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OPTIMIZATION OF WATER CONSUMPTION THROUGH ARTIFICIAL INTELLIGENCE BASED TECHNIQUES

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Abstract: The excessive use of water while bathing has caused deep problems and contributed a lot to the water crisis all over the globe. The excessive use of water by a single person doesn't seem to be dangerous, but if a large number of persons are concerned, this would be surely a serious problem. To address the issue, the paper proposes the concept of a smart bathroom deploying the artificial intelligence based techniques, which will be smart and will not allow people to use more water than necessary while bathing. The proposed system includes a database that stores the information about the amount of water required for different people with various combinations of height and weight to bath. The smart bathroom concept consists of various sensors and an Internet of Things (IoT)-based device where a machine learning algorithm can be used to decode hidden patterns in IoT data by analyzing massive amounts of data from the database. The smart bathroom will access the data about the amount of required water for a person through the person's fingerprint. Thus, the smart bathroom retrieves the information from the existing database and will deliver the required water once the process gets started.

Index Terms **- Internet of Things, artificial intelligence, machine learning**

I. INTRODUCTION

Smart bathroom as the name suggests is a smart functioning bathroom. It is termed as smart, because unlike a regular bathroom it doesn't let the person only bath. It makes sure that the person bathing doesn't use excess water while bathing. So using this smart bathroom we can contribute to solving the water crisis that is making the world not such a good place to live in. Considering Cape Town, it is on the verge of becoming the first ever city to run out of water. To reduce the wastage of water while bathing, the concept of smart bathroom has been proposed in this paper. Deploying the concept of smart bathroom, a person wouldn't waste water while bathing as he would have no choice to waste water. A person just needs to access the device with his fingerprint and for just one time he needs to store his data in the device. He doesn't need to do it again and again as the information will be stored in the cloud. Suppose he desires to modify it, he can do it through the application we would create after verifying through the fingerprint. So wherever he goes in any part of the world, he can use the device without any problem. thus a lot of water can be saved through this.

Internet of Things

The Internet of Things (IoT) is an emerging paradigm that enables the communication between electronic devices and sensors through the internet in order to facilitate our lives. IoT uses smart devices and the internet to provide innovative solutions to various challenges and issues related to various business, governmental and public/private industries across the world . IoT is progressively becoming an important aspect of our life that can be sensed everywhere around us.

Artificial intelligence: Rapid advances in the field of artificial intelligence have profound implications for the economy as well as society at large. These innovations have the potential to directly influence both the production and the characteristics of a wide range of products and services, with important implications for productivity, employment, and competition. But, as important as these effects are likely to be, artificial intelligence also has the potential to change the innovation process itself, with consequences that may be equally profound, and which may, over time, come to dominate the direct effect.

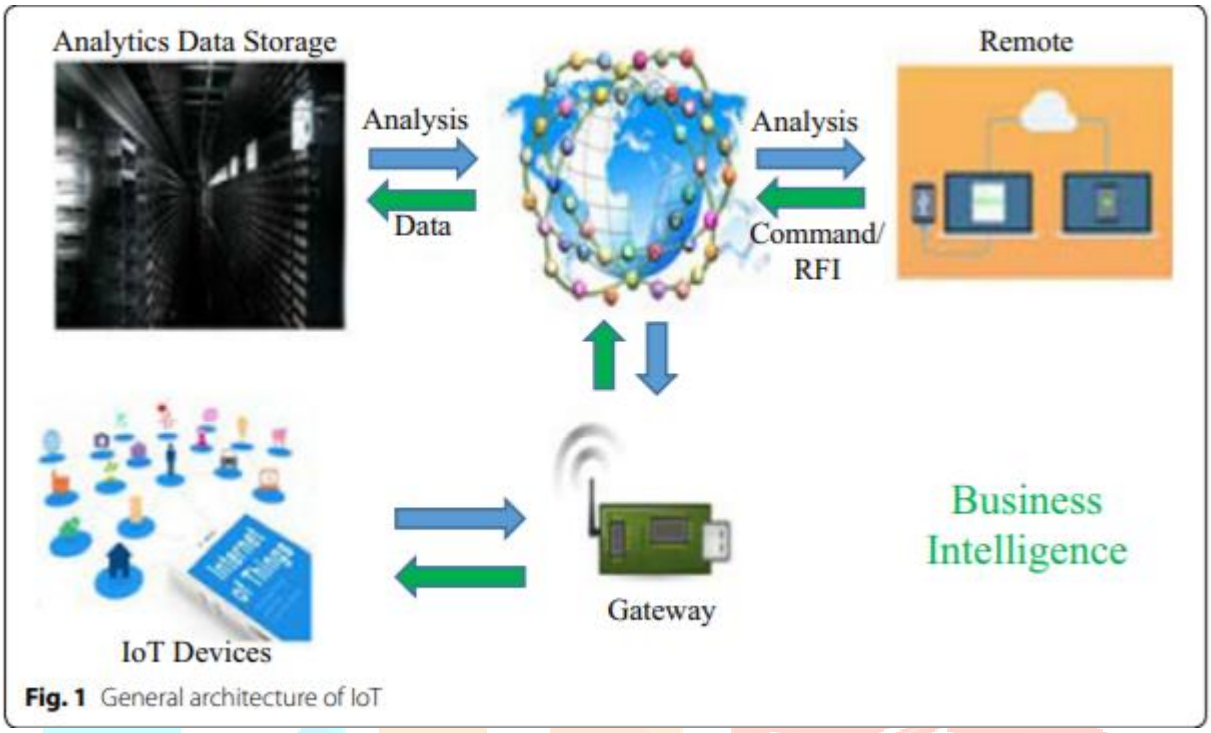

Fig. 1 General architecture of IoT

Artificial Intelligence

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Machine Learning

There is no error margin in the operations carried out by computers based on an algorithm and the operation follows certain steps. Different from the commands which are written to have an output based on an input, there are some situations when the computers make decisions based upon the present sample data. In those situations, computers may make mistakes just like people in the decision-making process. That is, machine learning is the process of equipping the computers with the ability to learn by using the data and experience like a human brain. The main aim of machine learning is to create models which can train themselves to improve, perceive the complex patterns, and find solutions to the new problems by using the previous data.

II. RELATED WORKS

A number of researches have been done to reduce water usage while bathing in different ways.
Many improvements have been made in this field. But everything seems to be an theory, and nothing seems to be so solid as to support the cause. Media campaigns have been regularly used in response to the drought crisis. A combination of price incentives, water use restrictions and knowledge transfer is claimed to lead to roughly 10–25% savings, in particular during drought periods and predominantly in lawns and gardens [1]. In particular, the wealthier, high-consuming households show the highest temporary water savings in response to these types of measures. When these high-consuming households are not well-informed about causes, impacts, and uncertainties of drought-related- issues, Salmon and Atkin argue that one-sided messages are most effective. Unlike two-sided messages that discuss both the pros and cons of curtailments, one-sided messages focus exclusively on the benefits of water curtailments. For an informed and often smaller target group, two-sided messages seem more reliable and persuasive, and may enable long-lasting water savings: not providing the cons would evoke suspicion in the eyes of these households [2]. Experiments indicate that increased personal involvement in drought issues increases the short-term effectiveness of knowledge transfer [3]. Over 80% of the participants reported positive attitudes for the water conservation programme, and a strong correlation between this positive attitude and actual water savings was found.Kurz et al. [4] investigated how specific behavior can best be enhanced by increasing people's self-efficacy. In their 166 Australian household experiment, the impact of providing information through leaflets and attunement labels (labels indicating use of water by different appliances in the house) was scrutinized. The leaflets included detailed information about the importance of conserving energy and water, as well as short facts, tips, and questions about the environmental impact of the energy use and water use of various household appliances. By contrast, attunement labels were installed at specific household appliances (e.g. at the shower, lawns, and garden hose) and provided similar information as the leaflet but specified for the appliance in question. The six-month experiment revealed that information leaflets had no impact on water use, whereas the attunement labels resulted in water savings of 23%. Arguably, the attunement labels repeatedly improved people's self-efficacy of using the particular appliance when they were about to use it.[4]

III. Device Construction and Algorithm

1) APPARATUS REQUIRED

- An LED screen: An Led Screen is used to display the data of height and weight of the person. After it, it will show the mode of the shower.
- An IOT device: The most important part to operate the device will be the IOT device. We have used Arduino for this operation.
- A GSM kit: It will be used to give connectivity to the module.
- A Wifi kit: To connect through mobile.
- A shower: To pour water.
- A heater (OPTIONAL): To make the water hot.
- An external storage device: If the user wishes to use the device only for their own household, it won’t need to be connected to the cloud. So, for this, the data of the users will be stored in that device.
- Fingerprint sensors: This will identify the user.
- Basic Components: This will consists of wires and other things like LED, switches, etc for connection purposes.

2) Construction and Algorithm

a) Initially we will run a program that would count the amount of water for different and all combinations of weights and height possible. We will create a database of this data in any software, say oracle or anything like that. Then we will store it in the IOT device.

b) Then we will connect the fingerprint sensors in the IOT device. Once the fingerprint sensor realizes a fingerprint, it will execute a program.

c) The program will connect to the cloud to search for the existing fingerprint.
d) If the fingerprint exists in the cloud, then the screen would ask for the confirmation at the beginning of the shower, after it has set the limit of the shower to the required amount, as it would already have the information for the person's requirements.

e) Else the screen would be displayed where the person would be asked to enter his height and weight.

f) After that, Two programs would again be executed simultaneously,

i) The first would make the device to connect to the cloud and store the data for that fingerprint
ii) The second would check in the database for an existing fingerprint and the combination of height and weight. And after finding one similar combination, it would set the limit of the shower that much litres.

g) After that, it would ask the user for confirmation of the start of the shower.

So in this way, one person would be able to bathe with the most sufficient amount of water without any wastage.

The shower will be connected to the frame consisting of the digital LED screen and the IOT device with some wires that would be covered with a material which is waterproof and insulated.
If there is a heater connected to the shower than the person can turn it on through the switch that will be nearby the device.
So in this way, Smart Bathroom can be made.

IV. SYSTEM ARCHITECTURE:

The system architecture will consist of different various steps. The architecture will be explained with the following flowchart as shown in Fig.2.

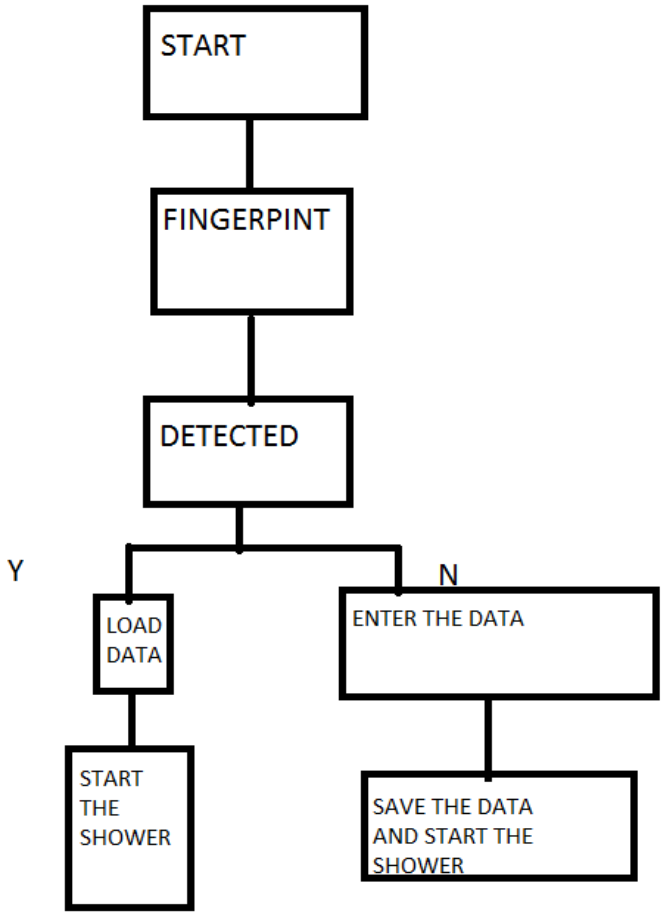

Fig.2 Flowchart of proposed system

- **START:** The device will be started by a button which will be just a tap button like a normal button to start the mobile phone. This will put the device in an active mode from the sleep mode. The device is made in such a way that when it is left idle for 10 mins, it goes to sleep mode. This is done for low power consumption.

- **FINGERPRINT**: After a user starts the device, he/she needs to put his/her fingerprint on the sensor. This will create two situations:

  a) If the fingerprint is detected in the server or on the external database. Then:

  i) The data for the user will be searched onto the database.

  ii) The parametrics of the user will be derived out.

  iii) After the parametrics, i.e height weight will be counted on, the data for the amount of water will be searched onto. The data will be then transferred into the measuring unit connected to the ARDUINO.

  iv) After this, there will be a message on the screen which will ask for the confirmation to start the device.

v) The user needs to set the time to bathe.

vi) The shower will get on then.

b) If the fingerprint is not detected then:

i) The user needs to set the data of his height and weight.

ii) After this, the data will be stored.

iii) After the parametrics, i.e height weight will be counted on, the data for the amount of water will be searched onto. The data will be then transferred into the measuring unit connected to the ARDUINO.

iv) After this, there will be a message on the screen which will ask for the confirmation to start the device.

v) The user needs to set the time to bathe.

vi) The shower will get on then.

This is how the Smart Bathroom will look on.

V. RESULTS AND DISCUSSIONS

A water-efficient showerhead uses approximately 9 litres per minute. An older style showerhead uses approximately 19 litres per minute - that's 10 litres more! Having a daily 5 minute shower with an older style showerhead uses about 36,500 litres of water a year. According to the Centers for Disease Control and Prevention (CDC), the average shower lasts **8 minutes**. So in an average, we can say that a normal person uses 80 litres of water at a time while bathing. Therefore we have come up with a chart which uses water in a very economical way. They could even bathe for 8 minutes in a less quantity of water. In table 1, the average uses of water for different persons in accordance to their height and weight are given.

Table 1: Average water usage

HEIGHT(inches)MALE	WEIGHT(kg) MALE	Water Required(litres)	HEIGHT(inches)FEMALE	WEIGHT(kg) FEMALE	Water Required
4.5-5.5	28-40	30N, 50W	4.5-5.5	26-35	30N, 60W
4.5-5.5	40-65	40N,50W	4.5-5.5	35-45	40N, 60W
4.5-5.5	65- above	50N,60W	4.5-5.5	45-above	50N,70W

N- normal condition
W- worst condition.
Now we can see that in the category of 4.5-5.5, we have saved a lots of water.

A graph is shown in Fig.3 that demonstrates the water usage for male only in the height category of 4.5-5.5 inches. The graph is:

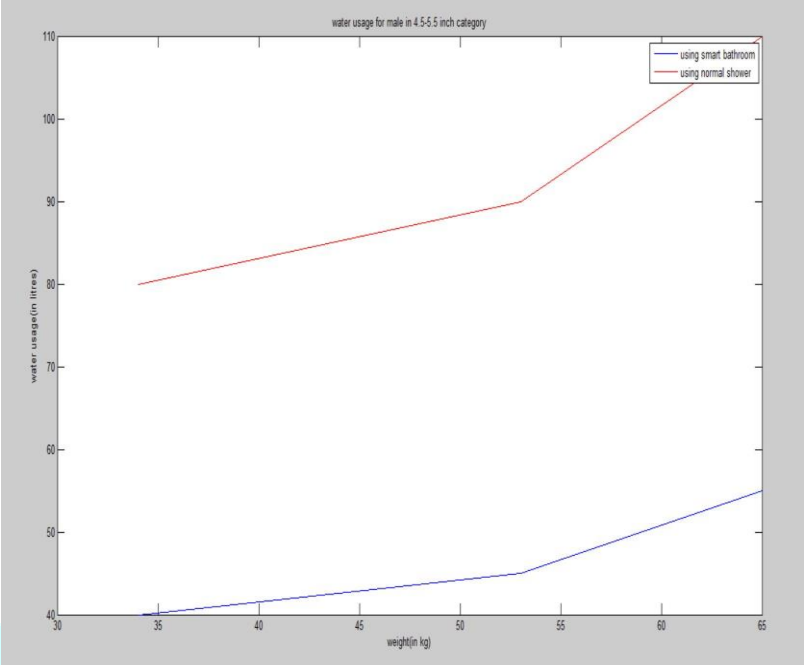

Fig. 3 water usage for male

Thus we can see the difference in the water usage while using the smart bathroom.

VI. CONCLUSION AND FUTURE WORK

According to World Wide Fund for Nature (WWF), 1.1 billion people worldwide lack access to water, and a total of 2.7 billion find water scarce for at least one month of the year. Inadequate sanitation is also a problem for 2.4 billion people—they are exposed to diseases, such as cholera and typhoid fever, and other water-borne illnesses. Two million people, mostly children, die each year from diarrheal diseases alone. Thus, it is a high time to think of saving water in every aspect of life. Though bathing is an important aspect, it is not acceptable that a family spend gallons of water in this process. Smart bathrooms will help to optimize the use of water. As for future work, it will be very important to include the other activities like washing, flushing. The goal is to create a recreational system to get the goal done. Maybe this will help in helping the world fight over water.

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