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Cloud Based Decision Support System for Waste-Water Management using Supervised Decision Tree Algorithm

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Abstract— As reuse is gaining popularity, there is challenge for the wastewater reusability also. Now a day's lots of research work are in boon for such system. In context with this there is need to develop systems which help to decision maker where to use wastewater. Population grows with rising standard of living; more wastewater is generated and disposed to sensitive environments with negative impact on humans and ecosystems. The aim of this research is to develop a DSS by using Machine Learning technique specifically supervised Decision Tree Algorithm, which is intended for applying intelligent decisions supporting reuse of wastewater management. This developed system provides best decision for the reuse of wastewater after the treatment. Further this system is deployed on cloud, as Cloud computing provides a good manageability and fast computational service. Currently its very challenging for exiting system stakeholders specifically (Municipal Corporation or user) to use this type of cloud based DSS for waste water. To upgrade this management scenario, this research project proposes CBDSSWWM.

Index Terms— Cloud Computing, Waste water management, BOD, COD, PH, COLOR, MPN, TURBIDITY, TSS.

I. INTRODUCTION

Today environmental pollution is very big and challenging issue. As population grows with rising standard of living, more wastewater is generated. Climate change, population growth and unreasonable exploitation of water resources have caused environmental deterioration, the unavailability of freshwater and an imbalance between supply and demand to a global extent, thus seriously affecting the sustainable development and utilization of water resources [1]. In MNC waste water management system, city authorities have the waste water data of all the different areas of the city. They need to manually analyze the data and forward water flow to water treatment plant. After WW treatment they have to decide the future usage of the waste water. This task is tedious and time consuming. Our system makes this task autonomous and by deploying this system on cloud, they can get the results on any computer connected to the network.

Cloud Computing gives us access to remote servers hosted on the internet. We can store, manage and process our data on a distributed system. Cloud computing allows consumers to use applications without installation and access their files at any computer with internet access.[2] (Kanday, 2012). According to NIST, National Institute of Standards and Technology, Cloud Computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resource [3]. There are three principal cloud deployment models: public; private; and hybrid. The choice of model depends on the level of accessibility and security required. The public cloud, and all the applications and data on it, is open to all users [4].

A decision support system is an interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge or models, to identify and solve problems, complete decision process tasks, and make decisions.[5] Decision support system (DSS) is a computer program application that analyzes and presents data so that users can make decisions more easily. The main purpose of our research is to develop DSS which will help communities effectively by giving the design space of sustainable wastewater solutions that is relevant for the particular context, and make it possible to identify solutions that balance environmental, economic, and social needs.i.e.to identifying "the most sustainable solution" means finding solutions that minimize negative effects, while maximizing benefits for local and global environments.[6] This cloud based decision support system for wastewater management takes input as a wastewater parameter and by analyzing and computing it will provide best solution to user. This cloud based system gives access of distributed location data to any computer, which is connected in network.

The Aim of this research is to build up a cloud based DSS for wastewater Management keeping in mind the end goal to help communities to take the decision of wastewater solutions that is relevant for their particular context, and make it possible for them to identify best solutions that balance environmental, economic and social needs. The framework has been at first produced for organizers and their experts with the expectation to be created for use by the general population.

In this research paper Section I contains the introduction , Section II contain Background, Section III contain Proposed Architecture., Section IV contain Proposed Design Model, section V contain Proposed Algorithm, section VI contain Algorithm for computational Model, section VII contain Analysis of Proposed Algorithm, section VIII contain Implementation , section IX contain Conclusion and Future Scope, section X contain References.

II. BACKGROUND

SCADA stands for Supervisory Control and Data Acquisition; it is an industrial computer-based control system employed to gather and analyze the real-time data to keep track, monitor and control industrial equipments in different types of industries. The Central Queensland University (CQU) and industry partner GBG Project Management Pty Ltd have been developing Supervisory Control and Data Acquisition (SCADA) technology to remotely operate and monitor large scale on-site wastewater treatment and reuse systems. The current trend towards decentralized systems is increasingly of interest in this area. Issues identified with these types of systems in the past have included the use of inappropriate technologies, hydraulic surges, difficulties in monitoring operation and identification of maintenance issues. The SCADA technology is used in association with KEWT systems, an innovative series of recirculating filter and evapotranspiration beds. The SCADA system has also been designed to identify maintenance issues, especially in regards to pump performance and pump line blockages or ruptures. [7]

The presented concept of development of the remote monitoring and control of the wastewater treatment system has energy efficiency as one of its main aims. It is based on the local PLC controllers located in the dislocated facilities which communicate with the central dispatch SCADA system using a Web server that allows for the access to data on the system over a local network or the Internet. In addition to the SCADA server which functions as the central data acquisition and remote control server, the control of liquid level in front of the valve based is developed on the basis of fuzzy logic, which significantly improved the energy efficiency of the System. This approach, which is focused on the expert knowledge operator and not on the process, shows better performance than conventional controllers, in terms of response time, settling time, and especially robustness. The control is achieved without any additional fuzzy logic modules/software on the standard PLC controller, thus reducing the cost of control equipment, and retaining the benefits offered by the application of fuzzy logic. The standard simulation software was used as a tool for fuzzy control part of the System, as well as for the simulation of the system.[8] Hence it is observed that SCADA system is used to monitor and control the wastewater treatment plant.

III. PROPOSED ARCHITECTURE

The architecture of cloud base Decision Support System for Waste Water Management (CBDSSWWM) consist of five modules as shown in fig. 1

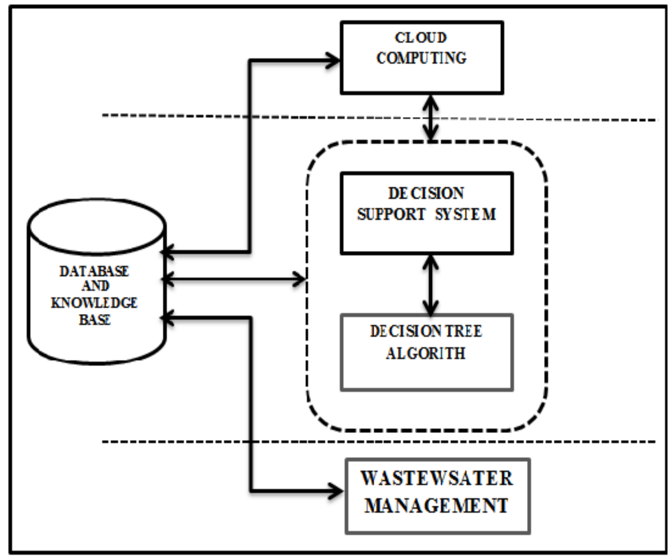

Figure1: CBDSSWWM architecture

Wastewater Management: whatever the parameter we get after the treatment of the wastewater are given to the DSS . DSS take it as the input parameter and after the computation it will produce the decision that is for what purpose user or planner can use this water.

Decision Tree Algorithm: This is one of supervised machine learning algorithm we suppose to apply in our system for the best decision.

DSS: This is the computational model of the system. It takes input value as a parameter values of the treated wastewater then it compute by comparing it with all database values. For this we apply Decision Tree Algorithm. Finally system will produce best solution.

Cloud Computing: Finally the System is deployed on Cloud, Cloud computing is used to describe different scenarios in which computing resource is delivered as a service over a network connection (usually, this is the internet). Cloud computing is therefore a type of computing that relies on sharing a pool of physical and/or virtual resources, rather than deploying local or personal hardware and software.

Database and knowledge Base: we generate database and knowledge base for training data set which is useful for supervised learning.

IV. PROPOSED DESIGN MODEL

The design model depicts the system handling all necessary issues and deployed on Cloud platform. This Decision support system using supervised Decision Tree is helpful for handling the decisions dynamically.

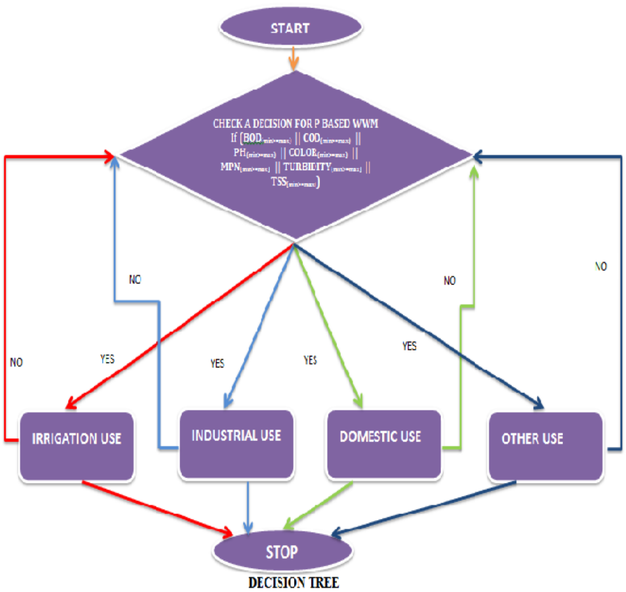

Figure2: Decision Tree of CBDSSWWM

V. PROPOSED ALGORITHM

Get sign in request from user

Fetch database for user authentication details from database

```
*String user_id = request.getParameter ("user_id");
*String password = request.getParameter ("password");
Enter your user user_id & Password
  If (match)
    {
    Authentication Successful!!!!!!!!!
    }
  Else
    {
    Authentication Failure…….
    }
  end if
```

To maintain waste water source usage, proposed algorithm in this research paper works as follows:

1) Invoke a system.
2) To access system, client/stakeholder/user needs to register on our system. Registration will be authenticated by our system.
3) Thereafter login credentials will be verified in order to prevent system from intrusion.
4) After successful log-in, user can enter parameters value as input (BOD, COD, pH, COLOR, MPN, TURBIDITY, TSS,) for classification of wastewater treatment in different arrears.
5) Decision tree algorithm is used for making decisions related to waste water parameters
6) After comparison our system will provide best decision that is where to use this waste water like IRRIGITION, INDUSTIRAL, DOMESTIC, and OTHER ACTIVITIES.
7) Result will be made available to concerned user
8) End of system.

VI. ALGORITHM FOR COMPUTATIONAL MODEL

STEP 1: Start

STEP 2: User put all input parameter in system like that, (BOD value, COD value, PH value, COLOR Value, MPN Value, TURBIDITY value, and TSS Value).

STEP 3: First used Decision Support System to compare all parameter based on decision tree.

Decision tree used to provide best solution for waste water where we can be used this water.

CASE3.1: Let….

$(BOD_{min})_i = \{BOD1_{min}, BOD2_{min} \ldots\ldots\ldots BODn_{min}\}$

// is the set of BOD minimum value of waste water resources.

$(BOD_{max})_i = \{BOD1_{max}, BOD2_{max} \ldots\ldots\ldots BODn_{max}\}$

// is the set of BOD maximum value of waste water resources.

$(COD_{min})_i = \{COD1_{min}, COD2_{min} \ldots\ldots\ldots CODn_{min}\}$

// is the set of COD minimum value of waste water resources.

$(COD_{max})_i = \{COD1_{max}, COD2_{max} \ldots\ldots\ldots CODn_{max}\}$

// is the set of COD maximum value of waste water resources.

$(PH_{min})_i = \{PH1_{min}, PH2_{min} \ldots\ldots\ldots PHn_{min}\}$

// is the set of PH minimum value of waste water resources.

$(PH_{max})_i = \{PH1_{max}, PH2_{max} \ldots\ldots\ldots PHn_{max}\}$

// is the set of PH maximum value of waste water resources.

$(COLOR_{min})_i = \{COLOR1_{min}, COLOR2_{min} \ldots\ldots\ldots COLORn_{min}\}$

// is the set of COLOR minimum value of waste water resources.

$(COLOR_{max})_i = \{COLOR1_{max}, COLOR2_{max} \ldots\ldots\ldots COLORn_{max}\}$

// is the set of COLOR maximum value of waste water resources.

$(MPN_{min})_i = \{MPN1_{min}, MPN2_{min} \ldots\ldots\ldots MPNn_{min}\}$

// is the set of MPN minimum value of waste water resources.

$(MPN_{max})_i = \{MPN1_{max}, MPN2_{max} \ldots\ldots\ldots MPNn_{max}\}$

// is the set of MPN maximum value of waste water resources.

$(TURBIDITY_{min})_i = \{TURBIDITY1_{min}, TURBIDITY2_{min} \ldots\ldots\ldots TURBIDITYn_{min}\}$

// is the set of TURBIDITY minimum value of waste water resources.

$(TURBIDITY_{max})_i = \{TURBIDITY1_{max}, TURBIDITY2_{max} \ldots\ldots\ldots TURBIDITYn_{max}\}$

// is the set of TURBIDITY maximum value of waste water resources.

$(TSS_{min})_i = \{TSS1_{min}, TSS2_{min} \ldots\ldots\ldots TSSn_{min}\}$

// is the set of TSS minimum value of waste water resources.

$(TSS_{max})_i = \{TSS1_{max}, TSS2_{max} \ldots\ldots\ldots TSSn_{max}\}$

// is the set of TSS maximum value of waste water resources.

CASE3.2:

```
for (i=1; i<=n; i++)
{
if(BOD_INPUT>=(BODmin)i || BOD_INPUT<=(BODmax)i &&
COD_INPUT>=(CODmin)i || COD_INPUT<=(CODmax)i && PH_INPUT>=(PH1min)i
||PH_INPUT<=(PHmax)i && COLOR_INPUT>=(COLORmin)i || COLOR _INPUT<=
(COLORmax)i && MPN_INPUT>=(MPNmin)i || MPN_INPUT<=(MPNmax)i &&
TURBIDITY_INPUT>=(TURBIDITYmin)i || TURBIDITY_INPUT<=( TURBIDITY max)i
&&  TSS_INPUT>=(TSSmin)i || TSS_INPUT<=(TSSmax)i)
  {
  (Return Sub Classification_type) i
  Go to sub classification for best solution
  Return best solution for waste water
  }
}
```

STEP 4:

Stop

VII. ANALYSIS OF PROPOSED ALGORITHAM

The analysis of the proposed algorithm is based on various security parameters such as confidentiality, authentication and integrity of data.

1. Confidentiality:

When user uploads data on the cloud it will be encrypted and then stored there. It requires user credentials keys to decrypt data. Therefore data confidentiality is ensured by keeping the keys known only to the data owners making cloud service providers unable to access the data.

2. Authentication:

User needs to give credentials to log in to the system. Only authorized user can register on to the system. When admin allows then only their registration will be successfully completed.

3. Integrity:

Integrity of the data is maintained by the encryption techniques. It ensures the data is secure over the cloud maintain data integrity.

VIII. IMPLEMENTATION

Table:1: Variable Declaration Table

Variable Declaration			
	COLUMN_NAME	DATA_TYPE	COLUMN_ID
1	MPN_MAX	FLOAT	12
2	MPN_MIN	FLOAT	11
3	TURBIDITY_MIN	FLOAT	13
4	TURBIDITY_MAX	FLOAT	14

5	PH_MAX	FLOAT	8
6	PH_MIN	FLOAT	7
7	COLOR_MAX	NUMBER(3,0)	10
8	COLOR_MIN	NUMBER(3,0)	9
9	COD_MAX	NUMBER(3,0)	6
10	COD_MIN	NUMBER(3,0)	5
11	BOD_MAX	NUMBER(3,0)	4
12	BOD_MIN	NUMBER(3,0)	3
13	TSS_MIN	NUMBER(3,0)	15
14	TSS_MAX	NUMBER(3,0)	16
15	TYPE_NAME	VARCHAR2(100 BYTE)	2
16	TYPE_ID	VARCHAR2(20 BYTE)	1

Table1 is used to declare all wastewater parameter as a variable in Sql Database.

Table:2 Classification

Para_List	Classification Table			
	Irrigation & wa1	**Industrial & wa2**	**Domestic & wa3**	**Other & wa4**
BOD_MAX	12	20	5	25
BOD_MIN	6	15	3	15
COD_MAX	30	15	10	14
COD_MIN	25	5	6	4
PH_MAX	9	2	0.8	7
PH_MIN	3	0.4	0.2	1
COLOR_MAX	17	8	15	8
COLOR_MIN	10	0	5	0
MPN_MAX	5	3	2	6
MPN_MIN	0.2	0.5	0.5	0.5
TSS_MIN	7	5	1	7
TSS_MAX	3	3	0.5	12
TURBIDITY_MIN	10	13	5	15
TURBIDITY_MAX	4	7	1	6

Table: 2 is used to define the Classification model to compare all possibility in Database and show the best solution.

Figure 3: Home Page & Login window Of the System

Figure 4: Test Window.

In Figure 4 we enters the wastewater parameter as input and do the Test.

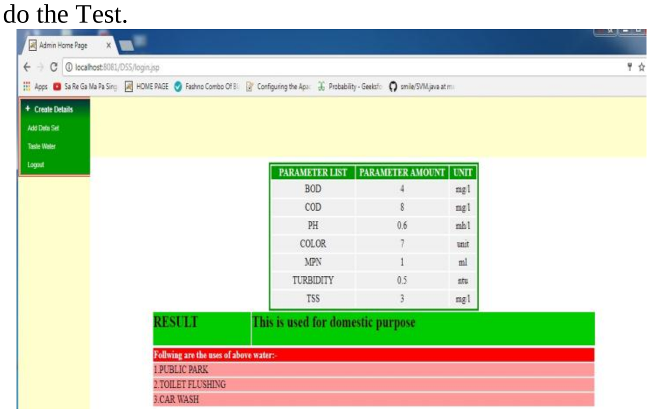

Figure5: Result for Wastewater Solution

Figure 5: give the result after the Test according to parameter.

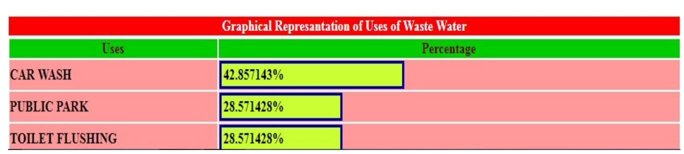

Figure 6: Graphical Representation of Waste water Solution

IX. CONCLUSION AND FUTURE SCOPE

As reuse is gaining popularity, there is challenge for the wastewater reusability also. Now a day's lots of research work are in boon for such system. In context with this there is needed to develop systems which help to decision maker where to use wastewater.
The aim of this research is to develop a DSS by using supervised Decision Tree Algorithm for the wastewater management. This system provides best decision for the reuse of wastewater after the treatment. Further deployed this system on cloud, as Cloud computing provides a good manageability and fast computational service. Municipal Corporation or user does not use this type of cloud based DSS for waste water. To upgrade this management scenario, this research project proposes CBDSSWWM.

In future we can interface this CBDSSWWM with IOT which will support automation in detection purity level in the water and can lead a system for automated decision making without manual intervention. This smart system will provide instant decision to user where they can reuse the treated wastewater.

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