PROJECT REPORT

ON

DATA GATHERING USING WIRELESS SENSOR NETWORK

Under the Guidance of

Dr. Dinesh Dash

Assistant Professor

(NIT Patna)

Submitted by

Akash Srivastava, NIT Patna

Priyanshu Singh, NIT Patna

Ritikesh singh, NIT Patna

Vyom Aggarwal, NIT Patna

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY PATNA

(An institute under Ministry of HRD, Govt. of India)

ASHOK RAJPATH, PATNA-800005 (BIHAR)

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Abstract

Recent work shows sink mobility can improve the energy efficiency in wireless sensor networks (WSNs). However, data delivery latency often increases due to the speed limit of mobile sink. In practice, some application has strict requirements on delay.

This project of our focuses on the path selection problem in delay-guaranteed sensor networks with a path-constrained mobile sink. The optimal path is chosen to meet the requirement on delay as well as minimize the energy consumption of entire network. According to whether data aggregation is adopted, we formulate the respective optimization problems and present corresponding practical algorithms. Theoretical analysis validates the effectiveness of the proposed formulations and algorithms by comparing the energy consumption with some baseline algorithms.

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1. INTRODUCTION

1.1 Overview of Sensor Networks

A wireless sensor network (WSN) is a wireless network consisting of spatially dis-tributed autonomous tiny computing devices, each equipped with sensors, a wireless radio, a processor, and a power source. Sensor networks are envisioned to be deployed in the physical environment in order to monitor a wide range of environmental phenomena.

Previously, sensor networks consisted of small number of sensor nodes that were wired to a central processing station. However, nowadays, the focus is more on wireless, dis-tributed, sensing nodes. In most cases, the environment to be monitored does not have an existing infrastructure for either energy or communication. It becomes imperative for sen-sor nodes to survive on small, ¯nite sources of energy and communicate through a wireless communication channel.

Sensor network application like weather monitoring needs data like temperature, baro-metric pressure etc called as sensing modalities, there exist different sensors to sense each sensing modality. Various steps involved in sensor node applications are generally divided into

1. Data Acquisition network
   - Monitor and collect data
   - Assessing and evaluating the information
   - Storing
2. Data Distribution network
   - Serve useful data to external network (web)

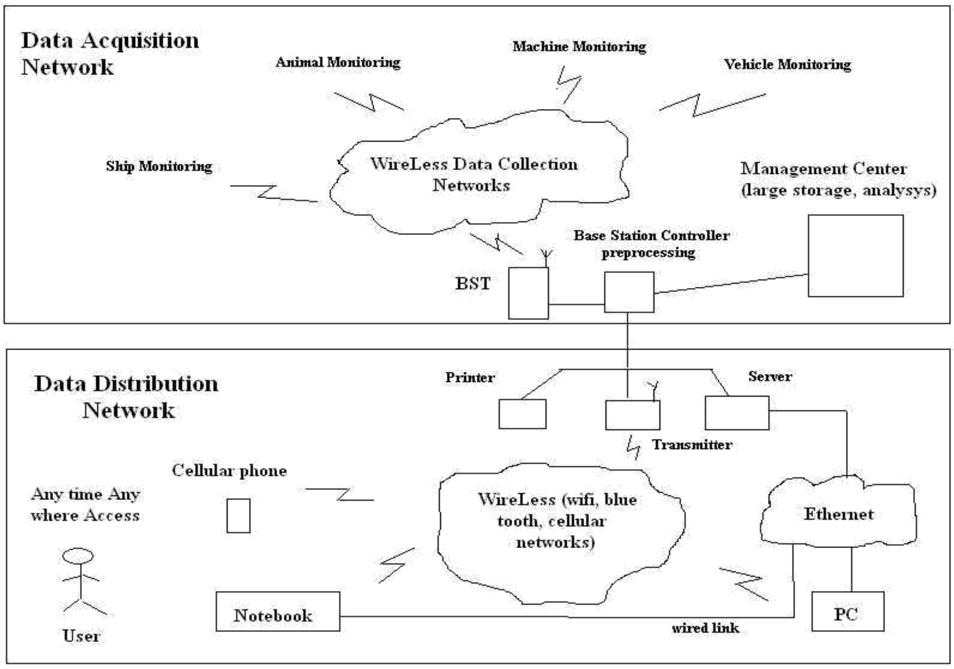


Figure: Overview Of Sensor Networks

1.2 Applications of sensor networks

Sensor nodes come in different sizes varying size from shoe-box to very small size there are many sensors which can be embedded in to many structures like walls, machines etc to monitor the changes. Sensor networks have a variety of applications.

1.2.1 Machinery Monitoring

Wireless sensor nodes can be mounted on various parts of machinery and plant to promote early fault detection and analysis. Their small size and autonomy enables their placement in locations that are usually difficult to access. In addition, it is also possible, with minimal changes to the machine configuration, to deploy sensors on the machinery after it has been installed. The sensor nodes cannot only monitor their own output but also collaborate with neighbouring nodes to determine the health of the overall machines and provide early warnings of potential failure.

1.2.2 Volcanic Monitoring

Today's typical volcanic data-collection station consists of a group of bulky, heavy, power-hungry components that are difficult to move and require car batteries for power. Remote deployments often require vehicle or helicopter assistance for equipment installation and maintenance. Local storage is also a limiting factor stations typically log data to a Com-pact Flash card or hard drive, which researchers must periodically retrieve, requiring them to regularly return to each station. These volcanoes can be monitored[12] by deploying sensor nodes in a distributed fashion, these nodes will collect seismic and acoustic data on volcanic activity, then they transfer the data collected to a central base station with the help of radios. These nodes are small and power efficient so that they can operate for longer durations than the traditional machinery.

There are many other areas where sensor networks play vital role, few of them are

- Environmental monitoring
- Animal tracking
- Vehicle tracking
- Weather monitoring
- Network monitoring
- Medical Care
- Seismic Detection etc.

Sensors

Sensors are hardware devices that produce measurable response to a change in a physical condition like temperature and pressure. Sensors sense or measure physical data of the area to be monitored. The analog signal sensed by the sensors is digitized by Analog-to-Digital converter and sent to controllers for further processing. Sensors are classified into three categories.

1. *Passive, Omni Directional Sensors*: Passive sensors sense the data without actually manipulating the environment by active probing. They are self powered i.e energy is needed only to amplify their analog signal. There is no notion of direction involved in these measurements.

2. *Passive, narrow-beam sensors*: These sensors are passive but they have well-de¯ned notion of direction of measurement. Typical example is camera.

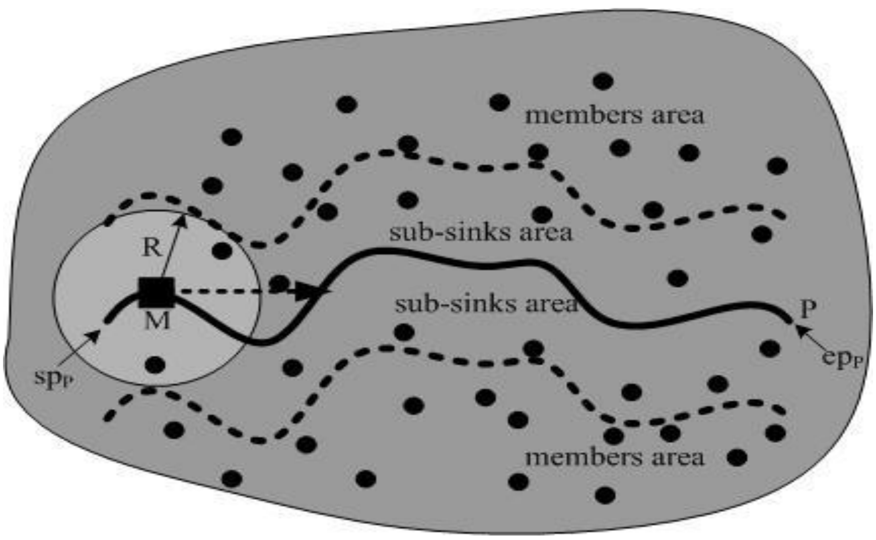
3. *Active Sensors*: This group of sensors actively probe the environment, for example, a sonar or radar sensor or some type of seismic sensor, which generate shock waves by small explosions.

2. RELATED WORK

Guo et al. (2014) [1] investigated problem of joint wireless energy replenishment and mobile data gathering for rechargeable sensor networks is studied. In particular, a multi-functional SenCar is deployed in the sensing field to charge the visited sensors via wireless energy transfer and simultaneously collect data from nearby sensors via multi-hop transmissions. An anchor point selection algorithm to determine the sensors that should get recharged with higher priority and the sequence of the anchor points that the SenCar visits is proposed. Then the WerMDG problem is formulated into a network utility maximization problem by taking into account the overall energy consumption and the time varying recharging rate. Pottner et at. [2] introduces method for the construction of schedules and evaluated it in a real industrial setting. An algorithm to find best schedule and presented suitable heuristics to reduce the computational complexity is proposed. This approach considers not only requirements in terms of data delivery latency and reliability, but also reduces transmission power which is important for industrial scenarios. A framework for schedule life-cycle management to constantly adapt to changing environmental conditions is also discussed. Evaluation was carried out on a real-world wireless sensor network deployment in an oil refinery in Portugal. The results show that while the computation time can be reduced significantly by using the heuristic, the energy signature and the length of the epoch is increased. Still, the savings in computation time outweigh the increases. Yao (2015) et at. in [3] proposed EDAL, an Energy-efficient Delay- Aware Lifetime-balancing protocol for data collection in wireless sensor networks is proposed, which is inspired by recent techniques developed for open vehicle routing problems with time deadlines (OVRP-TD) in operational research. The goal of EDAL is to generate routes that connect all source nodes with minimal total path cost, under the constraints of packet delay requirements and load balancing needs. The lifetime of the deployed sensor network is also balanced by assigning weights to links based on the remaining power level of individual nodes._Ming et at. proposed a mobile data-gathering scheme for large-scale sensor networks.We propose a spanning tree covering algorithm for the single M-collector case.For some applications in largescale networks with strict distance/time constraints for each data-gathering tour, we introduced multiple M-collectors by letting each of them move through a shorter subtour than the entire tour.

3: EXPERIMENT EVALUATIONS

3.1: Problem Statement



An example of a path-constrained mobile WSN

Experiment Parameter:

R: Communication radius of mobile sink

M: Mobile Sink

P: Path Length

3.2 Proposed Approach

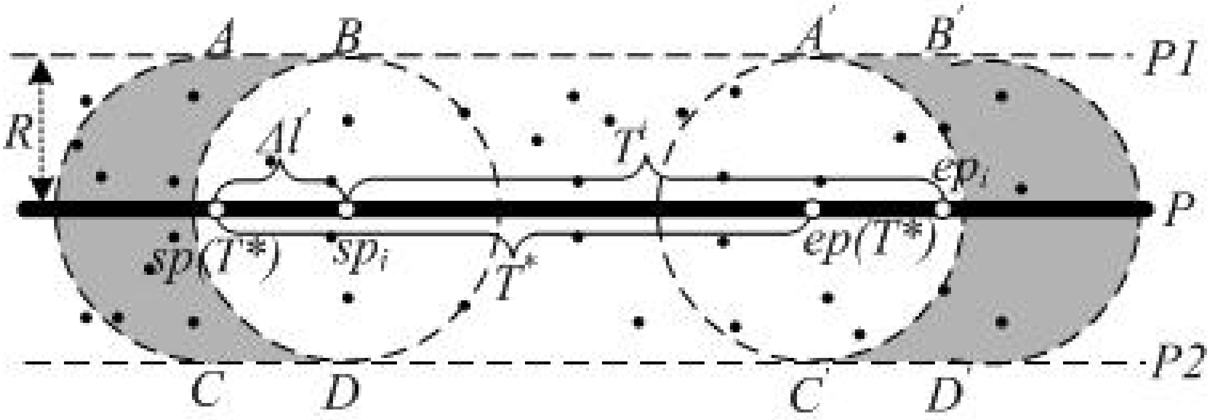


Fig: Accuracy analysis of FPFL-Ag-ES

sp(T*) : Start point of optimized path T*

ep(T*) : End point of optimized path T*

Ti : Sink path from spi and epi

Δl : Distance between sp(T*) and spi

3.3 Proposed Algorithm

Input: the set of sensor nodes S = s_u , u=1,…. ,n total; a fixed path p with the length l; the length of the partial path T is lmax = v*d/2; scale length Δl .

Initialization: calculate the iterations of the exhaustive operations m = l-lmax/2; the vector recording the number of the sub-sinks nss[1….m] = 0.

Main:

1. Find m start trial points of the sink spi(i = 1,….,m) on P, such that

    1) sp1 = spp and |**sp**m**ep**p| = l – lmax ;

    2) ~~y~~i < m,|spispi+1| = Δl. Find m end trial points of the sink epi(I = 1,…,m) on P such that ,|spiepi| = lmax .

2. For 1 <=i<=m, calculate the current set of the sub-sinksSSi along the path from spi to epi . Let nss[i]. = |SSi|.

Output: Optimized path T from start point spi and end point epi is chosen, such that i= arg. max **n**ss[i].

3.4 Parameters

Parameters	Value
Length	2 meter
total distance	5000 meter
Radius	100 meter
time to gather data	5 minute
Velocity	10 km/hr.

3.5 Implementation

```
#include<bits/stdc++.h>
#include<fstream>
using namespace std;


long long int count[5000];
typedef pair<int,int> pa;  // pair for nodes value
vector<pa> a;



void check(int x1,int y1,int r,int max,int o)      // for counting no. of sub sink at a particular point
{


    for(int i=0;i<max;i++)
    {
        int dist=sqrt((x1-a[i].first)*(x1-a[i].first) + (y1-a[i].second)*(y1-a[i].second));

        if(dist<=r)
         ::count[o]++;

    }
```

```

}

int main()
{


 ifstream infile;
 ofstream outfile;
 infile.open("input.txt");
 outfile.open("output.txt",ios::app);


long long int r=100,max,i,j,t,l=2,p=5000,n,x,y,final,o,maxva;



//now here we will run this program 50 times for different different values of max(nodes)
//={50,100,150,200,250}

//for every run of 50 nodes we will find the averge result(maximum no. of sub sink)and so on for
//100 nodes ,200 nodes

```

```
//finaly we will draw a bar graph of no. of nodes v/s maximum sub sinks
// l is length after iteration , p=5000 m total distance


t=1;
srand(time(NULL));
long long int pre_ra=0,ra=0;

while(t--){

    final=0;o=0;maxva=0;

    infile>>max;//max no.of nodes  ,  r= radius of sub sinks

    memset(::count,0,2500);         // initialize "count" be 0

    _sleep(200);

    for(i=0;i<max;i++)
    {
            ra=rand();
            //cout<<ra<<"\n";
```

```
            ra=rand();
            //cout<<ra<<"\n";

        x=ra%500;  //function for creating random values of nodes
        y=(-250)+ra%500;

        a.push_back(make_pair(x,y));
    }
    pre_ra=ra;

    for(j=0;j<p;j++)    // loop for iteration after "l" length
    {
        check(o,0,r,max,o);  //call check() function
        o=o+l;
    }


//  for(int i=0;i<p;i++)
//   outfile<<::count[i]<<endl;  // print no .of active sub sink at each point

    int win=(5000/6),m=0;  // here win is windows size which is v velocity=10km/hr * time of gathering

    for(int i=0;i<win;i++)    // find maximum value of a subarry for a "win"  sliding window
```

```
    for(int i=0;i<win;i++)    // find maximum value of a subarry for a "win"  sliding window
    {
        m=m+::count[i];
    }
    int val,c=0,start=0,end=win-1;
    maxva=m;
    for(int i=win;i<p;i++)
    {
        val=::count[i]+maxva-::count[c];

        if(maxva<val)
        {
            maxva=val;
            end=i;
            start=c+1;
        }

        c++;
    }

    final=final+maxva;  // "final" will calculate the sum of all the maximum no. of sub sink
    //after every step.
```

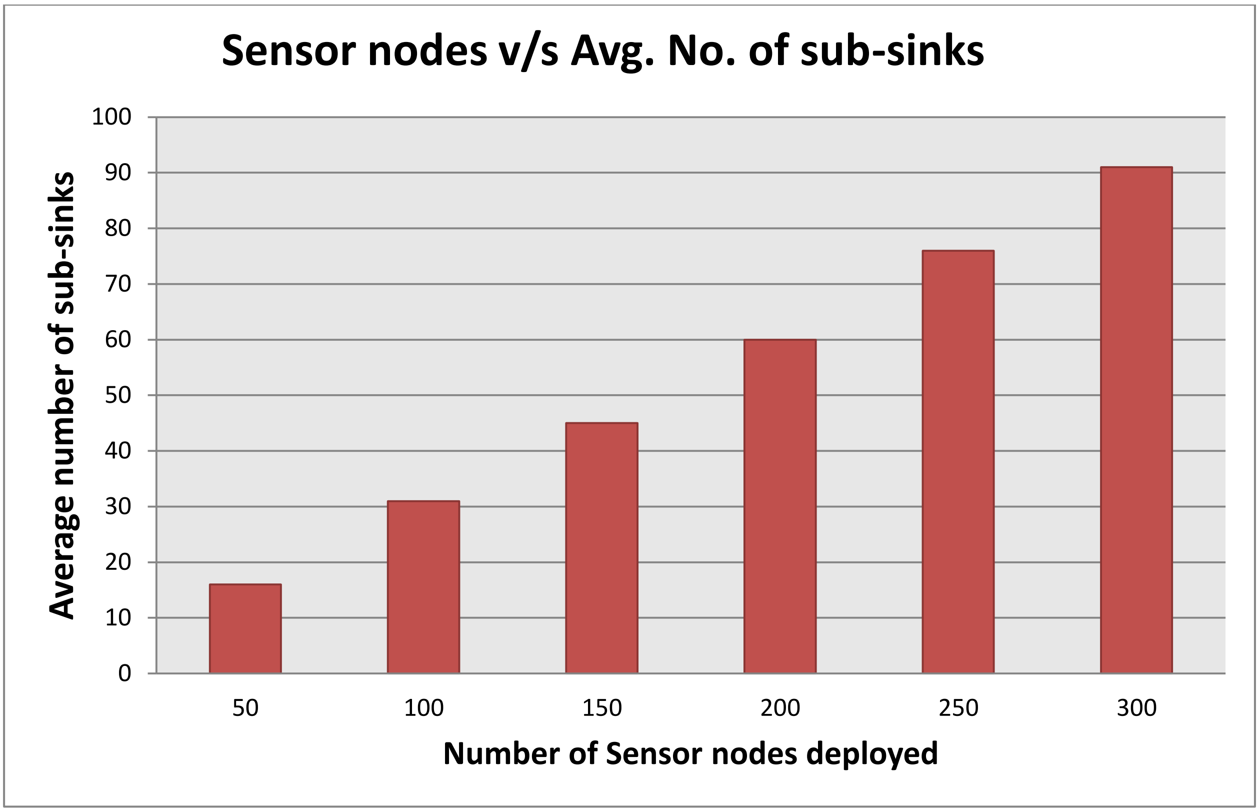
```

    outfile<<"\n\n\nMAX::: "<<maxva<<" START::"<<start<<" END::"<<end; //print index of starting
    //and ending point of a sliding window

}
outfile<<"\n\n\nthis is average of 50 runs"<<(final/50)<<endl; // average result of 50 runs*/
infile.close();
outfile.close();
    return 0;
}
```

4. EXPERIMENTAL RESULTS

Result -1

Maximum number of nodes deployed	Total number of sub-sinks
50	16
100	31
150	45
200	60
250	73
300	92

Result-2



5. CONCLUSION

This report discusses in details the various approaches to gather data in wireless sensor networks. It provides a detailed view of the different applications and potential challenges of data gathering in various WSN models that makes it a difficult task. We have seen the applications of wireless data gathering techniques in fields like Military, Health Care Monitoring etc.

We study the path selection problem in randomly populated wireless sensor networks with a path-constrained mobile sink. Based on the data aggregation model that is adopted, we formulate the corresponding optimization problems. For that problem, we propose an exhaustive search based algorithm.

Theoretical and graphical analysis is done, about the algorithm performance.

Experiment simulations based on C++ shows that the proposed algorithms can achieve satisfactory performance of the proposed algorithm.

As future work, we intend to extend the path selection problem in delay-guaranteed sensor networks. We also plan to study the path selection problem with network lifetime maximization as the optimization objective.

6. REFERENCES

[1] Guo, Songtao, Cong Wang, and Yuanyuan Yang. "Joint mobile data gathering and energy provisioning in wireless rechargeable sensor networks. "*Mobile Computing, IEEE Transactions on* 13.12 (2014): 2836-2852.

[2] Pöttner, Wolf-Bastian, et al. "Constructing schedules for time-critical data delivery in wireless sensor networks." ACM Transactions on Sensor Networks (TOSN) 10.3 (2014): 44.

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[4] Ming Ma, Yuanyuan Yang, and Miao Zhao ,"Tour Planning for Mobile Data-Gathering Mechanisms in Wireless Sensor Networks ",IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 62, NO. 4, MAY 2013