Volume 18, December 2017, Pages71-77
[22]. UN Water World Development Report, Nature-based Solutions for Water-2018