A responder's critical path

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The SAFE-NET routing platform. Credit: National Institute of Standards and Technology

We've all come to rely on the navigation apps on our mobile devices to steer our daily itineraries. Within seconds of typing our destination into a blinking search bar, we have an expertly planned route and estimated time of arrival. These apps are incredibly accurate, usually predicting your travel time within a few minutes of accuracy. For our nation's first responders, however, those few minutes could mean the difference

between resuscitating someone from a heart attack and getting there too late. In the public safety world, minutes, even seconds, can mean all the difference. NIST Public Safety Communications Research Division's funded project from Southern Methodist University aims to create a tailored-to-public safety navigational platform to support the efficient and safe dispatch of personnel for emergency response. This project intends to surpass capabilities of typical navigation apps by seeking to predict impediments to emergency response like weather, floods, traffic patterns, and response resource availability.

The Problem

Fire trucks are not very similar to a typical civilian vehicle, so applications like Google Maps and Waze that have become accessible and reliable to everyday Americans fall short in meeting the needs of first responders. First and foremost, emergency vehicles are significantly larger and harder to steer when compared to a regular car. As such, they often cannot be driven on certain winding or narrow roads. Another risky maneuver for large trucks is left turns, which can increase the risk of traffic accidents. The researchers working on the SAFE-NET project saw an opportunity to modify existing navigation algorithm systems to meet the specialized routing needs of public safety.

Dr. Khaled Abdelghany, the principal investigator on this project, explains the overall goal of their research: "We wanted to develop an analytical platform that uses data to provide better capabilities for the first responders in terms of how they dispatch their resources from fire stations and to make sure the dispatching is fast and safe." The SAFE-NET research team worked alongside the Dallas Fire-Rescue Department to fully understand the challenges faced by public safety for incorporation into their solution. To build the platform, the team considered the specific navigational challenges faced by emergency vehicles, travel time, the risk of traffic accidents, and flood risks. The

team of researchers incorporated each of these data layers into their platform to predict the fastest and lowest risk route an emergency vehicle could take when responding to an incident in their jurisdiction.

The Risks of Driving an Emergency Vehicle

One of the most significant risks emergency vehicles face is arriving too late. As such, the team investigated the risk involved with traffic slowdowns from accidents. May Yuan explains, "Emergency dispatch is a very sensitive operation and there are a lot of nuances that go beyond the mindset you have as a researcher." Dr. Yuan analyzed traffic accident data to determine the site characteristics that could influence the likelihood of traffic accidents (like rough pavement or uneven lanes). She then used those common characteristics to identify other potential traffic accident locations fitting those criteria across the city of Dallas. Dr. Yuan explained "We categorize locations by high and low traffic risk based on the site characteristics and traffic accident data over the last 10 years. The idea is that if we want to dispatch emergency vehicles, you may be better off dispatching along a road less likely to have a traffic accident that could delay the arrival of the emergency vehicles at the call site."

An additional risk identified by the Dallas Fire-Rescue Department that the team needed to consider was the risk of flood on potential emergency dispatch routes. With the increased frequency of storms caused by climate change, flooding in Texas is expected to be an ongoing problem to the men and women navigating emergency response. The rise in urbanization and subsequent impervious surfaces is also increasing the likelihood of flooding. Roadway flooding poses a threat to first responders' missions through road closures, traffic slowdowns, and—in the worst-case scenarios—their lives could be at risk. Dr. Barbara Minsker points out, "First responders need to be able to route around certain areas that might be flooded—there have been cases where

first responders have died because their vehicles have washed away in a flash flood."

The SAFE-NET platform aims to estimate the probability of flooding on roadways with data-driven modeling. Dr. Minsker explains, "We used data from Dallas for the last two years of storms, where people have recorded that certain areas were flooded. We analyzed how often these particular areas flooded relative to the strength of the storm, average rainfall, and the topography of the area. Then, we created a statistical model that related these data points so that we could predict the risk of flooding in the area."

The team used machine learning and artificial intelligence to build the SAFE-NET platform, incorporating each of these elements of risk and other special considerations for emergency vehicles, aiming to help first responders to find the fastest, most efficient, and safest route, given their requirements.

Next Steps in the Research

"It was really compelling to do something for first responders," explained Dr. Minsker, "It gave us a chance to connect with Dallas Fire-Rescue and build on some of the things that we each, individually, had been doing in a new way to help responders." PSCR's funding opportunities require collaboration with first responders to ensure the outcomes have a real impact. Dr. Yuan adds, "In academia, we do a lot of theoretical conceptual work, and this project is really a good bridge between conceptual, theoretical investigation, and real-world applications. To see our research in the real-world operations—in this case, to help first responders provide a safe community for the city—was very fulfilling."

The team hopes to continue this line of research, building off of the

statistical models and machine learning algorithms they've developed for the SAFE-NET platform. Dr. Michael Hahsler reflects, "The idea is that we can also use artificial intelligence to predict where the next emergency is most likely to happen. There are areas where fires are more likely or areas where medical emergencies are more likely, during different times of the day. If we have the power of this knowledge, we can actually move vehicles closer to where we think an emergency is most likely to happen next time."

More information: For more information, see www.nist.gov/ctl/pscr/safe-net … e-computing-platform

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