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Safe Route Discovery for Vehicles using VANET

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Abstract— ***People travelling by vehicles to reach their desired destination find difficult to choose the safe route. A road may be damaged due to natural calamities and not be safe for vehicles. Those who are travelling long distances will not have enough knowledge regarding the safety of the road. An IoT device monitors road conditions and generate an alert message. The message is generated when water level reaches threshold level. Data analysis algorithm is employed to detect the safe route using previous conditions. The message is transmitted to a Road Side Unit (RSU) which then broadcasts it to a vehicle. The vehicle then sends the message to next nearest vehicle. This broadcasting happens until all vehicles within a range receives the message. Other Road Side Units helps in improving the signal strength of the message. RSU's can also send message to vehicle if there is failure in Vehicle-Vehicle Communication. Protocol used for message broadcasting is Adhoc On-Demand Distance Vector Routing (AODV). It is slightly modified to improve efficiency and accuracy. Based on the alert message received vehicular nodes can take different path that is safe to reach the destination.***

Keywords: VANET, Road Side Unit, Vehicle-Vehicle Comm., AODV

I. INTRODUCTION

Roads that are situated near river areas may get damaged due to overflow of water from water bodies due to which results in flood. People travelling by vehicles may not be aware of this condition and may choose a road that is damaged. Due to which they will not be able to reach the destination in time and safety of travelers is not ensured. When large number of vehicles cannot mobilize in the damaged zone it results in traffic jam. To avoid all these issues a system has to be designed to predict the safety of a route.

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An IoT device is designed to measure the range of water level. When threshold level is reached an alert message is generated. The message is received by a Road Side Unit (RSU). It then broadcasts it to vehicles within its range.

The paper is organized as follows. Section II explains related works. VANET methodology and architecture is presented in Section III. Proposed system consists of IoT device, Cloud Storage and Message transmission protocol is explained at Section IV. Performance evaluation is elaborated in section V. In Section VI the paper is concluded.

II. RELATED WORKS

Valsangkar Farid and others [1] proposed that AODV routing performs better even after increasing number of nodes to a greater extent. AODV provides better Packet Delivery Ratio even after varying number of nodes and keeping the maximum velocity constant. Therefore, this type of routing provides delivery of packets is more efficient for varying number of nodes.

Wu and others [2] stated Position based broadcast protocol for VANETs, a node is selected for rebroadcasting based on node's coverage area with smallest waiting time. There also exists practical difficulty in calculating waiting time of the neighbouring node.

Noble Mary Juliet and others [3] suggested a mechanism to insert a new field finally called message broadcasted node ID. This id contains the neighbour vehicles which are going to send the message. This will help the upcoming broadcasting node to stop sending the same message to the same vehicles at least for a hop. This helps to increase the bandwidth utilisation.

Pratap and others [4] proposed that Destination Discovery Oriented routing protocol reduces overhead routing and end-end delay with higher PDR. This algorithm helps to find the at most node that is forwarding by allowing for delivery of packets more efficiently.

III. VEHICULAR ADHOC NETWORK

VANET have gained sufficient attention from the development community due to their increasing importance for making an intelligent vehicular transportation system. The VANET characteristics, such as higher mobility, partitioning of network, seamless connectivity and in city environment disturbances are challenging task for routing. These characteristics downgrades the performance of the routing protocol. Position-based routing is quite reliable in VANET

A wide range of services is provided by VANET such as a avoiding accidents, traffic flow regulating mechanism, providing internet access to the public on the road and parking location information.

A. Architecture

The basic architecture of the VANET consists of many things like intelligent vehicles i.e. vehicle embedded with transmitter, receiver and on-board application,
Road Side Units, management system for all nodes, links for communication etc, [5].

In VANET architecture moving vehicles communicate with other vehicles within range and also communicate with nearby Road Side Units (RSU). A major difference between VANET and MANET is that the vehicles do not move randomly as in MANET, whereas in VANET the vehicles moving follow certain rules and moves along roads or highway. The architecture consists of three modules namely Mobile unit domain, Infrastructure domain and Management domain.

IV. PROPOSED SYSTEM

Figure1 shows the overall block diagram of the process. Water level data is generated from the IoT Device. The implementation was done using Raspberry pi and ultra-sonic sensor. Generated emergency message broadcast to RSU. RSU will broadcast this message to all the vehicles which are located it communication level. Once the message is received by an intelligent vehicle which transfers it to other vehicles within its range (vehicle to vehicle communication). This process continues until all vehicles within a particular range received the message.

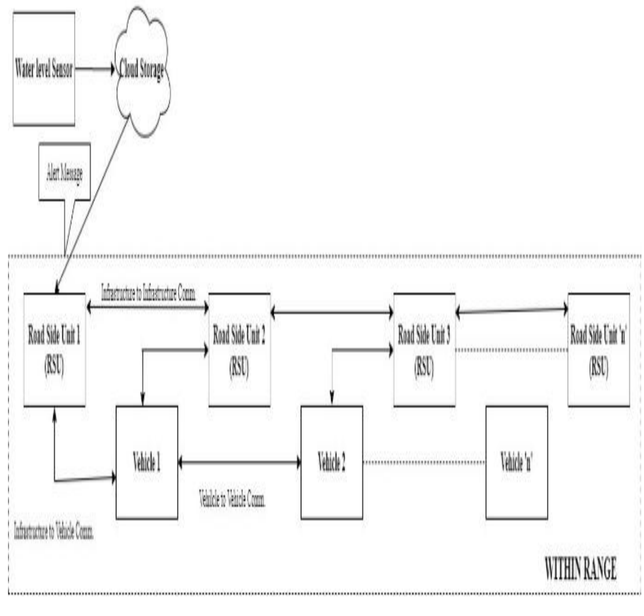

Figure1. Block Diagram

A. IoT device

An IoT device is designed using ultrasonic sensor to measure the water level. A transmitter, receiver and a control circuit are present within the sensor. The sensor generates waves which is reflected once it hits the water surface. The signal is received by the ECHO of the sensor. Based on the delay in receiving the signal distance or the height is measured. A Raspberry Pi microprocessor is used to control the ultrasonic sensor. Collected data is sent to cloud.

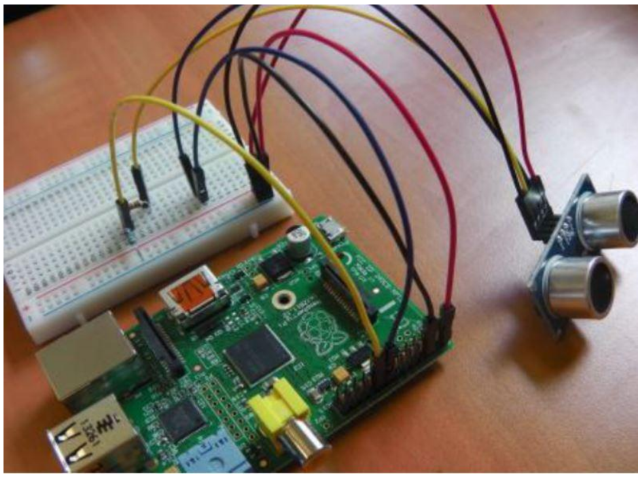

Figure2. IoT device

B. Cloud Storage and Analysis

The Google Firebase database is a cloud-hosted NoSQL database that helps to store and synchronize data between multiple users in real-time. The proposed system (IoT Device) located near water sources continuously monitors the water level and updates that information to cloud server. The water level along with the timestamp is stored in firebase.

Classification comprises of two-step process, learning and prediction. In learning, the model is developed based on a given training data. In second step, the trained model is used to predict a response for given particular data. The best suitable algorithm to predict the safe route is Decision Tree Analysis algorithm.

Binary values of water level range, road damage, presence of traffic, speed of the water are the parameters in decision tree. The dataset is trained using these values and results are predicted for future conditions. When the algorithm predicts that the route is not safe, the message is generated. Flowchart of the tree is shown depicted in Fig

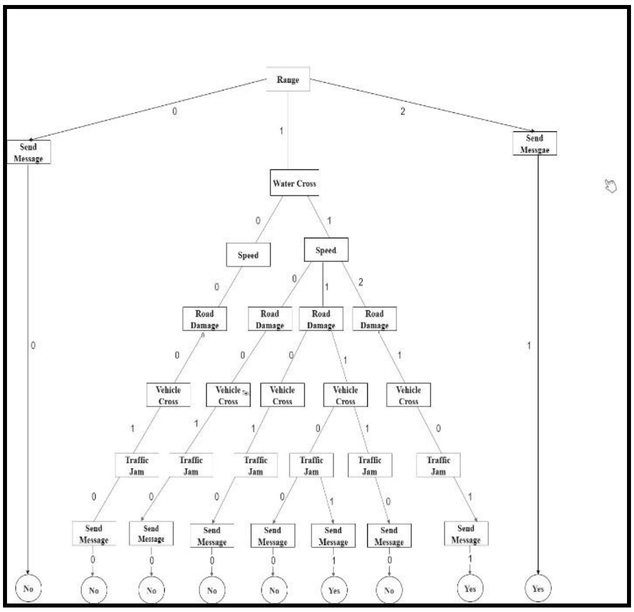

Figure3. Decision Tree Flowchart

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C. Message Transmission Protocol

- **AODV**

In VANET nodes moves in high speed and have high mobility. AODV is a routing protocol that is reactive and operates on hop pattern. In AODV protocol participating vehicle nodes wishing to establish and maintain an ad hoc network is provided with dynamic and multihop routing**.** The protocol allows nodes to get routes fastly for new destinations and does not require nodes to maintain routes to destinations that are not in active communication.

There are three types of message types defined in AODV such as route request (rreq), route reply (rrep), and route error (rerr). When a node receives a broadcast query (rreq) it records the address of the node that sent the query in their respective routing table. This method of recording its previous hop is known as backward learning. Once arrived at the destination a reply message (rreq) is sent to the overall path obtained through backward learning to the source. At every stop of the path the node records its previous path so a forward path from the source is established. A two-way path is established due to query flooding and reply sending. Once the path is established it will be kept until source uses it. If a link failure is detected it is informed to the source which generates a request to find a new route.

- **Discovering AODV Route**

A route is discovered by broadcasting a route request to all of its neighbouring nodes. The broadcasted request contains addresses of the source and destination, their sequence numbers, broadcast ID and a counter, which counts how many times requests has been generated from a specific node. When a source node broadcast a request to its neighbours it acquires route reply either from its neighbours or the neighbour rebroadcasts request to their neighbours by incrementing in the hop counter. When node receives multiple route requests from the same broadcast ID, it drops repeated route requests to make the communication loop free [1].

- **Routing Table Management in AODV**

AODV Routing table management is required to avoid those entries of nodes that do not exist in the route from source to destination. Destination sequence numbers is used to handle routing table information.

- **Route Maintenance in AODV**

When a route is not valid for communication the nodes in the network detects it and delete all invalid entries from routing table for that particular route. This invalidity of route is informed to current active neighbouring nodes through a route request. Only loop free routes are maintained by AODV.

V. PERFORMANCE EVALUATION

- *Throughput:* Throughput is defined as in a communication link the amount of data per unit time delivered from one node to another. The throughput is measured in Packets per unit Time Interval Length or bits per Time Interval Length. When the throughput of sending and receiving packets is higher than the performance is also better. *If* the throughput of dropping packets is low, performance is better. [1]

$$Thro = \frac{\sum_{i=1}^{n} Nobi}{Ti}$$

Equation 1

where $Thro$ is the throughput of the node i, Nob is the number of bits transmitted from source to destination and t is the time taken for transmitting the message.

- Average Throughput: It is the average of overall throughput. It is also measured same as individual throughput. Average throughput of VANET is computed as sum of successfully broadcasted throughputs of all vehicle nodes divided by total number vehicle nodes in the network.

$$Avg(Throughput) = \sum_{i=1}^{n} Thri$$

Equation 2

where i is vehicle node number

- *Packet Delivery Ratio:* It is calculated as the ratio between number of packets containing data transmitted successfully to the destination. Calculation given by Equation 3

$$pdr = \frac{\sum Pre}{\sum Pse}$$

Equation 3

where pdr is the packet delivery ratio, Pse is the total number of packets sent between a source node and a destination node, Pre is the number of packet received in total successfully.

- *Packet Size:* It is the size of packets which is in bytes. The actual data to be transferred is present at the payload section of the packet.
- *Simulation Time:* It is the total time taken for simulating the message transmission. Measurement is done in seconds.

Table 1

Parameters	Values
Discrete Network Simulator	NS 3
Open Source Traffic Simulator	SUMO v12.0
Map	Open Street Map (Pollachi Town)
Simulation Time	5 mins
Routing Protocol	AODV
No of Vehicles	100
Transmission range	500 m
Minimum Speed	1 km/hr
Maximum Speed	60 km/hr
Packet Size	512 bytes

VI. RESULTS AND ANALYSIS

The system that is proposed uses AODV protocol with slight modifications. Message broadcasting is fast and efficient than the other existing systems. For the system of 100 nodes Average Packet Delivery Ratio is 92.15% for a given short alert message. Average Packet Loss Ratio for the same system is 7.58%. Connectivity between vehicular nodes is around ±90%. Figure 4 shows that proposed system has enhanced throughput than the existing system.

Hence the proposed system is better than existing system in terms PDR, PLR, Throughput, Delay, Communication Overhead and Connectivity.

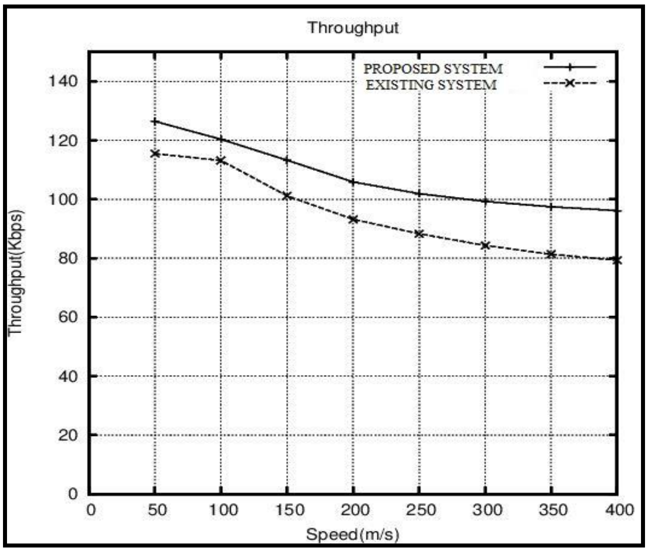

Figure 4. Average Throughput between systems

VII. CONCLUSION

The underlining objective of the paper is to discover safe route for vehicles and alert the population through alert messages using VANET. Protocol used for message transmission is AODV. It is modified so that it delivers message without much packet loss, better connectivity, less communication overhead and delay. A real time vehicular movement is simulated similar to that of real system so that the system is evaluated and performance is improved. In future the system can be implemented in real world by improving protocol for security measures.

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