Modelling and Simulation on Traffic Emergency Response Based on Unity3D

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***Abstract*—A traffic emergency response plan must test under the real traffic situation, but it is dangerous to test the emergency plans on a running highway. Therefore, the simulation is becoming a necessary way. In this paper, firstly, a framework of simulation and evaluation are built. Secondly, modeling for the emergency response models related to the traffic situation, e.g. the virtual environment for streets, automobile vehicles, weather condition or pedestrians walking is built. It also offers planning to mimic the emergency situation on the road, vehicles, e.g. cranes or ambulances in 3D Scenarios. Thirdly, simulate a traffic emergency situation by using graphic system UNITY3D followed by 3Ds MAX. Fourthly, simulate the rescue plan to deal with the traffic jam under the panic situation. The traffic emergency rescue response scenarios are simulated to evaluate the entire solution plans so as to select the best response solution to support the traffic emergency decision.**

***Index Terms*—Traffic emergency response, modeling, simulation, UNITY3D.**

I. Introduction

As we known that, the strong traffic accidents often not only bring the severe damage problem, but also lead to the more severe traffic jam and the wounded more dangerous if the accident is no well response in time. The occurrence of traffic accidents, traffic congestion or transportation delays is common problems in highway around the big cities.

It is very imperative to take actions to deal with the traffic jam in time. However, the time of traffic accident takes place is uncertainty, it is difficult to plan, train and deal with the emergency response of transportation. Considering of the advantages of the simulation, the frameworks of simulating the traffic accident plan is required. In fact, the frequent occurrences of traffic accidents demand careful concern regarding the planning or scheduling the resources for expressway emergency rescue strategies. The current literature analysis indicated that about two third (2/3) persons were severely wounded in traffic accidents or lost their lives. The reason behind the severe consequences was ascribed to the delayed rescue actions with bad communications [1].

In order to reduce the life and property losses caused by traffic or natural accidents, it is essential to develop optimized traffic emergency rescue resource scheduling method so as to shorten rescue decision time and improve the quality of rescue services for the people.

Modeling based Simulation is an admitted model for simulating human behavior in working environments. The official examples of that are in traffic simulation, a relatively mature field, and in simulating the road accident and their rescue through highway. Significant to both certain approaches is occupying the movements of people in the area. Simulating situations similar to traffic jams is beneficial for different reasons. First of all, a fully developed simulation can contribute insight toward the measure of the road accident and actions that can begin to traffic jams. Secondly, Unity3D-based simulations provide planners with the knowledge to decide situations to deal with the emergency event.

And therefore, the Modelling and simulation methods on Traffic emergency response are researched as following chapters.

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II. Literature Review

As for the related research on the emergency response for the traffic system, there are some literatures, for example, Antoniou et al. [2], [3] deem that he emergency response the simulated rescue plans include various strategies, e.g. the first called, first served strategy, the nearest origin dispatch strategy, or the flexible dispatch strategy. The need for improved incident response models or the data available for developing such models was described by Ozbay and Kachroo. Similarly, recognizing the highly stochastic nature of traffic or the incident management operations, the simulation models were introduced that can be used in designing a new freeway service patrol [4], [5]. The dynamic truckload routing and scheduling problem with time windows were reported for operations in the over-saturated conditions on public highways [6].In a study by Ozbay and Bartin, a simulation model was developed using Arena simulation package and used to model and examine the effects of various incident management strategies for the incident management operations in the Washington D.C [7]. In order to improve the operations of existing programs, Liu and Hall develop a computer program that simulates the occurrence of highway incidents, the dispatching of emergency vehicles and the traffic flow on the network [8]. The causes of delay during the freeway emergency response planning were reported in a previous study [9]. The simulation model considered the trade-off between freeway accident delay and the size of the freeway emergency response fleet, or the effect of alternative dispatching strategies on the performance of the freeway emergency response fleet. Similarly, Goldberg et al. developed a simulation model to evaluate the alternative base locations for an emergency response fleet in Tucson, Arizona [10]. The literature also shows the development or optimization model for flexible dispatching strategies by utilizing available real-time or travel time information. The simulations considered the real-time travel information to assists the emergency vehicle dispatchers or routing after assigning response vehicles and guiding those vehicles through non-congested routes [11]. The study demonstrates that the removal of obstacles on the road or traffic channeling or evacuation is a critical activity during the disaster management planning [12]. Due to the lack of enough

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emergency response information, lack of knowledge and theory of the emergency response mechanism, the decision-makers find it difficult to make a response decision [13]. And therefore, it is necessary to adopt the modelling and simulation methods to support the traffic response.

III. A Frame of Simulation and Executions

In order to improve the emergency response capability, it is important for us to design a framework to guide the modelling and simulation so as to support the traffic emergency response. In this paper, the primary focus is to plan, collect, process or respond during the emergency situation. In Fig. 1, the tasks, activities or the sequence of activities described to arrive at a decision or to manage the situation. The components of the designed strategy indicate the time point in the arrangement of occasions during the response period. The strategic response evaluates the situation, decide the alternative solutions or considered the physical features, e.g. traffic pattern, location, or time of the day to manage the emergency situations.

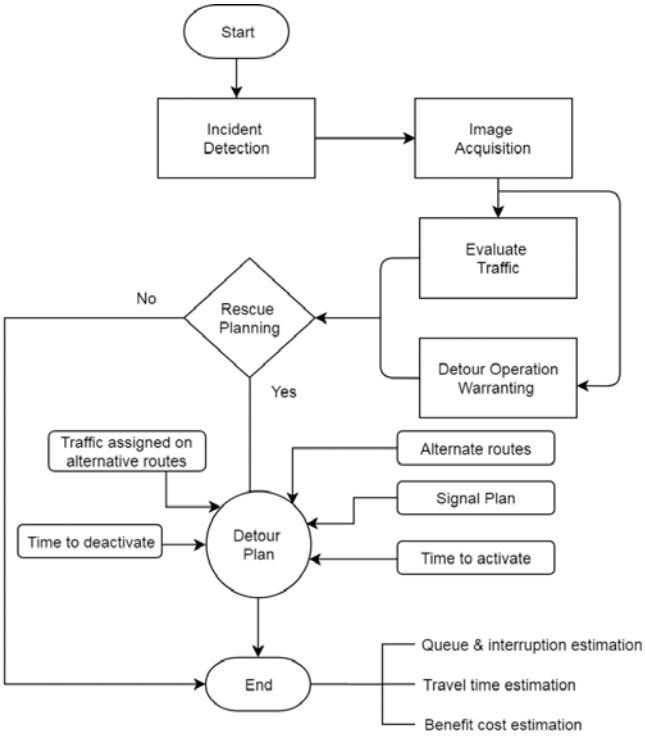

Fig. 1. A framework of simulation and their execution.

The proposed strategy comprised three consecutive stages, i.e. initial phase, sending alerts, arriving or handling and completion. In the initial phase of crisis identification, the gadget for the emergency alert was checked by working individuals in the building. The individual suspecting the emergency issue send alerts to the desired department. The processing of alerts follows the initiation of response by the concerned emergency personals, e.g. arriving or handling the situation. They begin to manage the situation by sending specialists team to the crisis region. The initial task includes assessment of the fear-based oppressor environment followed by vigilant decision to arrive at the best work strategy to overcome the emergency on the highway. The end of the strategy was simulated after following the control of circumstance.

Guided by the framework, the simulation environment is built in detail by means of the Unity3D and C# tools. The useful Unity 3D travel simulation and modelling tools offer great opportunity to model traffic on the highways along with the geographical information, e.g. hilly areas, plain areas or area with the possibility of landslides.

IV. Modeling and Simulation for the Traffic Emergency Response in Unity3D

The computer assisted simulation is a powerful tool to include traffic, accident or affected area or proper response in space and time.

Example as an emergency landslides are clearly visualized to assess the situation in the flow of traffic or making plans to divert the routes and facilitate rescue activities or clearing the affected roads after landslides. The simulation of emergency response provides useful information to the managers, planners or general users to evaluate local accident area scenarios and decide possible solution to reduce the risk of loss of precious lives.

A. Common Traffic Simulation

During the common traffic simulation, we set the volume of traffic on the road. Fig. 2 displays the common simulated situation using the Unity 3D to generate the local traffic scenes along a hilly road side with the possibility of landslides in rainy season.

Fig. 2. Traffic generation in scene using Unity3D.

B. The Emergency Accident Scenes Simulation

Vehicle incident scene can similarly result in numerous other threats, together with electrical/arcing lines, mechanical damage/intrusion hooked on construction buildings, natural gas/propane leaks, spills of gasoline or other flammable liquid leaks, and other potentially hazardous materials situations. A typical dispatch for vehicle accident will possibly contain emergency medical services (EMS) components and maybe a rescue. The ladder company might be allocated for traffic obstructive if working on a multilane road or might be allotted as the interruption company. If around one or more victims trapped or pinned in the accident report, the dispatch is expected to enhance the rescue components or additional apparatus as you can see in Fig. 3. In Fig. 4, after the accident, the whole road has been blocked, and one-way traffic flow has been stopped. The Simulation of traffic accident comprised basic information: (1) Accident location, (2) occurrence time, (3) or the number of casualties in Table I.

TABLE I: The Basic Information for Simulation

Information	Description of Entire Information
Location	The site area of the accident, GPS
Time	Which time like a year, day, month
Cause	The major casualty for the accident

Fig. 3. The traffic accident from land sliding.

Fig. 4. Traffic jam after a car accident occurred.

C. Traffic Emergency Response Modeling and Simulation

The rescue response simulation demonstrates the accident response scenes as shown in Fig. 5. The response planning constitutes the major part of the model to control the traffic on the highway in case of emergency, i.e. road blockage due to landslide or fall of heavy stones on the road. The response was initiated to clear the obstacles on the road to avoid a further accident or create temporary traffic diversion on public roads. The response also considered controlling the upcoming traffic at the right time, updating the travel time based on the traffic output, dispatching the service vehicle on the spot, monitoring the whole situation of the accident.

Fig. 5. The scene is showing the accident simulation response.

D. The Simulated Vehicles Dispatch Action

The dispatch center role is to provide different types of rescue vehicles, e.g. cranes, ambulance. The availability of rescue resources is a critical phenomenon to save the lives of the affected peoples. The present study considered following dispatching strategies to build a simulated rescue framework: (1) First, come and first serve strategy. The dispatch policy required sending the duty or rescue vehicles to the incident sites that were reported leading by the system. In that dispatch planning, incident sites might be neglected by the duty vehicle which implies assigned to an incident happened first at a considerable location. (2) The Nearest associate. This dispatch plan dispatches the duty vehicle to the following site of the incident. The Nearest associate system seems to happen in the shorter waiting period for service following massive workloads because this dispatches the duty vehicle to the nearest location by a need for help, although of the event of disaster occurrence and cruelty.

Several response carriers in the line represent a competent crew and implement emergency assistance. From this simulation station, vehicle movements are defined by holding track of the position, the situation, the point and the path before the destination as every vehicle.

The process of finding the shortest route remains a primary graph difficulty during computer-assisted simulations. The calculation regarding the necessary components in various design algorithms becomes multiple practical-world applications. In the simulation framework, it was used to update the accident or vehicle information. The information for vehicles to update includes the current location, the route, the destination, the time point of next status, current status, or next prediction status. However, if the position of vehicle changes, accident response module will update the information matrix and resume the shortest path accordingly, e.g. re-routing and updating destination paths. The informed decision regarding an accident or rescue plans requires regular updates includes adding or removing an accident site or the remaining time along with the required time limits in particular situation affecting the life of people on the roads.

V. Conclusion

A simulation framework was designed and used to simulate an emergency response system for highway traffic safety and security or to minimize the average response times associated with different accidents on the road. The rescue strategies were simulated to educate or improve the performance of road safety planner or managers. The Unity 3D based simulation was designed to train or educate the road safety and security official to plan various activities to rescue precious lives in time and space. The coordination of various rescue activities was realized through A* search algorithms. The situation analysis and prompt decisions enabled effective planning to tackle the emergency situation on the road. The developed rescue design and simulation play a key role in the current or future work to better utilize the rescue resources and save the physical infrastructure of the live of the people. The idea present in this study offers an opportunity for present or future planner of the safe roads for the smooth traffic flow and safety measure in case of a traffic accident in real-world situations.

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