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Virtual remote view system in traffic jam using smartphone peer-to-peer image propagation

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Abstract

You usually want to know the traffic situation ahead while driving. For example, you probably want to see a situation at the head of a traffic jam. In this study, we propose a virtual remote view system in a traffic jam. Smartphones on a dashboard are connected as peer-to-peer communication, and the jammed road images are propagated to them behind. An experiment was conducted to confirm that this system works properly. Some positive evaluations for a virtual remote view were obtained from subjects.

CCS Concepts

• ***Information systems*** → ***Multimedia information systems;***

1. Introduction

You usually want to know the traffic situation ahead while driving. You also want to know it over the vehicle in front of you. The see-through view system has been proposed [SH12], a road image taken at the front of a truck is displayed on a rear panel of a compartment. The other see-through view system has been proposed too [RHJ*16], a vehicle on a road image is detected and removed by using some different position camera images. They need large equipment and are expensive to get "remote view". We have also proposed a deferent type see-through system [MIF18], that is smartphone application and transfers a road image to a behind vehicle smartphone. Note that some automobile manufactures use the word; see-through also for an image monitor such as a navigation system that displays blind spot image. Our system does not need a special device or server computer, but is realized by peer-to-peer communication.

Here, these systems work for nearby vehicles, and they ahead are made transparent. On the other hand, jam information is generally reported and displayed on a navigation system recently, you probably want to see the situation at the head of a traffic jam. Although there is a research to provide traffic jam road images from server to client [TOY*13], it still contains a same problem of a see-through view system. In this study, we propose a virtual remote view system in a traffic jam. Smartphones on a dashboard are connected as peer-to-peer communication, and the jammed road images are propagated to them behind. You, driver can grasp traffic condition ahead intuitively. Of course this system does not contribute to safety directly, unlike see-through, it is expected to relive the driver's stress, and to improve safety.

2. Concept and outline

The virtual remote view system needs (1) a function to judge whether it is a traffic jam or not, and (2) a function to propagate an image to behind.

(1) Traffic jam judgement: In order to distinguish a traffic jam from waiting at the lights and parking, first, when driving at less than a predefined threshold speed $V[km/h]$ for a threshold period $T[sec]$, this vehicle is judged in a candidate state of traffic jam. If one of the following three conditions is satisfied additionally, this vehicle is judged in a traffic jam state.

- A traveled distance is more than a threshold distance $M[meter]$ after the state is changed to candidate.
- The number of the vehicles that states are candidate and are traveling for a same direction is equal to or more than N.
- The number of the vehicles that states are traffic jam and are traveling for a same direction is equal to or more than 1.

(2) Image propagation: In order to send an image from a smartphone to another smartphone, each smartphone acts one of the roles as a head transmitter node, a relay transmitter node, and a receiver node according to each condition.

- There is no cars ahead that states are traffic jam and directions are same: this smartphone acts as a head transmitter node.

  It sends a front view image to a receiver node behind that requests. For the last receiver node within a threshold distance $D[meter]$ behind, the head transmitter node send it a message to act a relay transmitter node.

- A front image sent by a transmitter node carries a role change message: this smartphone acts a relay transmitter node.

  It works like a head transmitter node, i.e. sends an image and a message.

- There is a head or relay transmitter node ahead: this smartphone acts a receiver node.

  It sends the nearest transmitter node ahead an image request.

In other words, the system needs each smartphone position, and to calculate each speed, direction, and traveled distance. It also needs to communicate with other smartphones around it, and to know their information.

3. Implementation

The pilot application for virtual remote view is implemented on an Android device. GPS function of a smartphone is used to obtain its position data. Speed, direction, and traveled distance are calculated by GPS displacement. Wi-Fi Direct technology is also used to communicate with other smartphones around it. Some information of a smartphone is necessary to decide a node role before connection is established, so they are labeled within a broadcastable device name according to the Wi-Fi Direct standard. After connected based on a rule mentioned above, each smartphone send or receive a jammed road image as a socket communication.

A driver usually want to see not only a head image of a traffic jam, but also a halfway image of it, a road image ahead taken by not only a head transmitter node, but also a relay transmitter node is sent behind. However long traffic jam causes a large number of images, images should be thinned out. The GPS position data of images are compared for a pair of the closest images then more behind image is removed until a threshold number, to keep road images at equidistant intervals. They are displayed on an application screen in a list format (Fig. 1), and are able to scroll ahead and behind and to enlarge with text information as an image taken position something like that.

4. Result and conclusion

An experiment was conducted to confirm that this virtual remote view system propagates images taken by a smartphone ahead properly. Following thresholds and constant are used empirically in the experiment; $V = 20$, $T = 1$, $M = 100$, $N = 2$, and $D = 50$. The experiment assumed the situation where cars were in a traffic jam without any actual cars (Fig. 2). Four Android devices were used for the test. It was confirmed that each device changed a role according to the conditions, and propagated images each other (Fig. 3); Some positive evaluations for a virtual remote view were also obtained from subjects. In the future, thinning image method should be reconsidered, the images that are not appropriate to get the lay of the land, i.e. just a large rear panel image of a truck compartment, should be thinned.

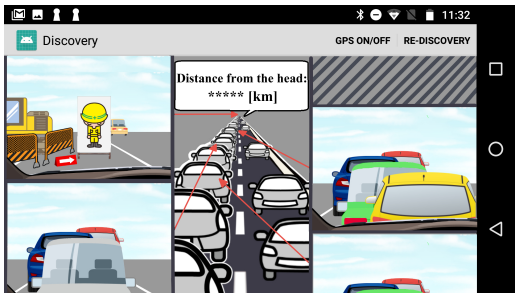

Figure 1: *Illustration of expected application screen*

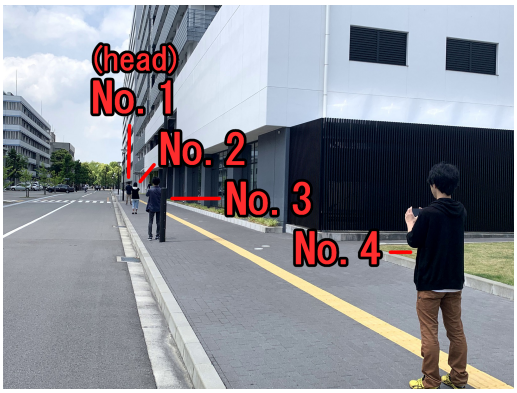

Figure 2: *Appearance of experiment*

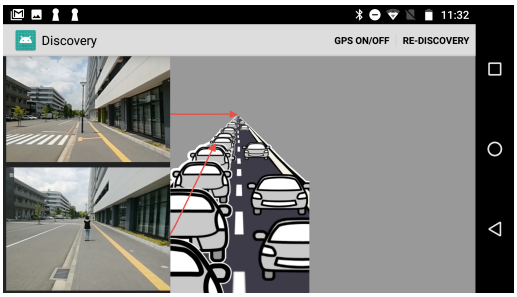

Figure 3: *Application screen (No. 4) of pilot system with images of No. 1 and No. 3 in Figure 2*

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