UTC Spotlight

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Travelers’ Rationality in Anticipatory Online Emergency Response

An innovative project at the North Carolina A&T State University (NC A&T), sponsored by the Center for Advanced Transportation Mobility (CATM), a Tier 1 UTC, is seeking to reduce the time needed for emergency response vehicles (ERVs) to respond to a sequence of emergency service requests while considering the behaviors of travelers stuck in traffic. The Travelers’ Rationality in Anticipatory Online Emergency Response project could improve on decision making related to the allocation of emergency response vehicles (ERVs) by taking real-time information about the behavior of affected travelers into account to anticipate traffic impacts and better manage response resources.

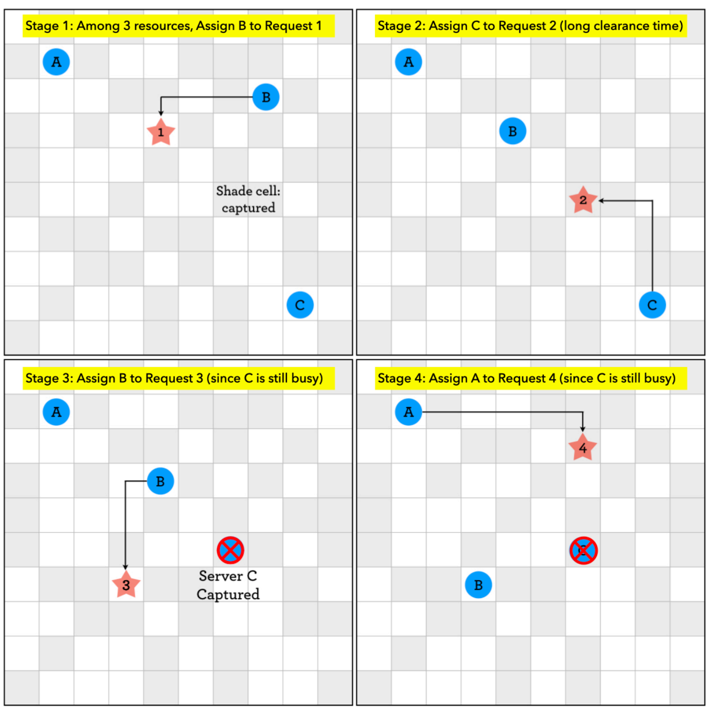

Figure 1: Online Dispatching Strategy with Look-ahead Busy Resources

Traditional decisions in response to requests for emergency vehicle resources do not account for traffic flow behavior, nor the rationality (i.e., ability to make wise and sound decisions) of travelers in the transportation network. Existing models have prioritized the fastest response, regardless of the severity of the incidents or potential need for additional emergency resources in a later stage in the incident chain. In this research, an approach from a patent titled “Transportation Infrastructure Location and Redeployment,” issued by the United States Patent and Trademark Office (USSN 16/254,474), has been modified to accommodate online models, consider the availability of emergency vehicle resources in the near future (Figure 1), and minimize the total travel time delay encountered by the users in the transportation network.

The online optimization model, Look-ahead-Work Function Algorithm (L-WFA), is extended to accommodate decisions in which there is a need to determine whether to change the allocation of emergency resources. This need is beneficial when the travelers’ rationality exceeds a certain level. The model considers future expected delays based on dynamic traffic flow. The decisions travelers might make in the vicinity of an emergency event are predicted based on travel time and volume data obtained from traffic sensors located in the real-world transportation network. A data-driven logistical regression model that considers the correlations of the various actions or paths a driver might take is used to illustrate traveler’s route choice changes before and after incident occurrence and is integrated into traffic simulation software. The route choice model (Figure 2) incorporates several factors, such as the time the traveler saves on the route, incident duration, number of lanes opened, and probabilities of occurrence.

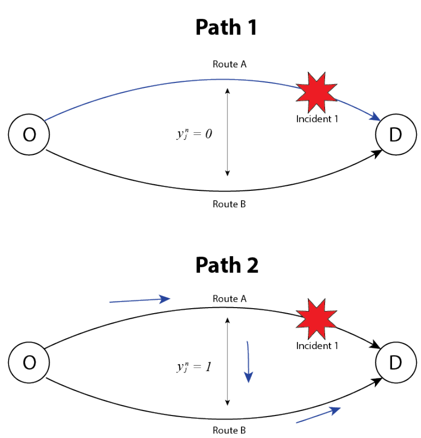

Figure 2: Example of a route-switching scenario when an incident presents on Route A

Table 1. Comparison of two ERV (A and B) dispatching strategies

Incident Location	Incident detection (AM)	Proposed L-WFA	Delay (veh*min)	Myopic	Delay (veh*min)	Duration (min)
I-695 EB AT US 1, EXIT 32	7:00	A	1893	B	1574	30
I-695 AT PROVIDENCE RD	7:40	B	1926	A	2468	15
I-695 NEAR EXIT 36 MD-702	8:15	B	1905	A	2059	30
I-695 AT EXIT 15B	8:30	A	1914	B	1193	15
US-1/SOUTHWESTERN BLVD/EXIT 12	9:00	B	1629	A	4775	30
MD-10/EXIT 2B & 3B	9:50	A	3460	B	3928	50
HOLLINS FERRY RD/EXIT 9	10:20	A	2291	B	1860	30
MD-140/REISTERSTOWN RD/EXIT 20	10:30	B	893	A	2034	10
EDMONDSON AVE/EXIT 14	11:20	A	1010	B	1951	10
MD-41/PERRING PKWY/EXIT 30	11:40	B	2339	A	2604	20
Total delay for all incidents (veh*min)	-	-	19260 (-5185)	-	24445	-

Since the path one vehicle might take to reach the driver's intended destination is likely to differ from the path another vehicle might take to reach a different (or even the same) destination, a boundedly rational travelers' choice model is a helpful decision-making tool, because it takes into consideration the limitations of both human cognition and the amount of time available to make the decision. This type of model has been shown to be more effective at dispatching ERVs such that traffic delays to the network are reduced. When incorporated into an easy-to-use interface, the L-WFA can be utilized by emergency responders to employ more efficient response strategies.

Using the method described above, a TransModeler simulation of Maryland I-695 was used to determine if travelers are likely to take an alternative route to reach their destination when an emergency incident occurs. Considering travelers' route switching and emergency response (either A or B), total delays on the network were calculated for each incident (Table 1). The proposed emergency dispatching strategy (A-B-B-A-B-A-A-B-A-B) was compared against the myopic strategy (B-A-A-B-A-B-B-A-B-A). For 10 incident occurrences in the morning, it was found that the proposed model could reduce the total vehicle delay by 21%.

Partnerships and Future Research

This research has been extended to use Unmanned Aerial Vehicles (UAVs) to help ERVs arrive more quickly to emergency sites to save lives, reduce secondary crash occurrences, and reduce delays to transportation network users (Figure 4). A stochastic processing model has been developed to predict evolving traffic conditions and future dependent emergencies in high performance computing and visualization environments. UAVs have been coordinated with ERVs in an automated framework to adapt to the revision of Federal Aviation Administration rules that already have been announced to accommodate more advanced operations. The NC Department of Transportation (DOT) and Virginia DOT cosponsored this idea of using UAVs to count the number of vehicles on the road and create scenarios for traffic operations. UAVs will be operated to provide useful information about traffic conditions on potential ERV routes. Sponsored by NASA, this model has been extended to catastrophic emergency scenarios (e.g., hurricane) when some traffic sensors are not working properly and UAVs assistance is required. The foundational method of information-theoretic modeling has been supported by the National Science Foundation's Robust Intelligence program.

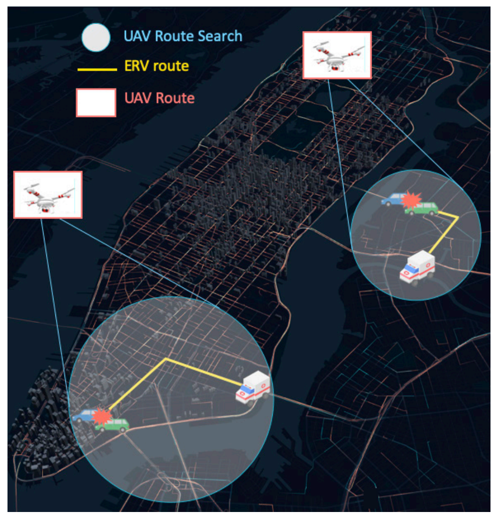

Figure 4: DRONETIM: Dynamic Routing of Unmanned-aerial and Emergency Team Incident Management

About This Project

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