MONITORING PARKING AREA USING MAGNETIC SENSORS IN A PERVASIVE ENVIRONMENT

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ABSTRACT: The parking of vehicles by the drivers at inappropriate places is due to the unawareness of proper parking places. In order to control the congestion occurring at the road every day and to park the vehicles at available space, the magnetic sensors are deployed in the appropriate parking places along the road. The neighbouring sensors are within the communication range of each other. A magnetic loop is deployed below the ground detects the presence of the vehicle. The communication between two sensors provides the information about the presence of the vehicle. The information is continuously sensed for a time period t, which is fetched by the driver [user] of the vehicle from the server. Base station serves as the gateway between the sensor network and the server.

KEYWORDS: magnetic sensor, base station, magnetic loop, congestion, gateway, server.

INTRODUCTION

In the present day monitoring the parking space is not an easy task, due to the usage of vehicle has been increased to a greater extent. Utilization of vehicles can't be minimized rather managing those vehicle movements could be organized in such a way that it does not cause congestion on roads. Parking the vehicles at inappropriate places leads to the congestion of the road.

The driver of the vehicle must be aware of the parking space in order to park the vehicle in such a way that it does not cause congestion on roads. The driver uses a handheld PDA to access the information. Initially the magnetic loops are placed below the ground, and then the sensors are deployed two meters apart at places where the vehicle should be parked.

The vehicles manufactured have some ferrous content on it. The magnetic loop gets deflected when a vehicle is stationary or passes over it. This deflection brings a small voltage change in the magnetic sensor and thus detecting the presence of the vehicle. Deflection is because the magnetic loop gets disturbed when a ferric (iron) content vehicle passes over it, since magnet attracts iron this happens. The corresponding change in voltage is determined based on the deflection of the magnetic loop. When a vehicle is detected by a sensor it passes the information to the neighbouring sensor as a vehicle is engaged between the two sensors which are within the communication range. In this way all the sensors sense and send the information to their neighbours.

When a vehicle is not detected it sends information that the space between the two neighbouring sensors is free and no vehicles are engaged between them. The information is sent in the form of a tree. The tree has a cost to represent to the user whether there is a vehicle being occupied between two sensors. The cost is a metric to detect the presence of a vehicle. Finally the information

reaches the base station in form a tree; the base station forwards it to the server where the user can access the information. Microcontroller maintains a time period say 1minute, for every one minute the information is sensed and sent as a tree to the server. Thus for every one minute the data collection tree is being updated in the server. After the time period, the microcontroller resets the timer. The user (driver) can request from the server via a handheld PDA where it displays the information of parked vehicles and available spaces. The information between two sensors is communicated by flooding protocol.

There are three more sections which describes the paper. Section 2 describes the work flow of the proposed work, tree formation and tree initiation is discussed in section 3. Vehicle detection is discussed in section 4. Section 5 deals with flooding of the information. Related work is discussed in section 6 and section 7 deals with the conclusion.

ARCHITECTURE

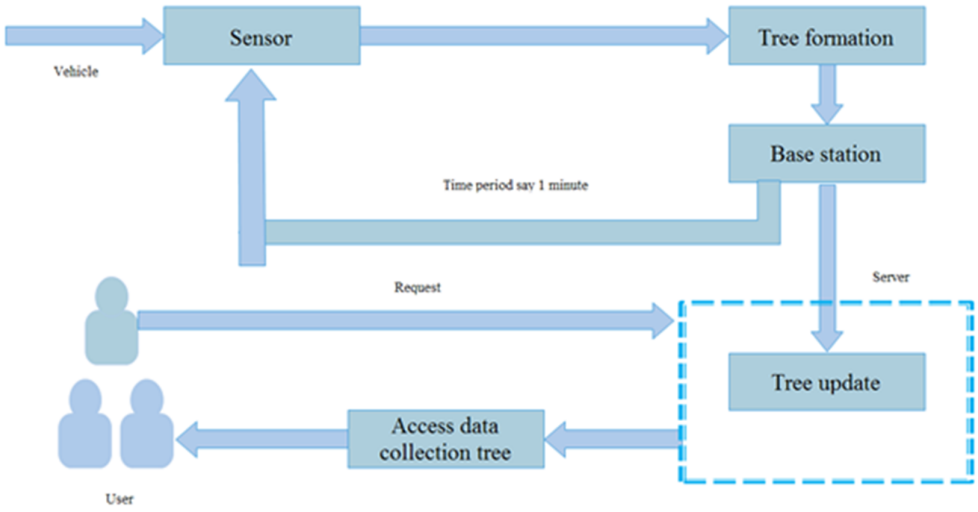

Fig 1. Architecture

It describes the basic work flow of the proposed work. This gives an outline of how the information flows. The information is that which are sensed by the sensors. The processing is done at the server and the results are updated [3]. The results are usually in the form of a tree and the tree is frequently updated. The user gets the results in the form of a tree which represents the free space at a particular region. Since the data collection tree is updated for every one minute, the information collected at the server is reset and a new tree is formed for next time period t.

Fig. 1 depicts the flow, where the information is updated for every one minute. The base station forwards the data to the server as an entire tree. The user queries and extracts the tree. The static sensor network is used since all the sensor nodes are stable and do not move even after deployment. The magnetic sensor is of type active. The ferric content of the vehicle is taken as an input by the sensor and a corresponding voltage deflection is produced as an output.

The deflection determines the occupancy of the vehicle. If there is no deflection then there is no vehicle sensed by the sensor at that instance of time. After sensing the vehicle, the cost based tree which assigns a cost as 1 between two sensors if there exists a vehicle or portion of the vehicle lies in this space. The cost is 0 when there is no vehicle or portion of the vehicle is between the two sensors.

TREE FORMATION

The tree is formed among the sensors deployed in the road. Sensors represent the nodes of the tree while the edges between the sensors represent the communication between them. The tree is formed for every one minute interval and then updated at the server. The tree is initialized when the sensor senses the vehicle. Moreover the cost is assigned between the sensors while the tree is formed. The cost indicates the occupancy of the vehicle between two sensors.

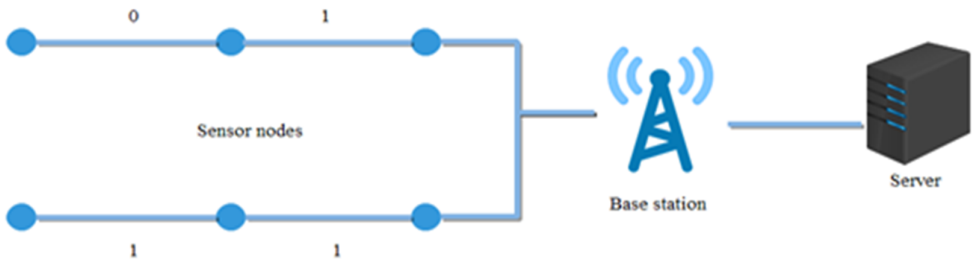

Fig 2. Tree formation (cost based)

Fig. 2 depicts the tree formed between sensors and the cost between them is represented by the edges between them. The cost is either 1 or 0 which represents whether the vehicle is present or not. The information is aggregated as a tree at the base station and then routed to the server for processing.

Performance

This deals with the performance of the data collection tree in the following aspects.

Scalable: The tree is scalable to many numbers of nodes. There is no restriction regarding the tree formation, since the communication is between two neighbouring sensors.

Reliable: There is a minimum chance for the loss of connectivity and loss of data. The neighbouring nodes of the sensor are in the area of coverage and thus failure of communication is minimal.

VEHICLE DETECTION

Vehicle is detected when the magnetic loop is disturbed; this is due to the ferric content of the vehicle. When a vehicle is parked the magnetic loop vehicle detector which is deployed below the ground is deflected causing a variation, this variation is detected by the sensor and then communicated to the neighbour sensor indicating a vehicle is occupied. After the vehicle is moved the loop is set back to normal position.

Vehicle Occupancy and Free space

The number and type of the vehicle is not focussed here rather the presence of the vehicle and the available space are given importance. The occupancy of the vehicle is determined by the cost assigned between the neighbouring sensor nodes. $O_v(u, v)$ is occupancy of the vehicle between two neighbouring sensors.

u - Sensor node.

v - Neighbouring sensor node for u.

(u, v) - Pair of neighbouring nodes.

Occupancy of the vehicle can either be 1 or 0 detecting whether the vehicle is present or not. Equation (1) represents, the vehicle is not present between the pair of sensors

$$O_v(u, v) = 0. \qquad (1)$$

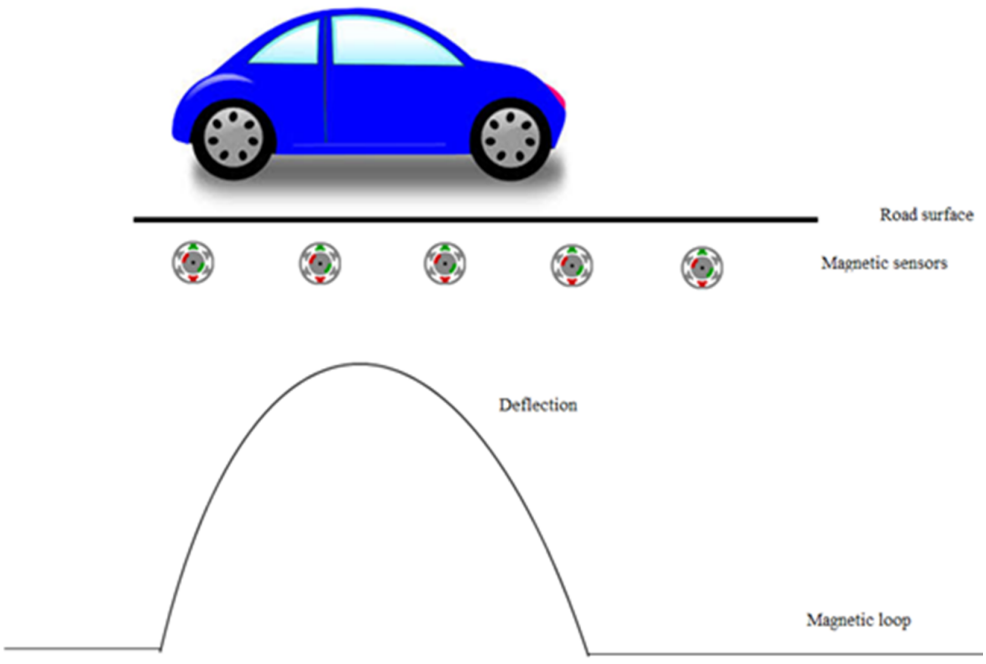

Fig 4. Vehicle Detection

Equation (2) represents, the vehicle or portion of the vehicle is occupied between the pair of sensors.

$$O_v(u, v) = 1. \qquad (2)$$

In fig. 3 The car occupies four sensors and the occupancy between these sensors are 1, since there is a deflection set by the magnetic loop is sensed by these four sensors due to the presence of the vehicle.

DATA COLLECTION AND AGGREGATION

The sensors after sensing the information sends it to the neighbour node, this can be done by flooding protocol. The flooding is done only to the selected neighbour. Each sensor node has two neighbouring nodes where one sends the information and another neighbour receives the information. A node u floods the information to the node v which is the child node of u (C_u). Thus all the nodes flood the information to their child node.

C_u - Child node of u.

Finally tree is updated at the server and then the user requests and extracts the information from the server.

Algorithm

While t>1minute
If deflection exists there is a vehicle between the sensors
Then $O_v(u, v) = 1$
Else
$O_v(u, v) = 0$
Flood $M_u(O_v(u, v))$
V ⟵ C_u
End if
End while
M_u – Message or information from the node u.

The information between each pair of the nodes is different and is independent. Every pair contains unique information

while communicating between them and all those sensed information must be reached as a tree to the base station.

RELATED WORK

Different approaches for controlling the traffic congestion have been studied earlier. Deploying RADAR sensor is one of a kind, where the line of sight of the beam is an overhead. In addition to it the complexity and cost involved is more when compared to the proposed work.

CONCLUSION

Parking the vehicles in busy roads is quite difficult. Determining the status of the parking area for available space, required for parking is proposed in this paper. The driver can access the information from the server via handheld PDA. Here the data is collected and represented in the form of a tree to the user. The driver can decide whether to park the vehicle in the available space or does the vehicle can fit in the free space could be determined by the information provided in the form of a tree. This approach could minimize the traffic congestion on roads. The main discrepancy is that the energy of the sensor. It consumes more energy for communication. This issue could be overcome by recharging the sensors in a static wireless sensor network, when the energy level falls below a threshold. This could be enhanced as a future work. The experimental evaluation with results could also be enhanced as a future work.

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