RapidEMS: A Novel, Systematic Signal-to-Vehicle Communications Strategy

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***Abstract*—Delays in Emergency Medical Service (EMS) response times significantly increase the risk of patient complications and, in some cases, even fatality. Traditional EMS vehicles often face delays of up to 10 minutes, which is further accentuated by their reliance on sirens to alert traffic. To solve this issue, we propose RapidEMS: a systematic traffic-to-infrastructure communications strategy and framework integrable into EMS vehicles to reduce response times. For testing, we developed RapidGLD, an updated version of the Green Light District (GLD) traffic simulator. The experimental results show that the implementation of a systematic communications strategy can reduce the average travel time of EMS vehicles.**

I. Introduction

THIS paper details our research in simulating and reducing Emergency Medical Services (EMS) response times. For optimization, we have developed RapidEMS: a communications strategy in which drivers along an EMS vehicle's route are alerted before its sirens become audible. Further explanation of our strategy can be found in section II;

Contemporary emergency medical services (EMS) response times in reaction to life-threatening events play a critical role in determining the mortality rate of a patient. Prior empirical research has provided evidence that largely supports the importance of reducing response time (Blanchard et al., 2012; Bürger et al., 2018; O'Keeffe et al., 2011; Sampalis et al., 1993). Additionally, the idea that quicker response times lead to improved outcomes for patients is a widely accepted and established principle within the EMS field (Blanchard et al., 2012). Introducing systems to EMS that decrease the response time of its vehicles is has a significant correlation with the likelihood of saving a patient.

Furthermore, EMS systems inevitably interact with stop-lights, road blockages, and vehicles. Previous research has shown that seemingly arbitrary variables such as the arrival frequency of buses and taxis to their stops slow down travel time (Carrillo-González et al., n.d.). Additionally, the effects of ambulance diversion (i.e. "a patient not being transported to their initially intended hospital because the hospital is unable to accept patients because of temporary emergency department overcrowding or closure") and clinical handover communication (i.e. "communication between staff in healthcare"), can effect the success rate of EMS systems (O'Keeffe et al., 2011).

Today, Emergency Vehicles utilize the OptiCom [CITE] system that control traffic lights to provide the fastest route to an emergency scenario. While it is an effective system, government agencies tend to stick to legacy systems due to their proven up-time and critical role. Modern amenities like traffic based routing and the advancement of the cellular network open the door to limitless optimizations and improvements.

Simulation of our strategy was conducted using RapidGLD, which we developed. RapidGLD is a derivative of Green Light District (GLD) Simulator (Wiering et al., 2004), a traffic simulator designed to test the performance of reinforcement learning (RL) traffic light controllers. RapidGLD enables us to test our strategy across varying levels of traffic density in a fully operational traffic infrastructure. The results showed that the usage of a strategy like RapidEMS can decrease the response times of EMS vehicles.

II. Communications

Our strategy necessitates a viable means of communication between vehicles and traffic infrastructures. We propose our main communication to drivers is through integration with vehicle information systems. Similar systems exist CITE like OnStarr, Starlink, and Connected Vehicle Services that provide emergency assistance whenever needed. RapidEMS would also integrate into local emergency agency's to grab the latest events and send them to all vehicles en route to the emergency. Our system would display an alert in the vehicles information cluster, whether it would for Advanced Lane Routing or notification of a developing emergency scenario.

Implement google maps, self driving cars

A. Strategy

Signals

B. Integration Into GPS Services

III. Rapid Green Light District Simulator

To simulate and assess our communications strategy, we developed Rapid Green Light District (RGLD) simulator in Java, building on the Green Light District (GLD) simulator Wiering et al., 2004. RGLD contains additional code that enables it to simulate the effectiveness of our communications strategy based on various statistical measures.

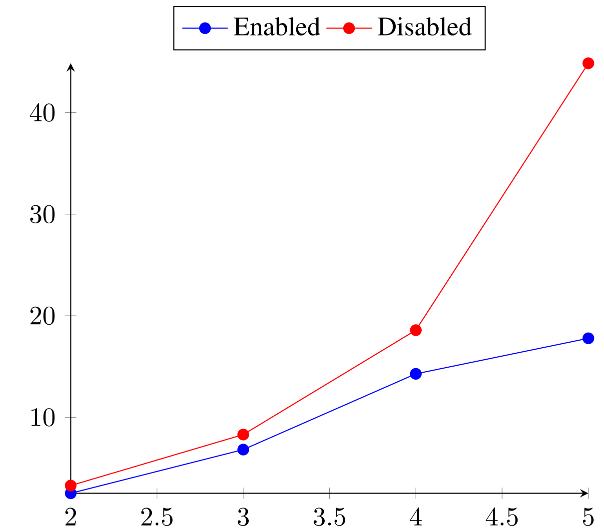
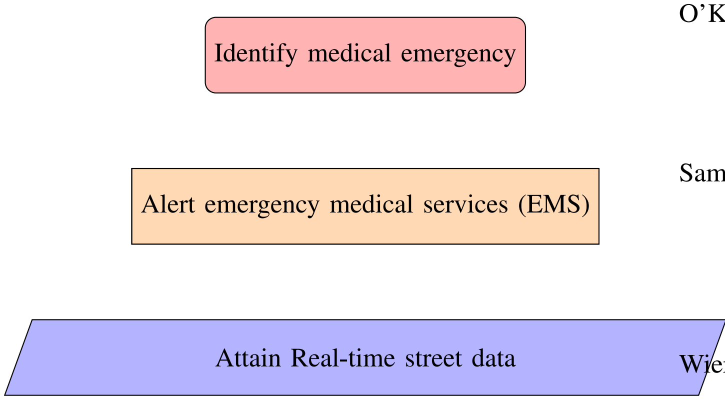


Fig. 1. Average total waiting times produced in RapidGLD with and without the implementation of RapidEMS.



IV. Experiments

V. Conclusion

Based on the data collected, with the implementation of RapidEMS, emergency vehicle response times decreases and routing efficiency increases, allowing there to be a positive outcome for the patient.

A. Limitations

However, there are limitations with this project. The simulation only used one map, focused solely on urban areas, and used wait time as the indicator for response time. Additionally, this demonstration was done on a simulation, meaning that it may behave differently form a real-life scenario.

Appendix A
Proof of the First Zonklar Equation

Appendix one text goes here.

Appendix B

Appendix two text goes here.

Acknowledgment

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