

Remote Monitoring And Localization: Tools For Smart Parking

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Abstract: The increase in usage of IoT environment is beyond the limits, which use Wireless (WSN). These networks can be used in many environments like logistics, supply chain management, health management, e-governance, smart parking, smart city, and smart appliances. WSN is a collection of sensors spread across them to base station/sink. Remote sensing sensors do sensing of an object remotely and detect the static or dynamic information. In this paper, discussion is made on how to monitor and track the person's car within a shopping mall. Remote monitoring and local optimization techniques are used in smart parking architecture, which suits for smart parking environment. Further, description of some of the monitoring and tracking techniques which was used earlier also been discussed with different types of protocols used for this appropriate environment. These systems can be implemented for effective smart parking.

Keywords: Localization, Monitoring, Clustering protocol, WSN, Sensors, Remote.

1. Introduction

The smart Parking environment comprises of WSN, base station, sink, number of sensor nodes distributed over a given region. The sensor nodes basically sense every type of node and its activity is based on the sensor type which access and gather information about the environment which is then transmitted to the base station. The base station keeps a record of all the data sent by all the nodes and the time of receipt of that data. Sensors can sense and log the temperature, pressure and humidity of the environment, fire, light sensing, pressure of tyre etc.,

Since, all the nodes are wireless and linked to base station, these nodes can be linked to stationary access points at different key locations within the smart parking environment. The access points will be connected to a base station through a wired /wireless medium. The transceivers connected to each individual will have wireless access points. Access points have a limited range restrictions where the data's can be transferred only within the specific range and the connection exist only between nodes and access points.

Localization is the process of detecting the exact physical position/location of sensor nodes. Localization in vehicle is implemented with the help of GPS[1]. WSN are used in applications such as Industrial Control System, Smart Home, Smart Grid, Smart City, Environmental Monitoring, Military Surveillance, Vehicle Tracking, Tracking of Animals i.e. Smart Farming, Waste Management, Smart agricultural field. Node Localization plays a vital role in all these applications related to IoT.

2. Designing Hybrid Methodology

An efficient localizing and remote monitoring of vehicles are done by using LEACH algorithm and HiRLoc algorithm. Surveillance camera also helps in effective usage of space in parking lot, car theft, behaviour monitoring etc. The main concept of this paper is to look at the routing and localization process and not based on energy efficient criteria. Server and database present in the sink represents access points of sensor and transceiver node. A tree topology is been constructed so that the node has direct communication to the root nodes and then the connection exist between the root node and the base station/sink. All the access points will be connected to the root nodes by means of a wired transmission medium. A star topology is used further to connect the access point with different nodes in the cluster. The usage of algorithms is described below

2.1 Leach

LEACH is a clustering method in real time which stands for Low-Energy Adaptive Clustering Hierarchy which works on random probabilistic method of uncertainty[2] with a two-tier WSN. LEACH is a dynamic/real time clustering and routing protocol [3][4] which can localize and minimize the energy but can maximize the efficiency of energy. LEACH is divided into many clusters and each group of nodes have a cluster head, which is linked to the sink node. LEACH algorithm picks cluster head randomly every time when the data transmission and

data fusion occurs. LEACH protocol has a single hop transmission. The data from all the nodes is been aggregated and sent to the Cluster head [5], which is passed to the base station/sink node finally. The LEACH process occurs in 2 stages. They are: steady phase and set-up phase [6][7]

2.1.1 Set up phase

Set up phase is like an initialization phase where every node has a random number generation of 0 to 9, if the values of the random number is below the threshold value, then it is assigned to be the Cluster Head for all nodes. At this stage, the data is been collected by the Cluster Head from its adjacent nodes and the collected data is transferred to base station. The Cluster Head (CH) are chosen randomly and whenever the data transmission occurs cluster head is been changed so that each node becomes as a Cluster Head at least once in its life time. The threshold value is calculated by,

$$T(n) = \frac{P}{1 - P * (r \bmod P^{-1})} \forall n \in G$$

$$T(n) = 0 \quad \forall n \in G$$

Where n is a random number between 0 and 1

- P is the cluster-head probability and,
- G is the set of nodes that weren't cluster-heads the previous rounds

- If $n < T(n)$, then n is assigned as a cluster head (CH)

2.1.2 Steady State Phase

After the Cluster Head Selection, the data transmission and data fusion occurs between the nodes.

EVENT 1: All the nodes which is interconnected to cluster head receives the message as advertisement packet using CSMA (Carrier-Sense multiple access) to broadcast the message that it became as a cluster head based on the probabilistic random model.

EVENT 2: The non-cluster head nodes transmits the message through transceiver, only when the message is to be transmitted.

EVENT 3: Time slot allocations are given to the nodes in Cluster Head by TDMA (Time-Division Multiple Access) so that the node transmits the data only in their allocated time slot. TDMA is used mainly for mobile communication which divides the cellular channel into various time slots for higher data transmission to be carried out.

2.2 HiRLoc

HiRLoc is a range-based node localization algorithm. High-Resolution Robust Localization for WSN. HiRLoc as the name itself indicates it is robust against all the attacks on WSN [7]. The nodes can be either anchor (Location known) \ locator node (location unknown). The Locator/Anchor nodes transmits beacon nodes with location information. The beacon signal gives information about angle of antenna, locator communication range, coordinates of locator node. Locator node updates information whenever data transmission takes place. Multiple directional antennas is used to cover all the directions. The estimation of Region of Intersection (ROI) is based on TOA (Time On Arrival) and TDOA (Time Difference of Arrival) [8], AOA (Angle of Arrival) and Received signal strength [9][10]. HiRLoc increase the complexity of computation and communication.

3. Proposed Monitoring Environment

The proposed work implementation idea is, each car will be tagged with RFID [11] and an external transceiver and it will be connected wirelessly. The sensors will be used to sense the physical location of the presence of car [4] and these data will be sent to transceiver module. An algorithm will be inserted into the transceiver such that if a data has any such deviations in sensors, it should be reported to base station/particular access points by having fault tolerance methods. This helps in identifying whether the car is in working condition or not, the pressure of tyre is been good or not. The flowchart below describes the LEACH Protocol and the proposed network.

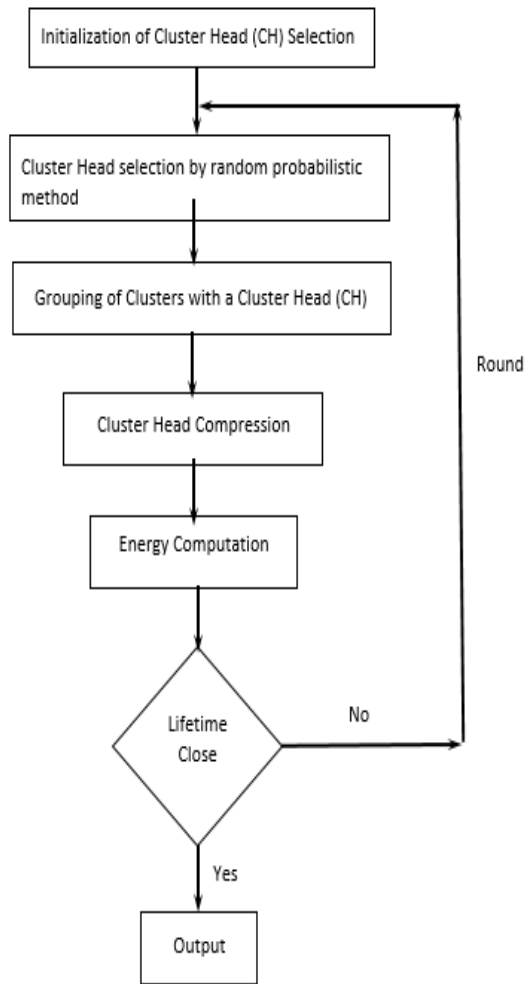


Fig 1. Flowchart of LEACH Algorithm

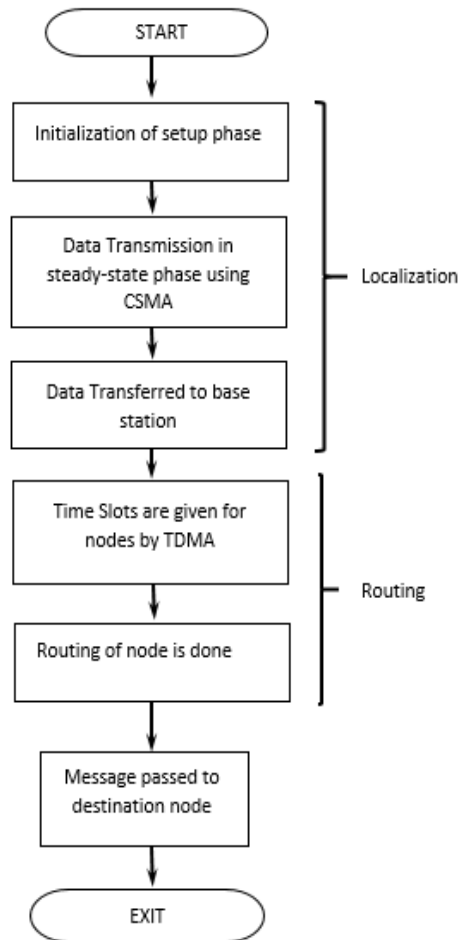


Fig2. Flowchart for Proposed Algorithm

Another algorithm has also been implemented to the transceiver module, such that the module works only in the working hours of shopping mall, condos etc., Whenever a car enters into the zone of condos , shopping mall , the transceiver module will be connected to the nearest access points in the particular zone. A server and a database will be maintained at the base station. The database has details such as node ID and the details of person using the node. At the base station, the operator can monitor and track resources with the help of database server. The information from the database keeps track of all information related to monitoring, tracking and localizing. The key concept involved here is explained in two phases such as clustering and routing.

3.1 Clustering Phase

When a set up is initialized for a node, it connects to its nearest access point. Group of nodes form as a single cluster with a Cluster Head which is linked to the Base Station. This phase is connected to a Smart Parking IoT environment, using LEACH Mobile algorithm for dynamic clustering and routing. According to LEACH algorithm, the Cluster Head is selected randomly or the highest energy level node can be the Cluster Head. After the selection of Cluster Head, the advertisement message using CSMA, broadcasted within a limited/ specified range. The Cluster Head registers the notification that the node receives the advertisement message. If more than one node, it receives the advertisement message from more than one Cluster Head, then the TDMA mechanism to be used for the transmission of nodes in allotted time slots. Data Transmission takes place only after the completion of localization process.

3.2 Localizing Phase

The proposed work is to keep track of all the vehicles in the parking lot. HiRLoc algorithm is used for localization which has anchor/locator nodes and normal nodes. Anchor nodes have the prior details of geographical location. The anchor nodes transmit Beacon signals using multiple directional antennas. Beacon signals have details about location coordinates, communication range. Range of Interaction is used to identify the location of normal nodes. After completion of Phase 1 and Phase 2, the node will continuously send its location coordinates along with its MAC address/Node ID to the sink through its nearest access point. Once the message reaches to the

base station, the server will process the entire message and it will forward to database where the vehicle Id of the particular node will be stored using the MAC address of the node. The particular vehicle is been tracked every moment and a record will be kept in the database. In case of any emergency, an alert will be generated at the server of base station along with individual's name, car details and its location coordinates to prove the system as a fault tolerance thereby improving system efficiency.

3.3functional Components

The functional components used are sensor node, transceiver node, access point and Sink/Base station.

3.1.1.Sensor Node

The sensors are used to sense different criteria's like pressure, fire etc., detect the space of parking lot whether it is occupied or not and WSN is used for navigation monitoring[6].

3.3.2 Transceiver Node

A transceiver node has a power supply button and it is switched on only when it receives the sensed data from sensor and when the data transmission is been carried out, since it is very energy efficient.

3.3.3 Access Points

Access Point nodes can allot time slots using TDMA. The access points transmit advertisement messages to its range by establishing connection between the node and the Cluster Head using CSMA. At the time of clustering process, it acts as a Cluster head and during localization process it acts as an anchor node. Multiple Directional Antennas is used to send and receive messages from all directions.

3.3.4Sink/Base station

Data fusing and data broadcasting takes place with the help of server and database. Server located in the base station process the data from all the nodes inside the cluster and updates the stored information as a record to the database. The database maintains a record of all details such as node id/ MAC address, ownership of the node, time slots allocated for different nodes, location coordinate position.

3.4.Pseudocode Of Proposed Work

The detection of parking space and tracking of navigated vehicle is done by LEACH and HiRLoc algorithms in WSN[12] [13]. The following are the steps to be carried out in implementing the proposed work:

1. Choose the nearest access point.
2. Broadcast packet advertisement message from Cluster Head to all Cluster nodes using CSMA.
3. Connection is established to access points.
4. Receive Beacon signals from access points.
5. Estimate range of Interaction to identify the location range coordinates.
6. Transmission of data takes place with node ID/MAC address with the help of allocating time slots using TDMA.
7. Repeat steps 1 to 6 until all the nodes become as a Cluster Head atleast once.

4.Conclusion

In this paper, the algorithms LEACH-mobile and HiRLoc is used to obtain the location information and to keep track and monitor the vehicles remotely by implementing this module. To keep track of vehicle efficiently in the car parking slot space, there exist a challenge and this paper concludes that the probabilistic model of LEACH algorithm is more suitable than deterministic model as it involves less computational complexity and higher efficiency. The future researchers can transfer this sensor information sent to Cloud-server-side application is to be managed and secured ,the geo positioning, parking lot space etc., has to be encrypted with Homomorphic algorithms and the privacy identity of secret information's should be masked by differential privacy and zero proof knowledge.

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