SRM NETWORK CABLE MANAGEMENT

PROJECT REPORT

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Course Code: 18CSC204J
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PROJECT REVIEW: DAA

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Problem:

Prims Algorithm in the design of Campus Network

Problem Statement:

The problem deliberated is that of networking a given set of network nodes with shortest possible cables of direct links. Simple practical procedures have been given for solving this problem. The techniques given are based on prims algorithms. Problem statement – Given a set of University buildings, connect them by a fibre network cables of direct terminal-to terminal links having the smallest possible total length (total sum of cable lengths). A set of buildings are connected, if and only if there is an unbroken chain of fibre links between every two buildings in the set. The purpose of the study was to investigate the effectiveness of PRIMs algorithm in the design of University LAN networks and to establish the effect of prim's algorithm in the design of a Campus Network at SRM University.

INTRODUCTION

The problem considered is that of planning a large-scale Campus network based on fiber technology. Such networks are expensive to install but are very reliable. Optic fiber network offers fast and reliable network that provides high end internet services. The reliability and service quality requirements of modern data communication networks and the large investments in communications infrastructure have made it critical to design optimized networks that meet the performance parameters [4]. Therefore for a fast growing institution of higher learning, these services are essential hence the need for reliable data networks in University campuses. This can be realized by installation of an optic fibre network. Optic fibre networks use light for data transmission. According to Optic Fiber is the most important type of media that uses light for data transmission. Data is transmitted in the form of light pulses emitting from a light emitting diode travels through glass filaments and are received on the other end by a photosensitive device. Optical fibers are used extensively for data transmission systems because of their dielectric nature and their large information-carrying capacity. Installation of such a network in a fast growing institution would therefore improve the quality and efficiency of data communication. Installation of the fiber network is an expensive affair and proper planning is required to realize a fully functional network. Though it is expensive to install optic fiber networks, this paper proposes a model in their design that, if adopted, can reduce the overall cost of installation. Given a set of University buildings, we propose a model based on Prims algorithm that would enable connection of all buildings to the optic fiber network at a minimal cost. A set of buildings will be considered connected if and only if there is an unbroken chain of optic fibre links between every two buildings in the set. A loop is not allowed and a redundant cable is not allowed either as this will increase the cost. The purpose of the PROJECT is to investigate the effectiveness of Prims Algorithm in the design of Campus Networks. The study demonstrates that the overall costs incurred during the interconnection of University buildings to the existing Local Area Network can be minimized.

PRIMS ALGORITHM

An algorithm can be viewed as a tool for solving well-specified computational problems. The problem at hand is that of establishing the shortest distance between all the University buildings. Prims algorithm has an application in finding the minimum length, commonly referred to as the cost of spanning tree. Minimum spanning tree (MST) problem is one of the traditional optimization problems . According to , the minimum cost of a spanning tree has a wide application in different areas. It epitomizes intricate problems such as: » Minimum distance for traveling all cities at most one (Traveling salesman problem). » In electronic circuit design, to connect n pins by using n-1 wires, using the least wire The minimum cost of a spanning tree can be established by use of Prim’s and Kruskal’s Algorithm.

In this paper, the objective is to find the minimum cost of connecting University buildings using the Prim’s algorithm. Prims algorithm is a greedy algorithm that obtains the minimum spanning tree by use of sets. It processes the edges in the graph randomly by building up disjoint sets. The problem at hand was modeled using a connected undirected graph G= (V,E) where V is the set of University buildings, and E is the set of possible interconnections between pairs of buildings and for each edge (u,v) ϵ E, we have a weight (u,v) specifying the length of the amount of optic fiber cables needed. We then preceded to find an acyclic subset T ϵ E that connects all the vertices and whose total weight w(T) = ϵ w(u,v). (u,v)/[T is minimized. Since T is acyclic and will connect all the buildings in the University, it will form a tree, referred to as spanning tree [2]. We are interested in the tree that spans the shortest distance within the overall University buildings; we refer to it as the Minimum spanning tree. Prims algorithm is a special case of the generic minimum spanning tree which operates for finding the shortest path in a graph. The algorithm has a property in that the edges in the set always form a single tree. The tree starts from an arbitrary root vertex and grows until all the vertices are spanned in V. Each step adds to the tree A a light edge that connects A to an isolated vertex – one on which no edge of A is incident. The algorithm implicitly maintains the set A from GENERIC-MST as A = {(v,v.π): v ϵ V- {r}-Q}. when the algorithm terminates, the priority Q will thus be empty. The minimum spanning tree A for G is thus A = {(v,v.π): v ϵ V- {r}}. According to , MST-PRIM(G,w,r) can be illustrated as follows:

Pseudo code

```
A = {(v, π[v]) : v ∈ V - {r}}
MST-PRIM(G, w, r)
 for each u ∈ V [G]
     do key[u] ← ∞
        π[u] ← NIL
 key[r] ← 0
 Q ← V [G]
 while Q ≠ Ø
     do u ← EXTRACT-MIN(Q)
        for each v ∈ Adj[u]
            do if v ∈ Q and w(u, v) < key[v]
                  then π[v] ← u
                       key[v] ← w(u, v)
```

SRM UNIVERSITY LAN

SRM University consists of several buildings and installations. Buildings host offices where internet services are essential. There exist some offices without reliable internet connections. Note that the internet provides several opportunities for academia with added benefits to teaching, learning and research. The existence of staff offices without this essential facility deprives their occupant of the above opportunities. The existing LAN at SRM University covers limited building structures and offices. There remains a challenge of networking all the University buildings using the optic fiber since it is expensive. By using prim's algorithms, we prove that all the buildings can be connected at minimal cost.

IMPLEMENTATION

SRM University consists of the various key buildings as illustrated in the map below. To implement the algorithm, we consider all the buildings that require an optic fiber connection. A building would qualify to be connected to a fiber network, if it requires a high speed internet connection and can be qualified for point to point communication. The building under consideration is as follows: [SRMIST,Library, MBA,SRM HOSPITAL,MAIN BLOCK,Hostels,TECHPARK,TP GANESAN,UNI ARCH,HiTECH]

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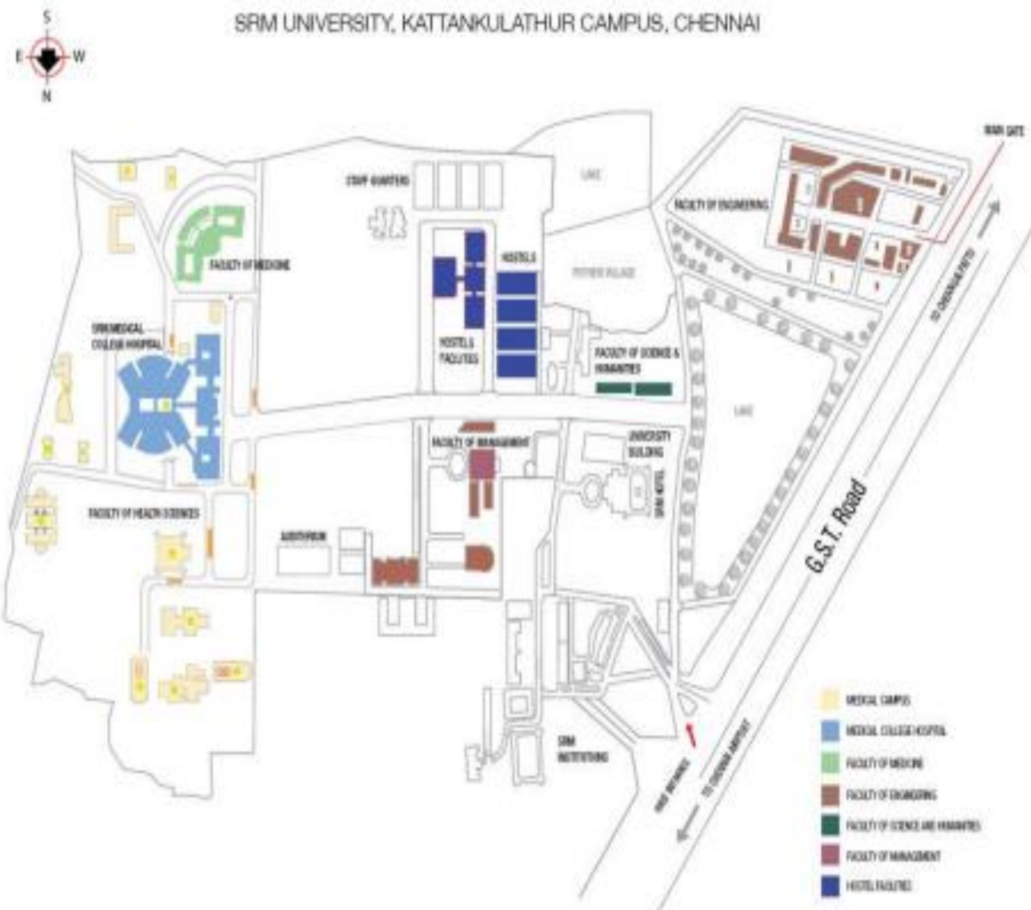
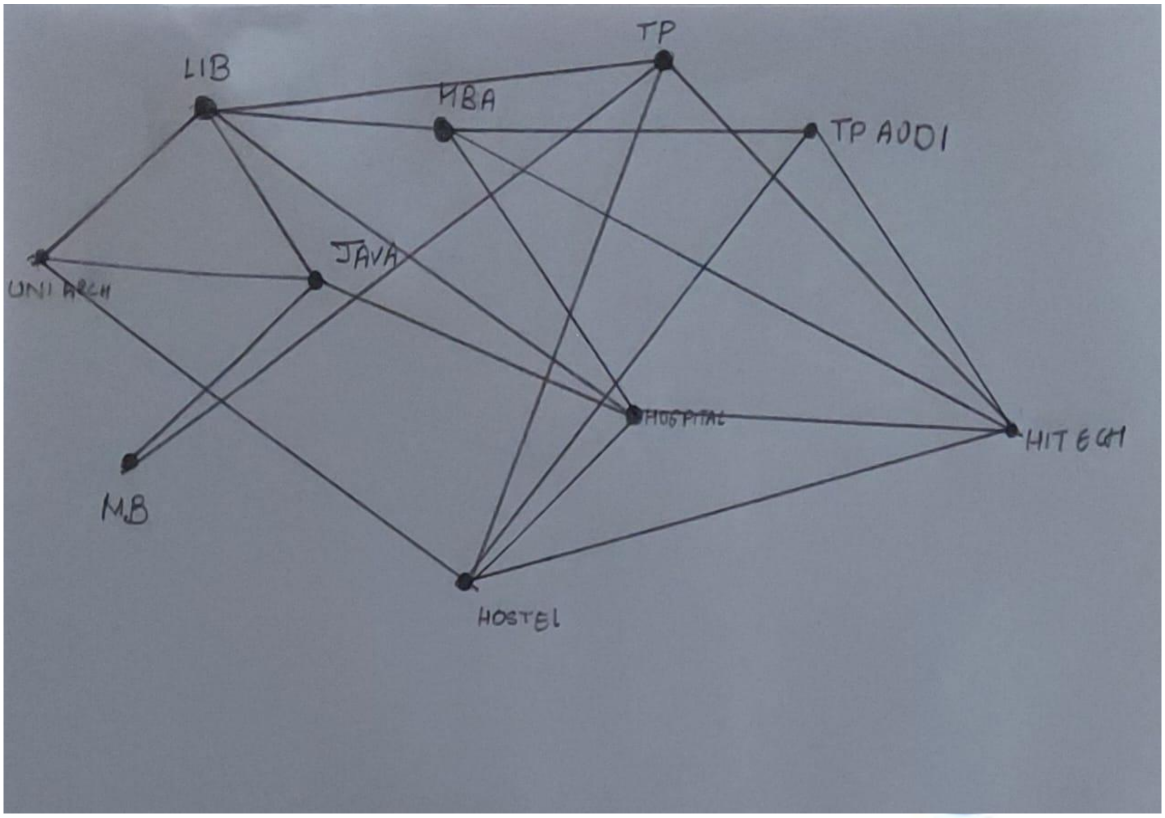


Key

[1: TECH PARK, 2:AUDITORIUM, 3:JAVA GREEN, 4:UNIVERSITY ARCH, 5: MAIN BLOCK, 6:BOYS HOSTEL, 7: GIRLS HOSTEL, 8: CENTRAL LIBRARY, 9: MBA BUILDING,10:SRM HOSPITAL, 11:Hi TECH PARK] .The above image shows a topological view of SRM University with main buildings visible. The study used-scaled sketches to prove that prim's algorithms could reduce the overall cost of fiber installation.



The figure above shows the existing fibre network at SRM University, the direct cable links leads to wastage of fibre cable used. With use of Prim's algorithm, the overall length of the cable used would be greatly minimized.

APPLICATIONS OF PRIMS ALGORITHM

In order to minimize cost, the relative distance of each building installation from the library center was measured. The distance from each building to its adjacent building was also measured. The starting point was the library center since it forms the root node or the starting point to the entire network. The results of the measurement are summarized in the table below.

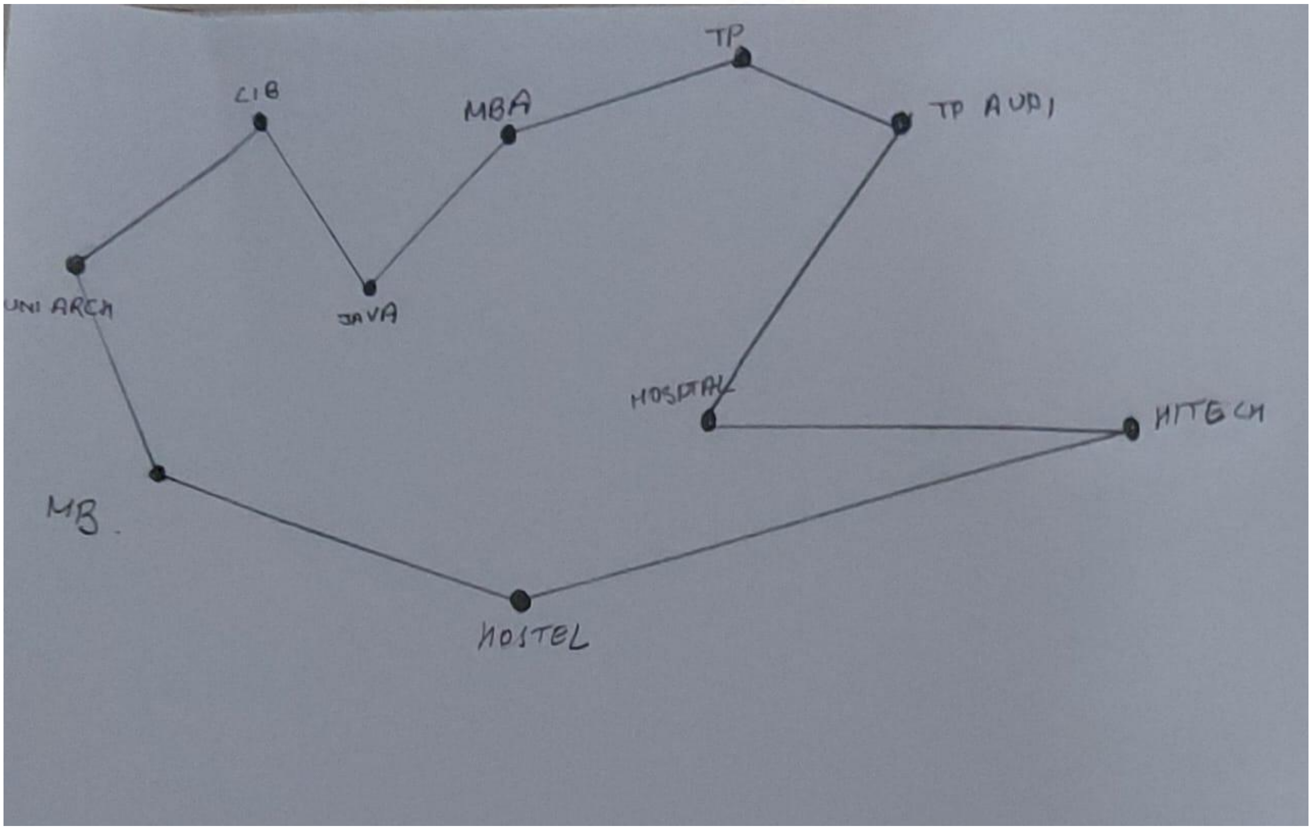
	LIB	TP	JAVA	MBA	HOSPITAL	HOSTEL	MB	TP AUDI	UNI ARCH	HITECH
LIB	0	850	600	400	110	750	650	850	150	800
TP	50	0	500	450	650	710	1400	200	700	1300
JAVA	600	500	0	50	800	580	910	550	800	1000
MBA	400	450	50	0	700	510	950	450	400	900
HOSPITAL	1100	650	800	700	0	600	1500	450	400	900
HOSTEL	750	710	580	510	600	0	900	800	650	800
MB	650	1400	910	950	1500	900	0	1400	600	800
TP AUDI	850	200	550	450	400	800	1400	0	900	1300
UNI ARCH	150	700	800	400	1000	650	600	900	0	500
HITECH	800	1300	1000	900	1500	800	50	1300	500	0

By applying the Prim's algorithm, proceed as follows to establish the shortest link. Let the LIBRARY form the root node, then proceed to the nearest building, which is JAVA GREEN and MBA block. Their edges have the minimum weight, therefore added to the queue. Library and the science building become our new roots. From here we extend towards other buildings, always using the shortest link. This continues till we reach all the buildings in the set without forming a loop. When the algorithm completes, the entire length of the required cable will be reduced, saving on the entire cost of connecting all the buildings. The figure below shows the outcome after application of prim's algorithm to redesign the existing LAN

```
spanning tree matrix:

0    0    0    400  110  0    0    0    150  0
0    0    0    0    0    0    0    200  0    0
0    0    0    50   0    0    0    0    0    0
400  0    50   0    0    510  0    0    0    0
110  0    0    0    0    0    0    400  0    0
0    0    0    510  0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    500
0    200  0    0    400  0    0    0    0    0
150  0    0    0    0    0    0    0    0    500
0    0    0    0    0    0    500  0    500  0

Total cost of spanning tree=2370
```


TP
LIB
MBA
TP AUDI
UNI ARCH
JAVA
HOSPITAL
HITECH
MB.
HOSTEL

CODE

```c
In [ ]: #include<stdio.h>
#include<stdlib.h>

#define infinity 9999
#define MAX 20

int G[MAX][MAX],spanning[MAX][MAX],n;

int prims();

int main()
{
int i,j,total_cost;
printf("Enter no. of vertices:");
scanf("%d",&n);
printf("\nEnter the adjacency matrix:\n");
for(i=0;i<n;i++)
for(j=0;j<n;j++)
scanf("%d",&G[i][j]);
total_cost=prims();
printf("\nspanning tree matrix:\n");
for(i=0;i<n;i++)
{
printf("\n");
for(j=0;j<n;j++)
printf("%d\t",spanning[i][j]);
}
printf("\n\nTotal cost of spanning tree=%d",total_cost);
return 0;
}

int prims()
{
int cost[MAX][MAX];
int u,v,min_distance,distance[MAX],from[MAX];
int visited[MAX],no_of_edges,i,min_cost,j;
//create cost[][] matrix,spanning[][]
for(i=0;i<n;i++)
for(j=0;j<n;j++)
{
if(G[i][j]==0)
cost[i][j]=infinity;
else
cost[i][j]=G[i][j];
spanning[i][j]=0;
}
//initialise visited[],distance[] and from[]
distance[0]=0;
visited[0]=1;
for(i=1;i<n;i++)
{
distance[i]=cost[0][i];
from[i]=0;
visited[i]=0;
}
min_cost=0; //cost of spanning tree
no_of_edges=n-1; //no. of edges to be added
while(no_of_edges>0)
{
//find the vertex at minimum distance from the tree
min_distance=infinity;
for(i=1;i<n;i++)
if(visited[i]==0&&distance[i]<min_distance)
{
v=i;
min_distance=distance[i];
}
u=from[v];
//insert the edge in spanning tree
spanning[u][v]=distance[v];
spanning[v][u]=distance[v];
no_of_edges--;
visited[v]=1;
//updated the distance[] array
for(i=1;i<n;i++)
if(visited[i]==0&&cost[i][v]<distance[i])
{
distance[i]=cost[i][v];
from[i]=v;
}
```

CONCLUSION

Applications of Prim's algorithm can be a valuable and useful tool in the design of large LAN networks. This is because of its greedy nature since at each step it adds to the tree the shortest edge that will contribute the minimum weight of the tree formed. The algorithm would cater for the existing and emerging buildings. The cost of such is highly reduced as the algorithm always results in the minimum overall distance. The savings on cost could be used to expand the network to other buildings and installations. This would enable the connections to several buildings enabling more people to be connected to the internet. Though the study was carried out on the existing LAN at SRM University, its findings can be applied to any other network setup that uses optic fibre to minimize the installation cost.