Smart Ambulance Approach Alarm System Using Smartphone

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***Abstract*—In order to inform the approach of the ambulance to other vehicles, we developed a smart ambulance approach alarm system by making the position information of the ambulance open. The position information of the ambulance has not made open until now due to the development cost or privacy issue. Our proposed system is to make an ambulance IoT just to put a smartphone installed special application on a dashboard. Our cloud side application also controls the position information of the ambulance distribution in consideration for the situation of other vehicles and the privacy of ambulance users. We inspected the functional effectiveness of this system by the proof experiment in the public road.**

I. Introduction

A traffic jam occurs frequently due to high population density in the urban area of Japan. Many vehicles also close a window and run due to high temperature and humid climate especially in summer period. Then, we have some cases that we do not hear the siren of the ambulance. This leads to the delay of the ambulance.

In order to solve this problem, we developed a smart ambulance approach alarm system which can be used for making the position information of the ambulance open. A characteristic of this system is to make an ambulance IoT just to put a smartphone on a dashboard. This system can transmit the position information of the ambulance only to the vehicles on the line of the ambulance. Besides, this system does not transmit position information of the ambulance when the ambulance does not run on major road due to privacy issues. Thanks to these characteristics, we were able to build the smart ambulance approach alarm system at low cost.

II. Related Work

Traffic Signal Preemption system has been proposed [1]. It allows the vehicles to preempt and operate the traffic intersections with the help of mobile devices, in case of emergencies on the way to hospitals in order to reduce the delay and improve the response time. This system pays attention to the traffic signal preemption, not to the ambulance position distribution.

A system to manage fire engines and ambulances effectively using position information has been put to practical use. For example, at the Kyoto city firefighting station in Kyoto prefecture, they manage positions and the activities of fire engines and ambulances in real time using special devices [2]. They operate the system letting an appropriate emergency unit dispatch by integrating devices. However, this system has been used only in the Kyoto city firefighting station. It has not been opened to the public yet.

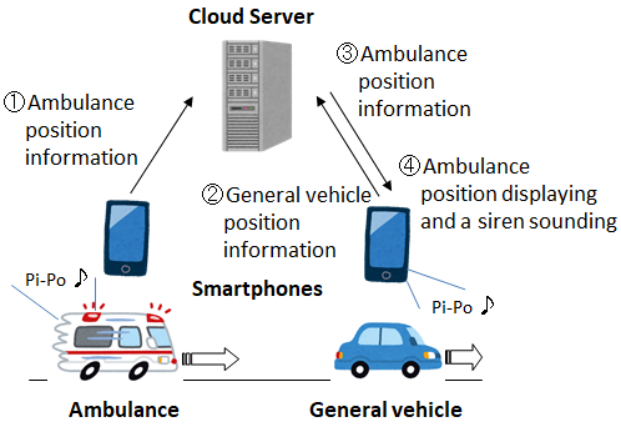

Fig. 1. System flow of Smart Ambulance Approach Alarm System

III. Smart Ambulance Approach Alarm System

A. System Flow

This system consists of smartphones in an ambulance and general vehicles, and a cloud server (Fig.1). The ambulance smartphone application is used for sending the ambulance position information to the cloud server. We designed the sound interface between the ambulance and the smartphone which was put on a dashboard of the ambulance. While a siren sounds, the ambulance smartphone application transmits the ambulance position information to the cloud server (①). This specification does not affect the ambulance itself or ambulance crew.

On the other hand, the cloud server application distributes the ambulance position information to the other general vehicles while satisfying the next condition.

- The ambulance runs on major road.
- The distance of the general vehicle and ambulance is less than 500m.
- The general vehicle and ambulance come close.

In order to judge these conditions, the general vehicle smartphone application transmits the position information of the vehicle to the cloud server application (②). If a condition was satisfied, the position information of the ambulance was transferred to the general vehicle smartphone application (③).

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Then, the position of the ambulance will be displayed on the general vehicle smartphone application and the siren will be sounded through the general vehicle smartphone (④). We developed the prototype system according to the specification described in TABLE I.

B. *The ambulance smartphone application*

This application acquires a sound from a microphone of the smartphone and judges it whether the volume of the specific frequency is higher than specific volume. When this condition is satisfied, the position information of the ambulance is transmitted to the cloud server. Frequency of the sirens of the Japanese ambulance is 960Hz and 770Hz.

C. *The general vehicle smartphone application*

We developed this application as a Web application. After user authentication, it displays the position of the ambulance coming close to the own vehicle on a map based on the instructions from the cloud server (Fig.2). We also implemented the function to compose the siren of the ambulance.

D. *The cloud server application*

From position information of the ambulance and the road map information, this application maps the position of the ambulance with respect on a road. It also calculates the line of the ambulance. After getting the request from a general vehicle, it replies to the general vehicle in the position of the ambulance when the condition described in A. is satisfied. In the case of Fig.3, only three red-color marked ambulances would be displayed. The other ones would not be displayed.

IV. EVALUATION

We evaluated the prototype system on May14th, 2018 near Bunkyo campus of Nagasaki University in Japan. We used two normal vehicles for this evaluation. One is for the role of ambulance equipped with the smartphone installed the ambulance smartphone application and a note-PC which includes the sound source of the ambulance siren (Fig.4 (a)). One is for the role of general vehicle equipped with the smartphone installed the general vehicle smartphone application (Fig.4 (b)). We checked all functional availability according to the system flow described in section III. A.

V. CONCLUSION

We developed the smart ambulance approach alarm system which can be used for making the position information of the ambulance open. By this system, we can realize the efficiency of ambulance operation without treating additional cost or concerning about privacy protection. We confirmed the basic functionality of this system through the proof experiment in the public road. In future work, we will make a plan to install our system into the real ambulance as a field experiment.

TABLE I. PROTOTYPE SPECIFICATION

	Ambulance	General Vehicle	Cloud Server
Hard-ware	・Sharp AQUOS EVER SH-02J	・Sharp AQUOS EVER SH-02J	・CPU: Intel(R) Xeon(R) CPU E3-1220 v3 @ 3.10GHz cpu cores: 4 ・Memory: 8GB
Soft-ware	・Android 7.0 ・JAVA 1.8.0 (JDK8) ・Android Studio 3.0.1	・Android 7.0 ・Google Chrome	・Cent OS 7.3 ・ Apache 2.4 ・PostgreSQL 9.5 ・PHP5.6

Fig. 2. General vehicle smartphone application display image

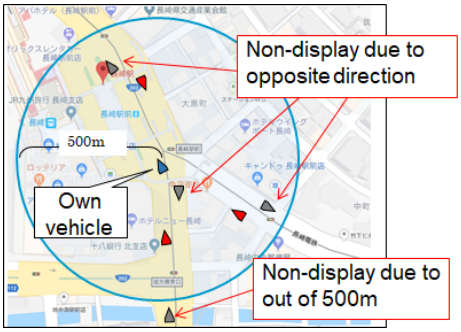
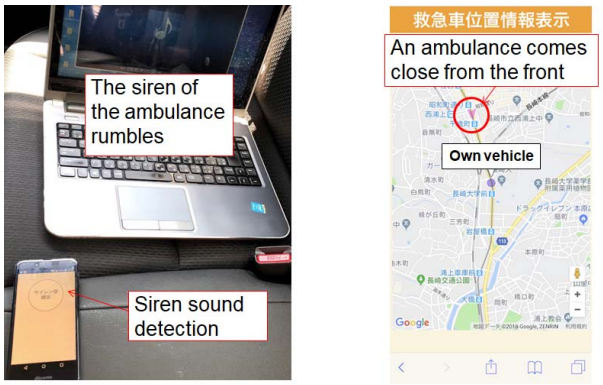


Fig. 3. Cloud server application control results



(a) Situation in vehicle of ambulance role (b) Ambulance approach scene

Fig. 4. Evaluation results

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[2] Kyoto city fire department, http://www.city.kyoto.lg.jp/shobo/page/0000224557.html