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A SMART AND ROBUST ROUTE NAVIGATION IN CASE OF EMERGENCIES USING PERVASIVE COMPUTING WITH WSN

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ABSTRACT

Road emergencies are very common now a days and navigation during an emergency is a challenge which decides the lives of many people, providing services that guide people to exit while keeping them away from emergencies are critical in saving lives .Without considering such aspects, existing navigation approaches may fail to keep people farther away from emergencies of high hazard levels and would probably encounter congestions at exits with lower evacuation capabilities. One of such work is SEND, which is built for navigation with in a building during emergencies such as Fire, Earthquake. SEND user a smart WSN which finds the nearest safest exit based on the hazard potential of the exits. With the use of AI algorithms, the probability of an emergency can be calculated and would be useful in increasing the efficiency of the system. With a situation aware wireless sensor network along with AI classification we can identify new factors to isolated the emergency conditions and can reduce the complexity of the overall system, we can provide effective navigation to the vehicle on road, for increased safety and attempt to reduce the cost of lives further. The proposed work should be able to create a model of the traffic and keep updating the model to stay track of the exits and hazard potentials in a vehicular environment when compared to the stationary environment.

Keywords: *Emergency navigation, situation-aware, sensor networks, hazard potential field.*

1. INTRODUCTION

Benefitting from recent advances in wireless sensor network technologies, large-scale deployment of WSNs has become viable and affordable which ever used to serve as an increasingly popular platform to engage continuous environment monitoring. Recently there is a trend to incorporate WSNs into emergency navigation systems aiming at providing early on and automatic discovery of potential dangers, such as geologic disasters, wildfire hazards and oil/gas leakages, and navigating people to safe exits while keeping them away from emergencies. Also, with the recent advent in the area of artificial intelligence and computing power of devices, complex calculation can now be run on smaller devices with a central or distributed server over the network. This ability further gives an opportunity to improve the overall efficiency of the existing system by many folds. The aim of this paper is to explore ways to identify the emergency situations and quantify them against the emergency situation. So that the system becomes faster in identifying the emergency conditions and also keeps a check on the working condition of the overall system.

This work considers such a WSN-assisted emergency navigation problem by utilizing the sensor network infrastructure as a cyber-physical system along with an AI agent for improved performance and efficiency. In this mobile scenario, people are equipped with communicating devices like mobile phones that can talk to the sensors and the AI agent. When emergencies happen, and mobile users are trapped in the field, the sensor network explores the emergencies and provides necessary guidance information to the mobile users in tandem with the AI agent, so that the users can be eventually guided to safe exits through ubiquitous interactions with sensors.

Although many WSN-assisted emergency navigation methods have been proposed almost all existing approaches equally regard the hazard levels of different emergencies, different emergencies could occur concurrently with each corresponding to a specific hazard level. Introducing AI agent to handle and monitor the concurrent hazards would reduce the load on the WSN network.

2. LITERATURE REVIEW

In [1] authors Liang He, Member, Zhe Yang, Student Member, Jianping Pan, in the paper "Evaluating Service Disciplines for On-Demand Mobile Data Collection in Sensor Networks" the on-demand scenario where data collection requests arrive at the mobile element progressively is investigated, and the data collection process is modeled as an M=G=1=c-NJN queuing system with an intuitive service discipline of nearest-job-next (NJN). Based on this model, the performance of data collection is evaluated through both theoretical analysis and extensive simulation. NJN is further extended by considering the possible requests combination (NJNC). The simulation results validate our models and offer more Insights when compared with the first-come-first-serve (FCFS) discipline. Many applications in wireless sensor networks are data oriented. Data collection in sensor networks typically relies on the wireless communications between sensor nodes and the sink, which may excessively consume the limited energy supply of sensor nodes due to the superliner path loss exponents. In wireless sensor networks (wsn) all the data collection by the sensor nodes are forwards to a sink node. Furthermore, sensor nodes near the sink also tend to deplete their energy much faster than other nodes due to the data aggregation towards the sink, which imposes them a much heavier volume of data to forward and leads to very unbalanced energy consumption in the entire network. In addition, these approaches are based on a fully connected network, which requires the dense deployment of nodes and thus introduces extra costs.

In [2] authors Jiliang Wang, Zhenjiang Li, Mo Li, Yunhao Liu, in the paper "Sensor Network Navigation without Locations We propose a pervasive usage of the sensor network infrastructure as a cyber-physical system for navigating internal users in locations of potential danger. previous work in that they typically treat the sensor network as a media of data acquisition while in our navigation application, in-situ interactions between users and sensors become ubiquitous. In addition, human safety and time factors are critical to the success of our objective. Without any pre knowledge of user and sensor locations, the design effective and efficient navigation protocol faces nontrivial challenges. We propose to embed a road map system in the sensor network without location information so as to provide users navigating routes with guaranteed safety. We accordingly design efficient road map updating mechanisms to rebuild the road map in the event of changes in dangerous areas. In this navigation system, each user only issues local queries to obtain their navigation route. The system is highly scalable for supporting multiple users simultaneously. As emergency or dangerous situation change, it becomes necessary to frequently update the route plans for the guided uses. The location information however, may not always be available in many realistic situations where emergency guidance is needed. For example, in an underground tunnel or coal mine a complex indoor area and so on.

In [3] authors Enyang Xu, Zhi Ding, Fellow,and Soura Dasgupta, Fellow "Target Tracking and Mobile Sensor Navigation in Wireless Sensor Networks" This work studies the problem of tracking signal-emitting mobile targets using navigated mobile sensors based on signal reception. Since the mobile target's maneuver is unknown, the mobile sensor controller utilizes the measurement collected by a wireless sensor network in terms of the mobile target signal's time of arrival (TOA).The estimated time of arrival or ETA is the time when a ship, vehicle, aircraft, or emergency service is expected to arrive at a certain place.TOA method tries to estimate distance between two nodes using time based measures. The mobile sensor controller acquires the TOA measurement information from both the mobile target and the mobile sensor for estimating their locations before directing the mobile sensor's movement to follow the target.

We propose a min-max approximation approach to estimate the location for tracking which can be efficiently solved via semi definite programming (SDP) relaxation, and apply a cubic function for mobile sensor navigation. We estimate the location of the mobile sensor and target jointly to improve the tracking accuracy. To further improve the system performance, we propose a weighted tracking algorithm by using the measurement information more efficiently.

In [4] the authors Lin Wang, Yuan , Wenyuan Liu, Nan Jing, Jiliang Wang, Yunhao Liu in the paper "On Oscillation-free Emergency Navigation via Wireless Sensor Networks" Emergency navigation is an emerging application of wireless sensor networks with significant research and social value. In order to ensure the safe and timely navigation of the evacuees, most of the existing works model navigation as a path-planning problem or movement decision support problem and adopt different metrics, such as the shortest route, the minimum exposure path, and the maximum safe distance. Without sufficient consideration of the dynamics of danger, the existing approaches are likely to cause users to move back and forth during navigation, known as oscillation. In this paper we Users oscillations in the dynamic environments into account and quantify the local success rate of navigation using a metric called ENO (Expected Number of Oscillations). We then propose OPEN, an oscillation-free navigation approach that minimizes the probability of oscillation and guarantees the success rate of emergency navigation. We implement OPEN and evaluate its performance through the trace from our system and extensive simulations. The results demonstrate that OPEN outperforms the current state-of-the-art approaches with respect to user safety and navigation efficiency. Navigation is an emerging application of WSNs, in which sensor nodes collaboratively explore the dynamic environmental conditions and people's movements [6]–[9], and then prevent people in danger from once again traversing into the dangerous area, such as a geologic hazard, fire rescue, oil spill, etc. Because the monitored area is very large and WSN deployment generally contains a number of sensor nodes, a directed user can only have a limited field-of-view and the local network information.

In[5] authors Chiranjeeb Buragohain, Divyakant Agrawal, Subhash Suri in the paper "Distributed Navigation Algorithms for Sensor Networks" distributed algorithms to aid navigation of a user through a geographic area covered by sensors. The sensors sense the level of danger at their locations and we use this information to find a safe path for the user through the sensor field. Traditional distributed navigation algorithms rely upon flooding the whole network with packets to find an optimal safe path. To reduce the communication expense, we introduce the concept of a skeleton graph which is a sparse subset of the true sensor network communication graph. Using skeleton graphs we show that it is possible to find approximate safe paths with much lower communication cost. In this paper, we propose more scalable solutions for the problem of navigating a user in the presence of disruptions or hazards in a sensor field. Our algorithms make two natural assumptions: (1) the operational environment is assumed to have no large holes in the coverage by sensors, and (2) an *approximately optimal* safe path is acceptable. Based on these two assumptions, we develop distributed navigation algorithms that are very efficient in terms of their communication cost; they find near-optimal paths with significantly smaller communication (and, thus, energy) overhead. The underlying idea behind our scheme is to activate a sparse sub-network within the dense sensor network and use this sparse network to solve the navigation problem.

In [6] authors Keun Woo Lim, Woo Sung Jung, Young-Bae the paper "Multi-hop Data Dissemination with Replicas in Vehicular Sensor Networks" multi-hop data dissemination method using data replication technique to collect sensor data in Vehicular Sensor Networks (VSN).The rapid increase of vehicular traffic and congestion on the highways began hampering the safe and efficient movement of traffic. VASNET is a self organizing Ad-hoc and sensor network comprised of a large number of sensor nodes even the majority of research based on VSN network protocols has some problems ,as they limit their data harvesting schemes to only single-hop or short distance transmission. High cost reply stations to support multi-hop cases.

Vehicular Ad Hoc Networks (VANET) is a communication technology that creates a network between vehicles [1] or roadside gateways to allow information exchanging between users. This technology can provide safety, comfort, and information to drivers on the road. Recognize the current road situation-The VSN can be used for the driver to recognize the current situation of the nearby roads and take appropriate actions. Also, VSN has potentials to be used in warfare to sense enemy vehicles or mines deployed on roads. The current road navigation systems using GPS technology can provide drivers an optimal path to the destination in terms of distance. However, sensors on the road can provide not only the distance based optimal path but also the current status of these roads, allowing more information for road navigation.

In [7] authors Nicolas Courty SAMSAR, Soraia Raupp Musse ,Braun,Bodmann the paper " We propose an original enhancement of a well known Simulation of Large Crowds in Emergency Situations Including Gaseous Phenomena "physics-based animation model which allows to consider influence of gaseous phenomena such as smoke or toxic gases in the behavior of the crowd. In order to get real time performances we also propose an implementation of this framework on modem graphics hardware, which allows LO simulate crowds of thousands individuals at interactive frame rate. Virtual crowds can populate collaborative virtual environments to increase their credibility. Different approaches have been proposed in order to animate crowds for the entertainment industry. Finally, researches on safety systems, where crowds are used to simulate behaviors of people in emergency situations, provide useful tools that can help the design of buildings and open-spaces. For such a system to be interactive, it is necessary to provide real time performances for large crowds and smoke or gas simulation. Therefore we present as a second major contribution of this paper an implementation of our framework based on modem graphics hardware, which permits simulations of high density crowds at interactive frame rate. This last topic is addressed in this paper. While a Lot of previous works focus on the behaviors of escaping crowd, few works have also dealt with potential risks that occur from smoke or gases-filled environments. In order to provide interactive performances for our simulation, GPW implementations of our framework is also presented, and allow to consider crowds constituted with several thousands of people in smoke-filled environments within real time. Moreover, this characteristic allows interactions with the crowd, which constitutes a plus for potential applications.

In[8] authors *Gazihan Alankus, Nuzhet Atay, Chenyang Lu, O. Burchan Bayazit* in the paper "Spatiotemporal Query Strategies For Navigation In Dynamic Sensor Network Environments" we present how sensor networks may assist probabilistic roadmap methods (PRMs), a class of efficient navigation algorithms particularly suitable for dynamic environments. A key challenge of applying PRM algorithms in dynamic environment is that they require the spatiotemporal sensing of the environment to solve a given navigation problem. We investigate the impact of different query strategies through simulations under a set of realistic fire conditions. Awareness of the environment plays an important role in mobile robot navigation. Until recently, the robots mostly relied on the on-board sensors. However, as the technical challenges of sensor networks are being solved, a new interest raised to employ them in the robot navigation task. Sensor networks are successfully utilized for robot navigation. However, most of these methods use all the sensors in the network increasing power consumption. Also, they distribute the path finding task to sensor nodes hence reducing the flexibility of using a different path _finding algorithm. In particular we note the *roadmap methods* which can quickly answer many diverse path planning queries in the same environment using a map, typically constructed during preprocessing, containing a network of representative feasible paths in the environment. Our system consists of three components that enable safe navigation in a dangerous region: (i) a sensor network to collect real-time information about the environment, (ii) a robot with a mote connected to it, and (iii) a controller which navigates the robot based on the information from the sensor network and on-board sensors.

In [9] authors Gene Eu Jan, Ki Yin Chang, and Ian Parberry in the paper "Optimal Path Planning for Mobile Robot Navigation" Some optimal path planning algorithms for navigating mobile rectangular robot among obstacles and weighted regions are presented. The motion planning problem is to determine a path of a mobile robot from its source (initial) position to a destination (goal) position through a workspace populated with obstacles. The obstacles may be either stationary or moving. The desired path is an optimal one with no collisions between the robot and the obstacles. Let M represent a moving rigid robot, the path planning problem for M can be formulated as follows.

Given the geometric descriptions of a moving robot and obstacles in a bounded region, a source (expressed by *S*) and a destination (expressed by *D*) of the moving robot M determine that a continuous collision-free path *LL* path from *S* to *D* exists or not, and if so, plan such a path. Most of the methods for solving the path planning problem based on the environment map for mobile robots are described by Latrobe, such as road map, cell decomposition, and potential field methods. Additionally, several recent approaches have been proposed to solve this problem. For example, Jiang *et al.* [3] used a visibility graph without generating a complex configuration space to find a shortest collision-free path for a point. The point is evaluated to find whether it can be used as a reference to build up a feasible path for the mobile robot.

In [10] authors Yang Yang, Miao Jin, Yao Zhao, and Hongyi Wu in the paper "Distributed Information Storage and Retrieval in 3-D Sensor Networks With General Topologies" data-centric processing aims to reduce energy consumed for communication and establish a self contained data storage, retrieval, aggregation, and query sensor system that focuses more on the data itself rather than the identities of the individual network nodes. Double-ruling-based schemes support efficient in-network data-centric information storage and retrieval, especially for aggregated data, since all data with different types generated in a network can be conveniently retrieved along any single retrieval curve.. The new paradigm of distributed in-network data-centric processing focuses more on data themselves rather than the identities of individual sensor nodes. Data are uniquely named, and data processing is achieved using data names instead of network addresses, aiming to establish a self-contained data acquisition, storage, retrieval, and query system. An information consumer simply travels along a simple curve with the guaranteed success to retrieve aggregated data through time and space with different types across the network. We conduct extensive simulations and comparisons that further show the proposed approach with low cost and a balanced traffic load.

3. PROBLEM STATEMENT:

SEND: a situation aware safe navigation inside a building, which identifies the hazard level and provides safe navigation in case of emergencies. In the near future, it can be expected that buildings will be equipped with a range of wireless sensors functioning as part of an overall building management system. Included in this set of sensors will be devices to monitor and smoke, allowing detection, localization and tracking of fires. It is expected such information could be used for a variety of purposes, including guiding building occupants to the nearest safe exit, and helping firefighting personnel to decide on how to best tackle the disaster. Fire sensors are expected to be programmed to report periodically and also when they detect a sensor input that exceeds a threshold.

By guiding users following the descend gradient of the hazard potential field, our method can thereby achieve guaranteed success of navigation and provide optimal safety to users. It is fully distributed and does not require any location information. It is more robust to emergency dynamics since the constructed hazard potential field reflects more global properties of the underlying connectivity. Both small-scale tested experiments and extensive simulations on large-scale WSNs. The Wireless sensor networks can be used more effectively with AI agent and can reduce the time needed to solve the issues in the existing system.

4. PROPOSED SYSTEM:

Proposed system uses the concept of situation aware navigation system to be implemented in the vehicular environment. The premise of the existing system is strong when considered the use of wireless sensor network. As it can be used to sense continuously the state of road intersections and update the system model to provide the effective navigation. Adding an AI agent in the mix would help the system to become more robust and smart in identifying the emergencies faster and also the rate at which the system prevents an emergency to happen is also increased by keeping a continuous track to parameters and with an updated knowledge base. The system would keep learning and the efficiency of the system would increase with more data fed to the system during training or usage.

4.1 Modules:

4.1.1. Environment setup
4.1.2. Map and navigation module
4.1.3. AI agent
4.1.4. Hazard detection and contingency module
  a) Safe state
  b) Hazard state
  c) Hazard management state

4.1.1. Environment setup

An environmental hazard is a substance, state or event which has the potential to threaten the surrounding natural environment or adversely affect people's health, including pollution and natural disasters such as storms and earthquakes. The four major environmental hazards are,

1. Pollution (air, water, noise and soil) 2.Global warming (ozone layer is damaged)

3. Deforestation (cutting of trees) 4.soil erosion (topsoil is eroded)

Hazards can be categorized in four types:

Chemical
Physical (mechanical, etc.)
Biological. The international pictogram for environmental hazard.
Psychosocial

4.1.2. Map and navigation module

Google Maps Navigation is a mobile application developed by Google for the Android and iOS operating systems that was later integrated into the Google Maps mobile app. The application uses an Internet connection to a GPS navigation system to provide turn-by-turn voice-guided instructions on how to arrive at a given destination. The application requires connection to Internet data (e.g. 3G, 4G, WiFi, etc.) and normally uses a GPS satellite connection to determine its location. A user can enter a destination into the application, which will plot a path to it. The app displays the user's progress along the route and issues instructions for each turn.

4.1.3. AI Agent

Artificial Intelligence (AI) is an area of computer sciences that emphasizes the creation of intelligent machines that work and reacts like humans. Some of the activities computers with artificial intelligence are designed for include: speech recognition, learning.

4.1.4. Hazard detection and contingency module

a) Safe state

A state is safe if the system can allocate all resources requested by all processes (up to their stated maximums) without entering a deadlock state.

b) Hazard state

A hazard is an agent which has the potential to cause harm to a vulnerable target. The terms "hazard" and "risk" are often used interchangeably. However, in terms of risk assessment, these are two very distinct terms. A hazard is any agent that can cause harm or damage to humans, property, or the environment. Risk is defined as the probability that exposure to a hazard will lead to a negative consequence, or more simply, a hazard poses no risk if there is no exposure to that hazard.

c) Hazard management state

Hazard management is a continuous process that is used to improve the health and safety of all workplaces. It is essentially a problem-solving process aimed at defining problem (identifying hazards), gathering information about them (assessing the risks and solving them(controlling the risk)

5. Output

This section consists of screenshots of the robust navigation methods used to find the best route using pervasive computing with WSN. The Fig 1 consists of sensors deployed throughout the area. The yellow color node is the client. The green color node is the benevolent. The blue color node is the relay.

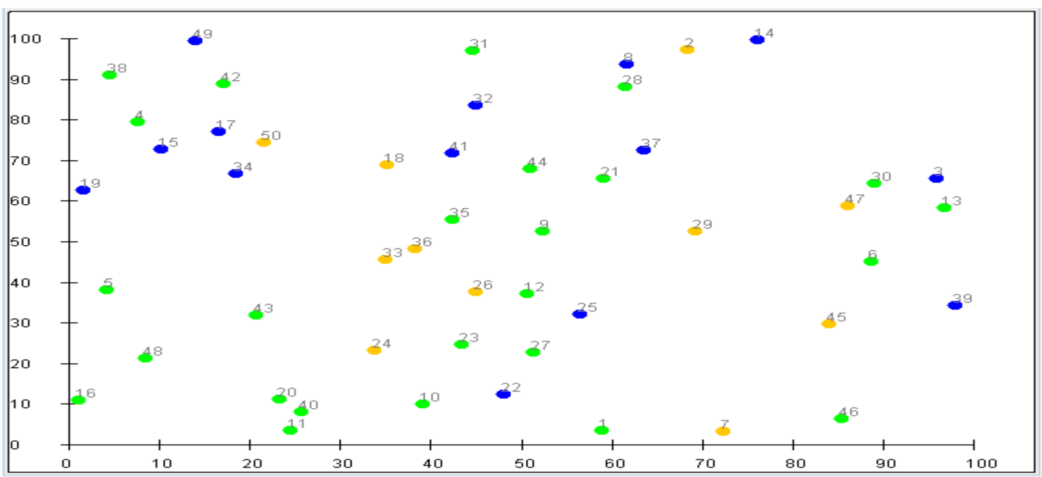

Fig 1 WSN nodes deployed in the area

The sensors keep sensing the parameter and keep the track of the situation on the road. The sensors send data to the relays and forward to the road side units which has the AI agent setup to classify the parameter continuously to identify the probability of a road accident. The topology of the WSN is shown in the below diagram.

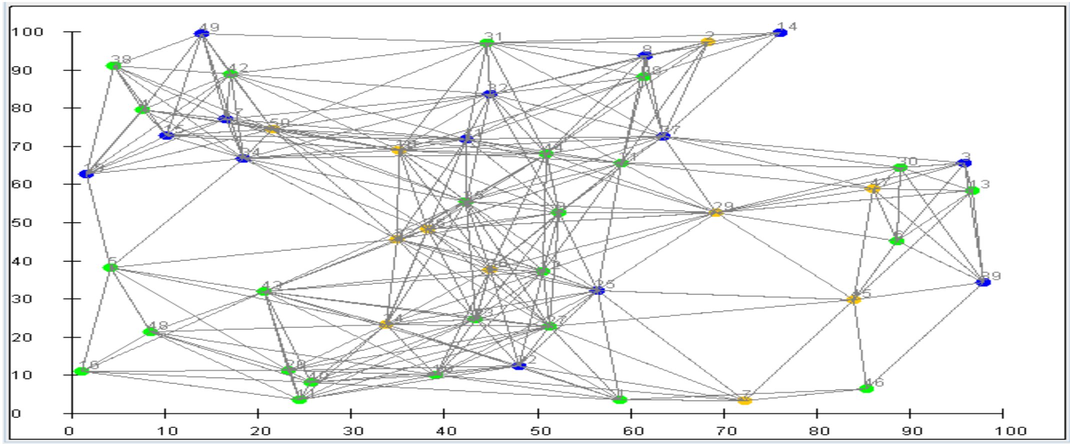

Fig 2: Wireless sensor network topology

The sensor range varies with the sensor types and reduces with the distance from the sensors. The sensor range also gets affected by the sensor battery level. The following image shows the ranges of the sensors spread across the environment and gives an understanding of the sensor network.

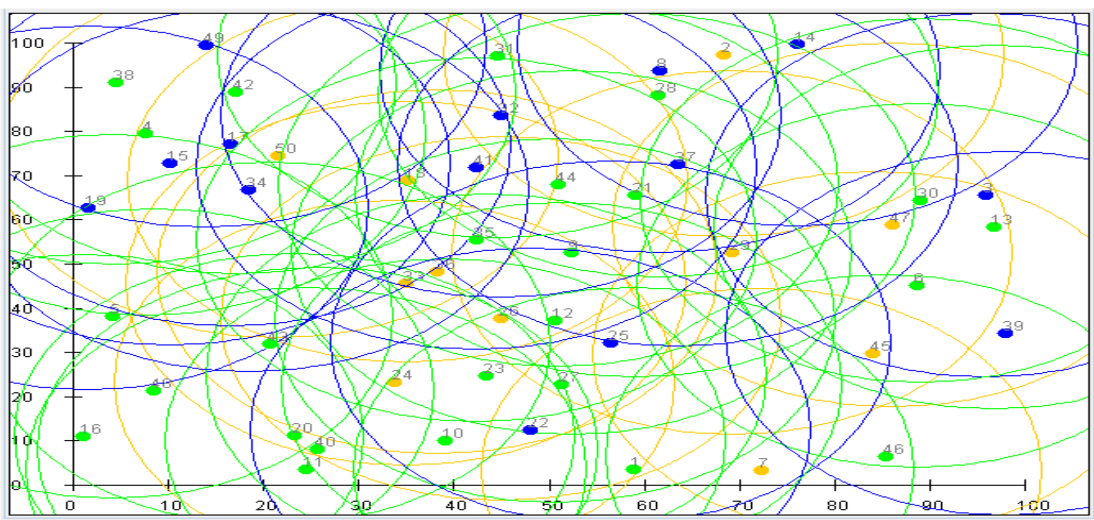

Fig 3 The sensor network range

The sensor network in sensing mode, the sensors actively sends the data to the agent, which updates the knowledgebase of the overall system. The sensors sometimes are also assisted with the relays to send information to the agent. The following image explains the communication happening in the topology of the sensor network.

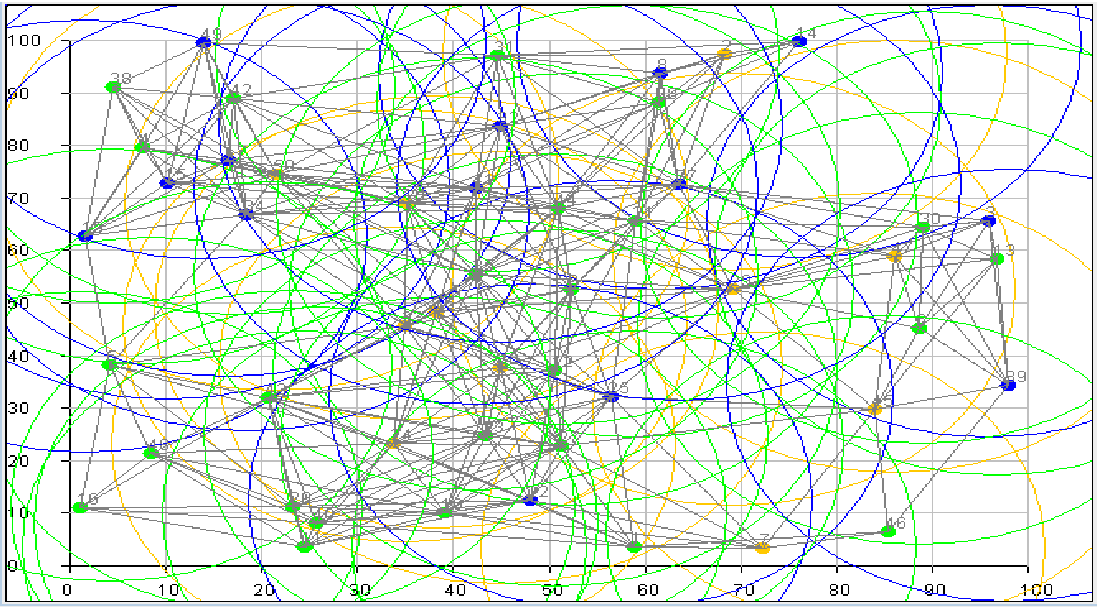

Fig 4 The agent and sensor network communication

6. Performance Analysis:

This section illustrates the comparison between efficiency of iteration times and the hazard potential by existing system and under different iteration methods. Analysis system uses the concept of situation aware navigation system to be implemented in the vehicular environment. The premise of the existing system is strong when considered the use of wireless sensor network. As it can be used to sense continuously the state of road intersections and update the system model to provide the effective navigation. The evaluation of the positioning accuracy could be based on the comparison of the measured positions after calibration with the content of the map database.

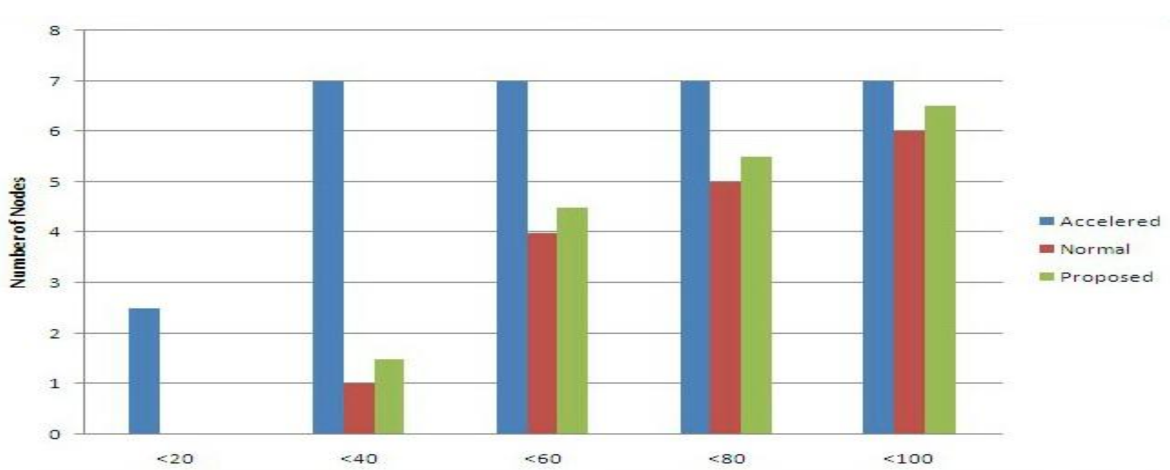

Fig. 5. Comparisons of the accelerated and non-accelerated hazard potential field establishing method; horizontal axis represents the iteration times

We count the iteration times of all the 10,000 sensor nodes, and report the statistic results in Figs. 5 and 6. As shown in Fig. 5, the proposed accelerated iteration method has more than 2; 600 sensors involved in the iteration times less than 20, and all the sensors are involved in the iteration times less than 60. Therefore, the accelerated method is much faster than the normal method. We then randomly select one sensor and depict the relation between the iteration times and the hazard potential under different iteration methods. The result in Fig. 6 shows that our iteration scheme terminates about 37 rounds of iterations, which significantly boosts the convergence speed. Therefore, it can save the precious time for emergency navigation.

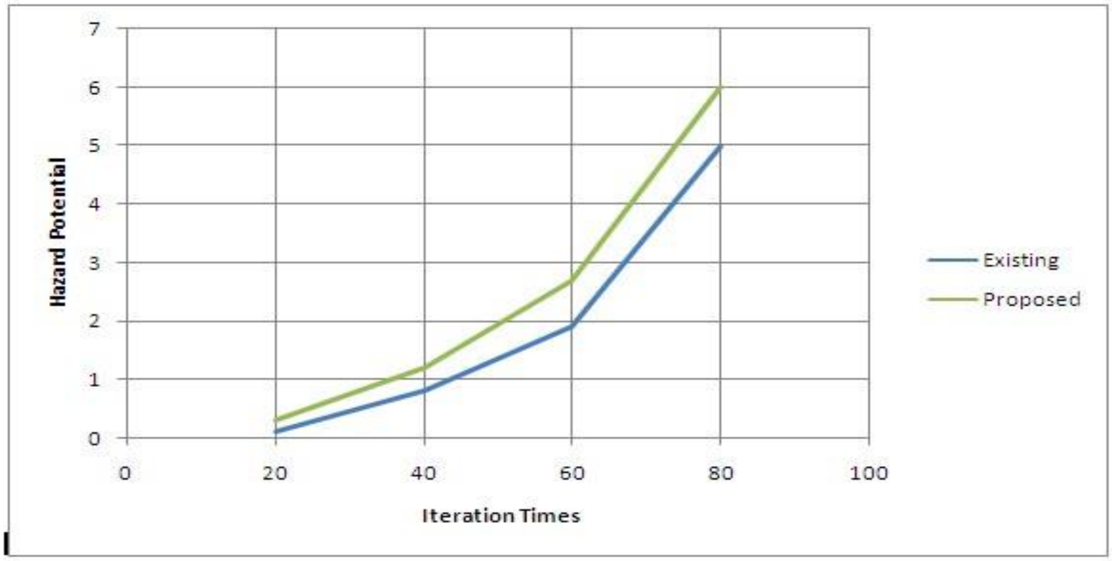

Fig. 16. The performance of the accelerated and non-accelerated hazard potential field establishing method for a randomly selected node.

The performance of the accelerated and accelerated hazard potential field .An emergency navigation problem is essentially to find the optimal emergency navigation paths in terms of safety. Quantifying the safety of a path is equal to quantifying the hazard of a path, which is closely related to emergency. In the following, we first focus on the hazard of an arbitrary point in the field of interest, which is the basis of finding the safest navigation path.

7. Conclusion and Future Enhancement

The present shortest situation aware emergency navigation algorithm, which takes the risk levels of emergencies as well as the emigration capabilities of exits into account and provides the mobile users the safest navigation paths accordingly. Motivated by the fact that the natural gradients of some physical quantities always follow a natural diffusion law e.g., water always flows from the place with a higher gravity potential to that with a lower gravity potential, we thus propose to model the hazard levels of emergencies and the evacuation capabilities of exits as hazard potentials with positive and negative values, respectively. Then we establish hazard potential field in the network, which is theoretically free of local minima. By guiding users following the descend gradient of the hazard potential field, our method along with the AI agent can thereby achieve guaranteed success of navigation and provide optimal safety to users. Also, the system efficiency would keep on increasing with usage as the AI agent's knowledge base is getting updated each time it identifies a new scenario.

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