ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 3, March 2014

Framework for Ease Maneuver of On Road Emergency Vehicles: Using Mobile Sink

Satheeskanna K[1], Praveena V[2]

M. Tech Student, Dept of CSE, SRM University, Chennai, India[1]

Assistant Professor, Dept of CSE, SRM University, Chennai, India[2]

ABSTRACT:In order to make timely and correct decisions and to avoid potential accidents, moving vehicles on the road need to acquire real time traffic flow and road information directly from WSN with the help of telematics services. The concept proposed in this paper involves the use of multiple metric to promote emergency vehicle an ease of transport during their crucial hours of time. This includes a proposal of a practical and scalable approach for point-to-point routing in wireless sensor nets which aims at providing the shortest path for emergency vehicles to save time, and to enable a robust paradigm for sensor network to change the primary path of the emergency vehicle dynamically. In addition to these, this paper also indulges in the proposal of analysing real-time traffic flow parameters using image sensors and controlling the congestion on priority basis.

KEYWORDS: Wireless sensor network, Routing, Dynamic, congestion control, emergency vehicle.

I. INTRODUCTION

Traffic management being a vast domain, WSN can be applied to gather information about the incoming flow of traffic, traffic load on a particular road, traffic load at particular period of time (peak hours) and in vehicle prioritization. Because of the recent developments in wireless networks and multifunctional sensors with digital processing, power supply and communication capabilities, WSN are being largely deployed in physical environments for fine-grain monitoring in different classes of applications [1] [10]. One of the most appealing applications is critical conditionmonitoring

The proposal of an adaptive and dynamic traffic intersection system include first finding of shortest path for the emergency vehicle to reach its nearby health care zone from the accident area usinga scalable a point-to-point routing schemecalled Beacon Vector Routing or BVR method. The second module is to find a better dynamic path arrangement for emergency vehicle, because the traffic status is changed dynamically. To achieve a fault tolerant and low latency algorithm, called PEQ (Periodic, Event-Driven and Query-Based Protocol) is employed. The main purpose to adopt this algorithm than any other existing routing algorithm is that PEQuse ordinary motes, with no special hardware and a simple processing at each node by using the hop level as the main information to minimize data transmission. The next part of this paper deals with an adaptive traffic intersection system where traffic light of one intersection communicates with the traffic light of the next neighbouring intersections and controlling the congestion [2][3] on priority basis using Dedicated Short Range Communications (DSRC) protocol so that traffic clearance will be prioritized.

II. FINDING SHORTEST PATH

Beacon Vector Routing, or BVR, is a point-to-point routing scheme for wireless sensor network that is being employed here to find the shortest path. Several existing point-to-point routing algorithms are analysed by BVR to build a service which has guaranteed delivery, is robust with respect to a dynamic network, and is simple and efficient for wireless sensor networks. For each node BVR defines a set of coordinates and a distance function where the coordinates are vectors of distances to a set of beacon node which are not defined geographically, but on network connectivity. Greedy forwarding is used to accomplish routing. A distance function over current node's and destination node's coordinates is being used to determine the next hop. On occasion, the forwarding mechanism reaches a local

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minimum of the distance function, BVR resorts to routing the message to the beacon nearest the destination. This is known as fall-back mode. If the message cannot make progress towards the destination from the beacon, BVR resorts to using scoped flooding to guarantee delivery.

Let q_i be the hop count from node q to beacon i, and let r be the total number of beacon nodes. A node's q position : P(q) =< q1, q2, . . . , qr> where these nodes are assumed to have a unique identifier which in case that the vector of coordinates computed is the same, will differentiate one node from the other. The constraint is that for this algorithm to work the nodes must know their neighbour'spositions. The distance function takes two arguments, a node p and a particulardestination d. Here this metric measures how good node p would be as the next hop to reach node d.It is noted that the metric favourneighbour's whose coordinates are more similar to the destination, and always move toward beacons if the beacons are closer to the destination.

$$\delta_{ki}^{+}(p,d) = \sum_{i \epsilon C_{ki}(d)} \max(p_i - d_{i,} 0)$$

$$\delta_{ki}^{-}(p,d) = \sum_{i \epsilon C_{k}i(d)} \max(d_i - p_{i,} 0)$$

Where Cki(d) is the set of k closest beacons to d and δ_k^+ is the sum of the differences for the beacons that are closer to the destination d than to the current routing node p, while δ_k^- is a measure of the sum of the distances to the farthest beacons. Here the algorithms choose the next hop that minimizes $\delta_k^-$and if there is a tie, then is broken by minimizingδ_k^-. Actuallyit's to implement δ_k = Aδ_k^++δ_k^- for some large constant A.

In order to route a message to a destination d, a packet has three header fields: (1)the destination's unique identifier, (2) its position among the k closest beacons and (3) the minimum δ the node has seen so far. Here forwarding a message proceeds as follows: The packet carries the minimum δ it has seen so far, according to the metric defined above and thengreedily tries to find a neighbor which minimizes the currentδ. In case if it finds such a node,then it will forward the packet to it or else the node will forward the packet to the beacon closest to the destination d, by sending it to the node's parent in the beacon spanning tree. Here once received by the parent, then a greedy attempt to forward will be tried and if it fails all the way up to the beacon node, then a controlled flood, ensuring that the packet will be delivered in the worst flooding the network. A mechanism to maintain the beacon nodes must be provided because in sensornets nodes are prone to fail, so the algorithm for Beacon Maintenance works as follows. Here the beacon nodes will be constantly updating their sequence number. In case when a node detects that a beacon is not updating its sequence number after a certain amount of time, it will remove it from its set of beacon nodes. And also when the number of beacons is below a threshold r, then non-beacon nodes willnominate themselves as beacon nodes. Hence, if the number of beacon nodes goes over r then some beacon nodes will cease to serve as beacons, based on its identifier. A node maintains the highest sequence number and a parentalong the tree to every beacon. These combined can eliminate count-to-infinity problems, loops, and allows for the detection of dead beacons and thereby prevent duplication in finding the shortest path.

III. DYNAMIC PATH ARRANGEMENT MESSAGE

The Dynamic path arrangement message is used to find a better path for emergency vehicles, because the traffic statusis changed dynamically. If the emergency vehicle adopts thesame shortest path from the original position to the disaster area, the travelling time may be delayed. Thus, the emergencyvehicle will periodically transmit the dynamic patharrangement message to the centralized server and then thecentralized server will calculate the real-time shortest path and response the result in the emergency vehicle. But how to return the calculated result to the emergencyvehicle is a major problem, because the emergency vehicle dynamically changesits position.

The main motivation for the work described here is to provide support for all of the following requirements simultaneously: low latency, reliability, fast path recovery in the presence of failures and energy savings. In the presence of failures, a switch to a fast recovery mode has kept doing, keeping the exchange of information among neighbor nodes to a minimum, different from other solutions. To achieve this routing algorithm PEQ is employed, which is realized in three steps. The first step comprises the construction of the hop tree wherethe sink starts the

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process of building the hop tree, which will be used as a configuration and a subscription message propagation mechanism in the sensor network. The second step is about the propagation of subscriptions to the sensor network. The last step is responsible for delivering events from the sensors to the sink, by using the fast and less costly route, in terms of energy savings.

IV. Path Repair Mechanism

Auniqueand efficient (promotes low latency and saves energy) path is created for sending the notification message which can alsobe used for the driven delivery of new subscriptions (for query basedscenarios, for instance, that may require randomsubscriptions). However, since the path is unique, any failurein one of its nodes will cause disruption, preventing the deliveryof the event as well as the subscriptions. In addition the possible causes of failureinclude: low energy, physical destruction of one or more nodes, communication blockage, etc. Many routing algorithms for sensor networks have been proposed earlier, where some are based onperiodic flooding mechanisms [8] [9], rooted at the sink, torepair broken paths and to discover new routes to forward trafficaround faulty nodes. It found that this mechanism is not satisfactory in termsof energy saving because it wastes a lot of energy broadcastingrepairing messages. And also, during the interval of networkflooding, these algorithms are unable to route data around failednodes, causing data losses.

An ack-based path repair mechanism is offered by PEQ algorithm which consists of two parts: failure detectionat the destination node and the selection of a new destination. Immediately after the initial configuration phase, each node has only onedestination node to forward data to the sink, due to the single (shortest) path created. A node named sender, when needs to forward data to itsdestination, it simply sends the data packet and sets a timeout andwaits for the neighbor's acknowledgment. It can infer that the neighbor is alive if the sender receivesits neighbor's ACK. Therefore the sender node knowsthat its packet was properly forwarded whentheneighbor node sends the ACK message right after it hasforwarded the original packet, and hence there is no need forretransmitting the packet nor choose another neighbor. If in case the sendernode does not receive the ACK message, a problem must haveoccurred with the neighbor and another node should be selectedas the new target. At that time the sender immediately broadcasts aSEARCH message to its neighbors as a result the nodes will reply with amessage to the sender containing their hop level andidentification. Hence the next step is to select a new destination. Thesender chooses the neighbor with lower hop level to be its newdestination and then updates its routing table to ease theforwarding of subsequent packets. The sender sets its own hop level to be thedestination, hop level plus one, in order to avoid creatingclosed paths (loops). The sender node has to retransmit thismessage, if any neighbor does not reply theSEARCH message. If in case the node is isolated, the only solution is to increase itsradio range. Hence, here the backtrack mechanism is implemented, as any node may respond to the request, even nodes withhigher hop levels, including the originator of the packet. Thus the path will be reconstructed once the repairing mechanism is exploited.

V. An Adaptive Traffic Intersection System

Here in this module a framework of an adaptive traffic intersection system based on Wireless Sensor Network is proposed.Based on Dynamic path arrangement message received from the mobile sink of emergency vehicle, the sensors of traffic light [6] react in alignment to the sink notifications. There by the traffic light of one intersection communicate with the traffic light of the next neighboring intersections and traffic clearance will be prioritized for special vehicles with the help of sensors.

Suppose an emergency vehicle has to travel a hundred miles to reach its destination health care center via some city and on its way it has to pass through numerous intersections of the city. Then the vehicle will waste precious time at most intersectionsif the traffic system at those intersections is controlled by preset timers. This can result in an unnecessary chaos situation. In this paper, the primary aim is to gather the information about moving emergency vehicles based on WSN to provide them a clear path till their destinations and traffic signals should switch automatically to give a clear way for these emergency vehicles.

The adaptive traffic signal system that can do the following:

- Intelligent traffic signal system based on the volume of traffic on each side of the signal.
    - o Minimize the average waiting time.
    - o Maximize the average number of vehicles passing through the intersection.

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 Prioritization of vehicles serving an emergency purpose like ambulance vehicle.

In the proposed method, based on the dynamic path arrangement message on the emergency vehicle that the mobile sink transmitted, traffic intersection will be able to communicate with the next neighboring intersection signals in order to send and receive messages about any emergency vehicle movement which is hereafter will be referred as II (Intersection to Intersection) communication. Here sensors are also installed on the road between two intersections of a road which will help to intersection about the movement of emergency vehicle.

In case if there occurs any delay in the arrival of emergency vehicle at a particular traffic signal point, then at that chaos situation the timer in the mobile sink will calculate an approximate delay time and transmit it to the nearby targeted traffic signal light sensors[5]. So that the targeted signal can go for either extending the waiting time of another vehicle on road accordingly (maximize the Red light signaling time) or prioritize the signal time such that the timer of signal sensor go for a change over to green signal to minimum time extend for another vehicle on the road to avoid congestion.

But another problem arises when all four sides of the intersection or more than one side of the intersection is loaded with emergency vehicle and approaching towards the common traffic intersection. In such a state, there will an ambiguous situation for the traffic signal to decide that, to which side it should give green signal or clear way.

In order to solve this kind of situation, whenever any emergency vehicle passes from the road, then the roadside sensors will detect the vehicle based on the sound system and then it will trigger an event to next traffic intersection point informing that an emergency vehicle has to pass and give a clear way with immediate effect which is hereafter referred as SI (Sensor To Intersection) communication. Hence, as soon as intersection will receive any signal from road side signals then it will give Red signal to remaining intersection sides and give green to that side from where the sensor has triggered that event. Suppose, if two sides or more than two sides of the common intersection point are loaded with emergency vehicle, then in such case, the intersection will serve on a first come, first serve basis and will give clear way to that side from where it will receive the first trigger event. Since, the intersection will maintain the information in buffer about other trigger events on same or nearby moment, and as soon as one way will be clear it will automatically allow for second side traffic to pass on. The intersection will clear the buffer once the vehicle will pass from the intersection. In this way, ambiguity of passing vehicle from more than one side can be resolved.

Using II communication, as soon as that vehicle will pass from the intersection, then intersection will inform to next neighboring intersections about movement of emergency vehicles. With respect to the II communication, as soon as any vehicle will pass from intersection, then immediately that intersection will communicate to next neighboring intersection about the movement of emergency vehicle and if the corresponding road side signal will trigger an event then they will give a green way to that side.

Thus, this module of this paper touched on key point to give a clear way to emergency purpose vehicles on the road so that they can reach to their destination in least time by not stopping at the traffic intersections. Traffic intersections will be smart enough to take care for flow of traffic if there is any emergency purpose vehicle need to pass on and in normal condition.

VI. EVACUATION MESSAGE

Here the evacuation message [7] is used to notify nearby vehicles,which include the vehicles in the front of the emergencyvehicle and other vehicles that will travel toward the primarypath, to travel the other paths or make the way foremergency vehicles. The evacuation message is controlled bythe centralized server since the centralized server has alltraffic information and the path that emergency vehicle willpass by and which also will calculate the controlledemergency distance to predict the region that will affect the emergency vehicle.

This module of the paper focuses on the issues of the evacuation foremergency vehicles and delivering warning messages to other vehicles through R2V (RSU-to vehicle) transmission way using DSRC protocol. Hence, in order to let emergency vehicles which have emergency services, to arriveat the disaster area in time, we propose a centralized traffic control mechanism that can control the traffic and announcewarning messages. Thus the main issues to be addressed in thispaper are:

(1) Data Dissemination: Where on transmitting warning messages to nearby vehicles effectively, vehicles canchange driving paths or wait and stay at the same lanes ofroad for emergency vehicles is another important issue.

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(2) Real-time traffic information: The traffic status on the road is dynamic which implies if emergency vehicles keep driving the same path from source to destination all the way, i.e. emergency vehicles cannot react with the dynamically changed traffic status, it cause serious delay of emergency vehicles and increase traffic chaos on the road.

In our proposed mechanism, the construct of path arrangement for emergency vehicles is calculated by the centralized server. Since the centralized server can control all dynamic traffic flow in the city, the collection of the traffic information is managed by RSUs. The system architecture is depicted in Fig. 1 where Road Side Units (RSUs), which are RSU1 and RSU2, are installed at each intersection, and each RSU gathers the traffic information of each direction in each road periodically and sends the collection results to the centralized server to provide real time traffic information. Here the traffic information includes time, average speed of vehicles, number of vehicles, the direction of each road and road ID that is sent from RSUs to the centralized server which in turn gathers statistics of the traffic information from each RSU. The emergency vehicles (EV) in fig 1 can send and receive the traffic information for emergency service fromRSUs. Each RSU has two kinds of network interfaces: one is an Ethernet network interface and the other is a DSRCnetwork interface where the DSRC network interface is used to communicate with emergency vehicles and other vehicles and the Ethernet network interface is used to communicate with the server. It's also assumed that each vehicle is embedded with an OBU (On Board Unit) and a GPS receiver. The centralized server will calculate the optimal path for emergency vehicles when the emergency vehicles send the requests with their current positions and destinations that derived by the GPS receiver and digital map information.

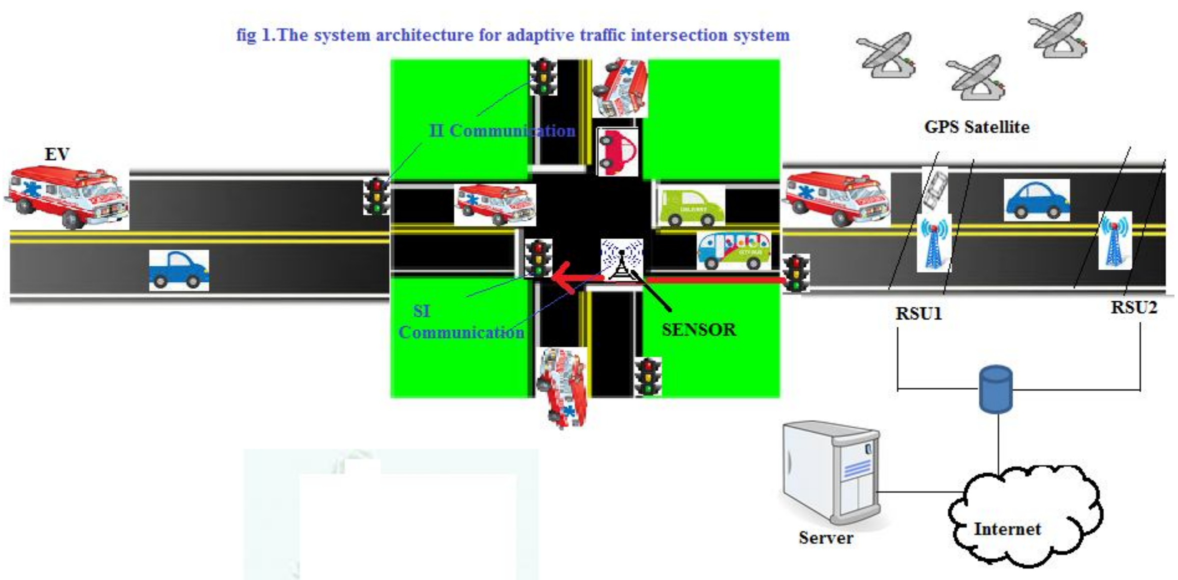

fig 1.The system architecture for adaptive traffic intersection system

VII. Performance Evaluation

BVR achieves good performance in a wide range of settings, at times significantly exceeding that of geographic routing. BVR generates good coordinates in that they correctly guide routes towards a target destination. Coordinates stability is important for routing performance, especially for applications that require a location database. Not only may routing to outdated coordinates lead to routing failures, but constant changes can generate heavy update and lookup traffic close to the beacons.so the work of BVR is limited in finding the shortest path from the accident zone to the nearby health care center. The rest part of finding the dynamic path arrangement in case of any network failure or breakdown is promoted to PEQ algorithm. PEQ uses the subscription message to propagate the initial configuration that builds the path to the sink and when the source receives the subscription, it uses this path to deliver data to the sink. Directed Diffusion (DD), on the other hand, propagates the subscription (interest) and, when the source receives it, it propagates an exploratory event to the sink using multiple paths - the sink will reinforce one of these paths. The PEQ path creation has fewer steps and is faster than DD, resulting in lower delays. Directed Diffusion paradigm [8] uses multiple routing paths to transfer data, so that node failures in one path can be overcome by sending the data through multiple paths what increases energy consumption and can cause packet collisions. All together the adaptive traffic intersection system can be able to meet the critical chaos situation with a silver bullet solution.

VIII. CONCLUSIONS AND FUTURE DIRECTIONS

Thus the above proposed framework is an optimal system for the approaching emergency vehicle to make its travelling path a convenient one. The system serves as a silver bullet solution to the current critical situation of traffic management. As a future work this system can be extended to the approach of monitoring road accident and accident detection, alerting automatically according to the seriousness of the incident and providing medical facilities via video conferencing.

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