Research Article

Maintenance of Water ATMs and Selection of locations for the Water ATMs on basis of Internal factors of the Location using Graph Theory

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Abstract: Under the Smart City Project, Guwahatians got facility of Water ATMs. In this research main aim is to find out the optimal locations in the city on the basis of internal factors of the location (like quantity and quality of water etc.) so that maximum number of citizens avail the benefits of water ATM.

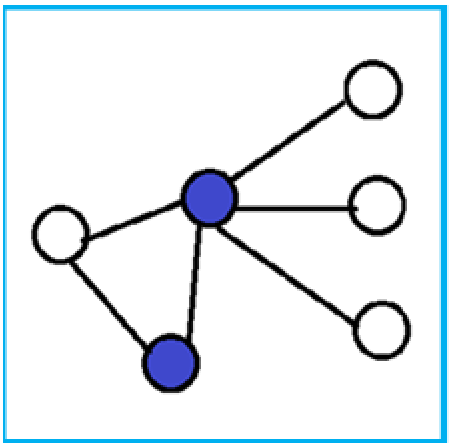
There are sets of Water ATMs that cannot be taken down together, because they have certain critical functions like -installation of new software, update of existing software, installation of required equipment, raw water supply problem, maintenance of pipelines, change the capacity of water tanks, electricity problem, plumbing or all routine maintenance etc. This is a typical scheduling application of graph coloring problem. It turned out that 3 colors were good enough to color the graph of 12 nodes. So they could install updates in 3 passes.

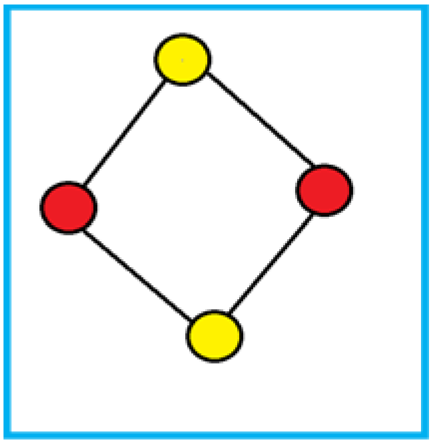
Keywords: Water ATMs, Minimum Vertex Cover, Problem_graph, Problem_weight, Water ATMs Maintenance

1. Introduction

Water plays a crucial role in the improvement of the socio-cultural and economic endowment of man. The river Brahmaputra and Bharalu also served as important sources of water for the people of the Guwahati city in the past as well as now. Poor water quality often leads to widespread of water-borne diseases among the residents like Cholera and Kala-Ajar. However, nature and magnitude of the problems relating to drinking water changed over time. After Independence, initiative for public water supply took a shape through the formation Municipality water is found to be more or less regular, except in dry season, when water supply becomes intermittent. Assam Public Health Engineering Department informed that in Kamrup (Metro) groundwater contamination with arsenic and fluoride. Consumption of contaminated drinking water over the years acts like a slow poison or a silent killer. Some of the hilly areas and many households living in upper slopes do not have any connections of piped water supply. A water ATM is an automated water vending machine that dispenses pure drinking water when a coin or note is inserted into it.

Graph theory plays a very important role in solving many practical problems. Like – layout of cable with minimum cost to make every telephone reachable from every other, to find out the shortest route from one location to another, to fill n number of jobs by n number of people with maximum total utility, use to find out maximum flow per unit time from source to sink in a network of pipes, find the number of many layers does a computer chip need so that wires in the same layer don't cross, arrange the season of a sports league be scheduled into the minimum number of weeks, find out the order a travelling salesman visit cities to minimize travel time, we colour the regions of every map using four colours so that neighbouring regions receive different colours. Vertex Cover: A vertex cover of an undirected graph is a subset of its vertices such that for every edge (u,v) of the graph, either u or v is in vertex cover and the set covers all the edges of the given graph. Minimum Vertex Cover defines the smallest possible number of vertices that covers all the edges of the graph. fig .(1). Graph Coloring Problem is labeling of vertices such that no two adjacent vertices have the same color fig(2). Coloring the graph with minimum number of colors is also of extreme importance as it influences how efficiently a problem can be solved





2. **Fig1.** Minimum Vertex Cover. **Fig 2**.Graph Coloring

Chromatic polynomial of hypergraph is the addition chromatic polynomial of a graph [1].The edge clique cover number of graphs is studied and proved that it is claw free [2].The conjectures for the class of line graphs is proved and bounds are all find out[3].Some regular graph neighbor diagnosability is studied[4].Importance of Betweenness centrality (BC) in the network is studied and its application in flow of information is studied [5].The pseudoachromatic number is tested and computed in different graph[6].Binary neural network is used to solved the minimum vertex cover and algorithm is developed[7].A locally bounded coloring is given in weighted vertex cover problem and investigated the problem[8].For exam scheduling application a graph-coloring-based algorithm is developed[9].Solving the graph coloring problem by Ant algorithm is done and graph coloring is used in scheduling problem[10].To solve the graph coloring a new efficient graph coloring algorithm is developed[11].To solve the timetable scheduling graph coloring method is used[12].new algorithm is developed to solve the graph coloring problem[13].Various applications and implementations of graph theory is discussed[14].

3. New Work

3.1 Generating Formula

In this system we have constructed a “Problem Graph” to find the optimal locations to place the Water ATMs. First we have selected a big area where these is a problem of drinking water. After that we selected some locations within that area where we will place the Water ATMs. We consider each location within that area as nodes of graph. After that we calculate the “Problem_weight” and assign the”Problem_weight” of each location depending on the problem of water of the locations. Considering distance of location 1km and more than 1km location from water source are identified. Because more the distance from the water source more the problem in availability of water.

In this way consider each location as a node and each node is connected to the adjacent node i.e. location. Weight of the edge depend on their adjacent vertices Problem_weight and actual weight. (Edge wt=Problem_ weight of the node +Problem_weight of the adjacent node + actual distance from the water source). Degree of the vertex depend on the number of edges incident on that vertex.

3.2. Preliminary processing

All the locations within a particular area are identified and assign the location number. Here we use 1 as the first location number and so on. Depending on the need of Water ATM and problem of water at that location we have given Problem_weight. Each location we have assigned Problem_weight=4(since we have considered four factors (problems)).We observe the each location and assign the Problem_weight and count it Table 2.

Rule-: By connecting Source of water and each location from the beginning to last location (node) form a graph.(Applying in fig. (4))

3.3 Calculating the weight

For calculating the weights according to their Problem weights. When adjacent locations (vertices) are connected for the graph to calculate the weight of the edge, then the Problem _weights help us to calculate the result.

Weight is calculated according to the Problem_weights, adjacent locations

Problem_weights and actual distance from water source of the locations.

[Weight = location's Problem _weights + adjacent location's Problem _weights +actual distance from the water source of the location].

We are using a fig. (3)to show how to find out the weight of Problem_ graph. The weight of edge between a and b is 9 and Problem_weight of each of them is 4 and actual distance is 1 meter. Now we consider another vertex c who's Problem_weight is 4 and c is adjacent to b. The weight of b to c edge is(4+4+4=12) 12 and now new total weight of b becomes 21.We will apply this procedure when we add new location. Suppose adjacent to a and b there is another vertex d whose Problem_weight is 4.After that total weight of b and a changes to 35 and 22 respectively and d becomes 27.Explaination of weight calculation is shown below.

Formula

*Weight of the edge =Location's Problem_weight*Pl+*Adjacent location's Problem_weight +Actual distance from the water source of the location*

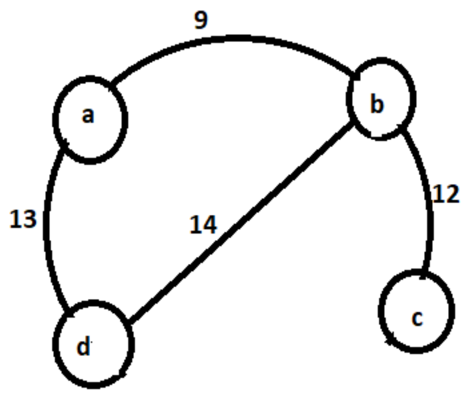


Fig. 3.Showing calculating weight

Step1:

The weight of the edge connecting the vertices a and b is 3

Each of them contains one Problem_weight =4+4

=8

Actual distance is 1 meter =1

Weight of the edge = 9 (I)

Step2: c is another vertex adjacent b

Problem_weight of c = 4

Problem_weight of b =4

Actual distance =4

Weight of the edge= 12 ------- (II)

From(I) and (II)

Total weight of b is changed to =9+12=21

Step3: d is adjacent to b

Problem_weight of d=4

Problem_weight of b=4

Actual distance =6

Weight of the edge =14 ----- (III)

From (I), (II) and (III)

Total weight of b is changed to =9+12+14=35

Step4: d is also adjacent to a Problem_weight of

d=4

Problem_weight of a=4

Actual distance =5

Weight of the edge =13 ----- (IV)

From (I)and (IV)

Total weight of a is changed to =9+13=22

From (III)and (IV)

Total weight of d is changed to =14+13=27

3.4 Calculating the Degree

The degree of the Problem_ graph is calculated according to the rules of graph theory.

The following algorithm has been developed to find out the minimum vertex cover of the Problem_ graph

We have developed an algorithm to calculate minimum vertex cover of the Problem_ Graph

Algorithm

We have considered Problem Graph as input for this algorithm.

We want the minimum vertex as our output.

Step1: while $e \in E = \varphi$ do

Step2: select xi with max (degree (xi)), ∀i,j = 1,2, 3 .... n

Step3: if degree (xi)=degree (xj) then

Step4: select xi with max (degree (xi)) and max(weight(xi))

Step5: else if (degree (xi) and weight(xi)) = (degree(xj) and weight(xj)) then

Step6: select either xi or xj

Step7: degree (xi,xj) = degree (xi, xj) - no of connected adjacent E(xi,xj)

Step8: weight (xi) = weight (xi,xj) – no of connected adjacent Weight(xi,xj)

Step9: end if

Step10: end while

4. Investigational Result

Guwahati Smart City Limited proposed locations Table 1(from our paper) for Water ATMs allotment. We have selected one area FancyBazaar in this paper.

In our research we have selected Fancy Bazaar area first. In this area government proposed to install 4 numbers of Water ATMs.

We have selected a few (12)locations in Fancy bazaar and also tried to find out problem of water in this location andaccordingly we have given some weight (i.e.Problem_weight).Also according to us the number of Water ATM required at those locations we have calculated on the basis of factors in Table 2

Sl No	Location	Nos. of Water ATM to be Installed
1	Kamakhya Temple	2
2	Fancy Bazar	4
3	Pan Bazar	2
4	Nehru Park/Cotton College	1
5	SukreswarGhat	1
6	DighiliPukhuri	1
7	Paltan Bazar	2
8	Chandmari	3
9	Silpuhkuri	1
10	DC Office	1
11	Guwahati High court	1
12	Bharalu	1
Total Nos. to be Installed		

Table1: Propose Locations of Water ATM

Since we have considered Fancy Bazaar Location most of the factors within these locations are identical except distance from water source

S.no	Factors(Internal) of Selection of Location of Water ATMs	Problem_weight
1	**Quantity of water**	**1**
2	**Quality of water**	**1**
3	**Distance of water source**	**From table 4**
4	**Topography of city and its surroundings:**	**1**
5	**Elevation of source of water supply etc.**	**1**

Table 2: Factors (Internal) of Selection of Location of Water ATMs

In this paper Problem_weight for each factor is 1, since most of the factors in the nearby location is almost same. If we consider differ valuesfor different factors then also we will get same result.

Slno	Name of the Locations	Short name of the locations	Problem_weight
1	SukreshwareGhat	SG	4
2	Council of Baphst Churches Northeast	CB	4
3	Guwahati Baptist Church	GB	4
4	Shiw Market	SM	4
5	Shanti Niketan, Opposite Jail Gate	SN	4
6	Machkhowa	M	4
7	Dr.SuryaKr.Bhuyan Library	DSL	4
8	Near HariSabha	NH	4
9	Gold Digital Cinema	GD	4
10	Bank of Boroda	BOB	4
11	Opposite police Reserve	OP	4
12	Satribari Christian Hospital	SCH	4

Table 3: Different locations of Fancy Bazaar

Water	Distance of each location from the water source

Locations												
Brahmaputra River Front (BRF)	SG	CB	GB	SM	SN	M	DSL	NH	GD	BOB	OP	SCH
	10	12	10	9	4	4	19	13	11	8	13	16

Table 4: Distance from Brahmaputra River Front (BRF) source of water to the each of the location of the Fancy Bazaar (1km and less than 1km locations are shown with blue color)

Weight of the edge =Location's Problem weights +Adjacent location's Problem _weights +Actual distance from water source

<u>Now applying Rule:</u>

We have now constructed graph fig.(4)

<u>Formula for weight calculation of edge</u>

> Weight of the edge =Location's Problem _weights +Adjacent location's Problem _weights +Actual distance from the water source
>
> x

CB's Problem _weights =4

SG's Problem _weights =4

Actual distance between CB and SG =7

Weightof the edge CB to SG =15

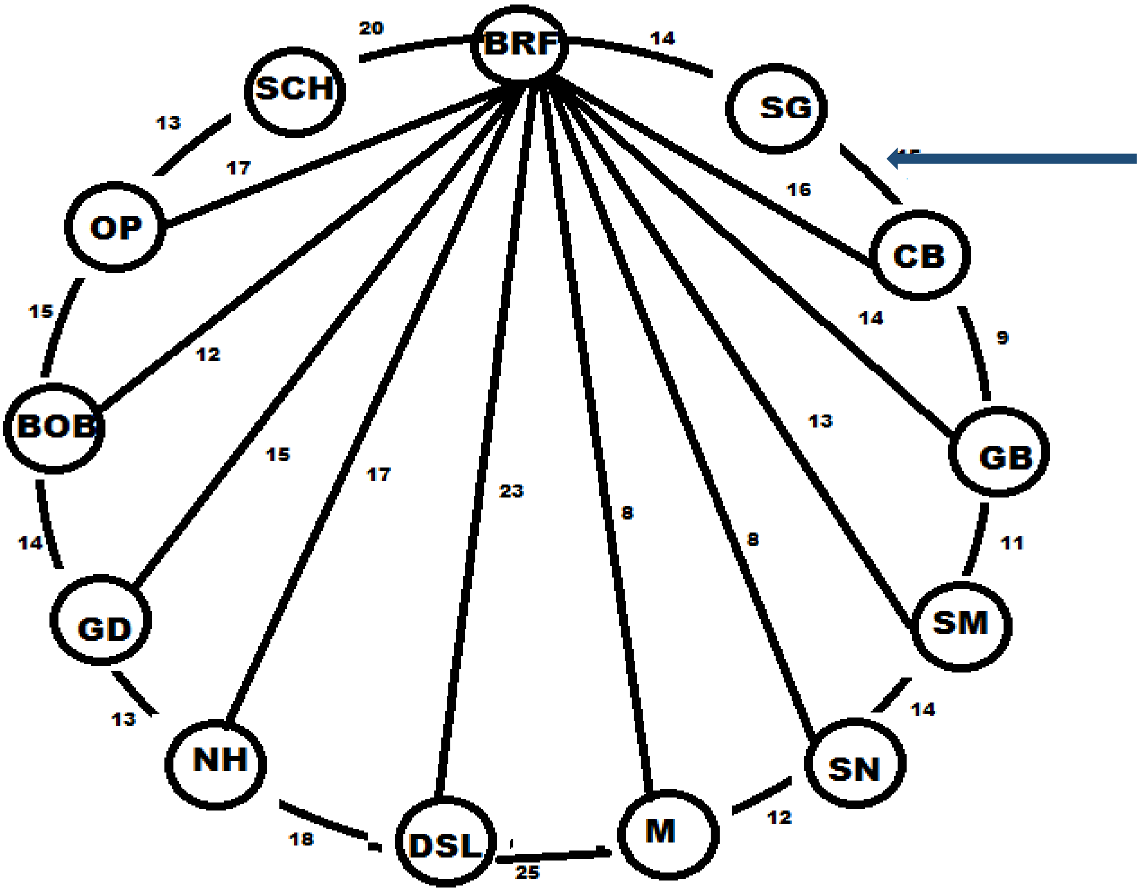


Fig. 4. Experimental Graph of distance calculation

We have constructed fig. (4) which is a regular graph. Applying the minimum vertex cover algorithm in location graph of fig.(4) and we found out 6 locations Table 6.We use 12 input locations as shown in Table 5

Our 12 input locations are as follows:

Sl no	Name of the locations	In short name of the locations
1	SukreshwareGhat	SG
2	Council of Baphst Churches Northeast	CB
3	Guwahati Baptist Church	GB
4	Shiw Market	SM
5	Shanti Niketan, Opposite Jail Gate	SN
6	Machkhowa	M
7	Dr.SuryaKr.Bhuyan Library	DSL
8	Near HariSabha	NH
9	Gold Digital Cinema	GD
10	Bank of Boroda	BOB
11	Opposite police Reserve	OP
12	Satribari Christian Hospital	SCH

Table 5 Input locations

5. Result of Experiment

Output of Experiment from fig. (4)

Fig.5.Experimental Results.

From the result obtain from the experiment fig. (5) of the graph Fig.(4) minimum vertex cover is 6.

From 12 vertices we get only 6 vertices. These are - DSL, OP, GD, CB, SM and SN. We can apply sorting algorithm (Bubble sort) to sort according to their serial number as follow:

CB, SM, SN, DSL, GD,OP

Appling minimum vertex cover algorithm we get following optimize locations shown in Table 6

Output Location of the experiment fig. (4)

Sl no	Name of the locations	In short name of the locations
2	Council of Baphst Churches Northeast	CB
4	Shiw Market	SM
5	Shanti Niketan, Opposite Jail Gate	SN
7	Dr.SuryaKr.Bhuyan Library	DSL
9	Gold Digital Cinema	GD
11	Opposite police Reserve	OP

Table 6: Output Locations

6. Discussion:

To install a new software , update existing software ,install the required equipment, any other problems-like raw water supply problem, maintenance of pipelines, change the capacity of water tanks, electricity problem, plumbing ,any natural problem or all routine maintenance we cannot taken down all the water ATMs together in any particular location.

Maintenance plays an important role in guaranteeing facilities' safety operation, improving facilities' quality, keeping and delaying engineering system lifetime as long as possible.

We have divided the all the water ATMs into three groups. We can do the maintain work in three separate passes. So that people can collect water from rest of the any two groups of water ATMs if the update or maintain taking place in one group.We cannot take down all the water ATMs together in any particular location.

From the output locations in the table 6,we calculate distance between each location to the other locations

Following table shows the Distance from each optiml location to rest of the optimal locations (Reduce the distances to 10 scales & converted nearest integer).

Serial no.	Optimal Locations	**500 meters and less than 500 meters locations are shown with blue color**											
			CB		SM	SN		DSL		GD		OP	
2	**CB**		--		**4**	9		9		**5**		10	
4	**SM**		**4**		--	6		13		**3**		8	
5	**SN**		8		6	--		17		7		10	
7	**DSL**		9		13	17		--		7		10	
9	**GD**		**5**		3	7		7		--		7	
11	**OP**		10		8	10		10		6		--	

Table 7: Distance from each location to rest of the locations (Reduce the distances to 10 scales & converted nearest integer).

In the figure 6 we have connected 500merter and less and 500meter locations because people may collect water from these Water ATMs during maintenance.

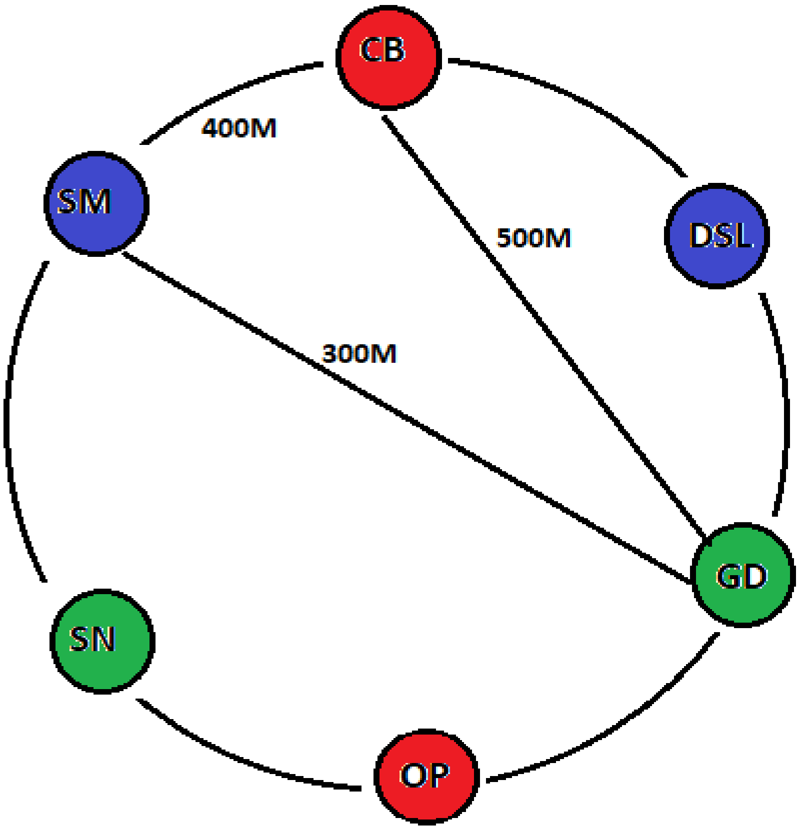


Fig 6: Maintenance of Water ATMs using graph coloring

7. Future Prospects

In this paper we have studied the Internal Factors Distance of water supply source, for selection of locations for placing Water ATMs. There are also some other Internal Factors— Quantity of water, Quality of water, Topography of city and its surroundings,Elevation of source of water supply etc. which are also important for selection of locations for placing Water ATMs. For that we require to collect the data from the survey by visiting on the site and also from the Directorate of Geology & Mining government of Assam. That part (Internal Factors) will be covered in the further study. In paper covered only one location of the Guwahati city.

8. Conclusions

We found that even if the number of Water ATM increase we can perform the maintenance of Water ATMs of a particular location in the three phases without take down all the water ATMs together in any particular location. That will help the people to collect the Water from nearest other Water ATMs. We have created a model to find out the optimal locations for Water ATMs. One can use our model and algorithm and find out the optimal locations for installation of Water ATMs such that maximum numbers of people avail the benefit of Water ATMs.

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