Basic Consideration of Video Applications System for Tourists Based on Autonomous Driving Road Information Platform in Snow Country

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Abstract. Autonomous driving is getting popular year and year around the world. However, applications over autonomous driving car have not been discussed so far. In this paper, video applications including AR and VR contents for tourists on the autonomous vehicle in normal case are proposed. Automatic disaster information and road navigation systems from current area to safe evacuation area in urgent case are also considered. The system configuration, architecture of the autonomous driving road information platform and its presentation method are precisely explained. Finally, a prototype system using current available autonomous driving platform is discussed.

1 Introduction

Recently, autonomous driving systems have been investigated and developed in industrial countries in the world. Some of countries, such as the U.S., China, Japan and Europe and produced the practical autonomous driving cars which can run on the exclusive roads and highway roads at level 3 or 4. However, most of those autonomous driving cars are only used to carry persons, goods and foods as the same as ordinary human driving cars on urban areas. In the snow countries, there are many tourist spots, such as national parks, historical places, festivals, sports events places, food centers, entertainment areas, spas and hotel etc. However, the autonomous driving system in those areas have not been considered. Since the road conditions are the worst because the road surface is snowy, dump, sherbet, icy in winter, it is very dangerous to drive on those roads. The information network infrastructure in rural has not also well developed.

For those reasons, so far, there are few applications of autonomous vehicles for various purposes to take advantages of autonomous vehicles in many application fields in addition to secure and trust life applications, such as disaster response, medical and emergency transportation and COVID-19 and so on. For example, in the case of sight-seeing for foreign tourists by taking public transportation or rental cars as tourist application, current situations, it is very difficult to go and look around the tourist spots without any difficulties because they are not familiar with driving road, indications and parking lots.
Furthermore, in emergency case such as earthquake and tsunami, they cannot safely and quickly evacuate to the safe evaluation place. In those cases, if the autonomous vehicles are used for those applications, they can enjoy more comfortable sight-seeing in normal case and can evaluate safely and quickly to the evaluation place in emergency case.

As automotive driving vehicle, electric cars, simply EV is very useful, cost effective and easily introduced even for the rural areas because the automatic control of electric car is relatively easy, just rotation control of motor and stealing compared with fuel typed autonomous driving cars. EV can also easily charge energy in the battery even at home and there is no gas station in the rural or mountain areas. EV is simple, light and small to drive even on the very narrow and mountain and bad roads. For those reasons, we apply EV as autonomous driving car and combine our road state sensing system and V2X communication system. Thus, in order to realize automotive EV system, we introduce road state information platform. The road state information platform collects, transmit and share those road state in realtime to automatically drive vehicle even in winter.

As video application system, AR/VR system is introduced for tourists to provide the information and video contents with tourist spots. Using this system, the tourists can enjoy the AR/VR video images with the surround view at the running roads, national parks and historical places.

By integrating and facilitating the EV based autonomous driving vehicle system, road information platform systems and video applications, more comfortable and attractive tourist oriented applications on cost effective autonomous driving system can be realized.

In the following, autonomous driving road information platform is introduced in Sect. 2. Then EV based autonomous vehicle and control system are explained in Sect. 3. Next, Video application system on road information platform are shown in Sect. 4. After that, disaster evaluation conducting system in emergency case and its function are explained in Sect. 5. Then, a prototype system to evaluate preliminary and basic functions and performance of the proposed system is explained in Sect. 6. Finally conclusion and future works are summarized in Sect. 7.

2 Autonomous Driving Road Information Platform

From our previous researches, we introduce a new generation autonomous driving road information platform based on crowd sensing and V2X technologies as shown in Fig. 1 [1, 2]. The wide area road surface state information platform mainly consists of multiple roadside wireless nodes, namely Smart Relay Shelters (SRS), Gateways, and mobile nodes, namely Smart Mobile Box (SMB). Each SRS or SMB is furthermore organized by a sensor information part and communication network part [3]. The vehicle has sensor information part includes various sensor devices such as semi-electrostatic field sensor, an acceleration sensor, gyro sensor, temperature sensor, humidity sensor, infrared sensor and sensor server. Using those sensor devices, various road surface states such as dry, rough, wet, snowy and icy roads can be quantitatively decided [4, 5].

In our system, SRS and SMB organize a large scale information infrastructure without conventional wired network such as Internet. The SMB on the car collects various sensor data including acceleration, temperature, humidity and frozen sensor data as well as GPS data and carries and exchanges to other smart node as message ferry while moving from one end to another along the roads [6, 7].
On the other hand, SRS not only collects and stores sensor data from its own sensors in its database server but exchanges the sensor data from SMB in vehicle nodes when it passes through the SRS in roadside wireless node by V2X communication protocol. Therefore, both sensor data at SRS and SMB are periodically uploaded to cloud system through the Gateway and synchronized. Thus, SMB performs as mobile communication means even through the communication infrastructure is challenged environment or not prepared. This network not only performs various road sensor data collection and transmission functions, but also performs Internet access network function to transmit the various data, such as sightseeing information, disaster prevention information and shopping and so on as ordinal public wide area network for residents. Therefore, many applications and services can be realized.

3 EV Control System

Figure 2 shows a system control system to automatically control EV combing with road state information system in cloud computing. Various sensors including dynamic accelerator, gyro sensor, infrared temperature sensor, humidity sensor, quasi electrical static sensor, camera and GPS measure the time series physical sensor data. Then, those sensor data are processed by the road surface decision unit (Machine Learning) and the current road state can be identified in realtime. Next, those road state data are input to the ECU to calculate the amount of breaking and steering and sent to the braking and steering components to optimally control the speed and direction of the EV. This close loop of the measuring EV speed and direction, sensing road data, deciding road state, computing and controlling braking/steering processes is repeated within a several msec.

On the other hand, those road state data also transmitted to the road state server in cloud computing system through the edge computing by V2X communication protocol and processed to organized wide the road state GIS platform. Those data are distributed to all of the running EVs to know the head road state of the current location. From the received the head state of the current location, the EV can look a head road state and predict proper target set values of speed and direction of the EV. Thus, by combining
the control of both the current and feature speed and direction of EV, more correct and safer automotive driving can be attained.

![Automatic EV control system](image)

**Fig. 2.** Automatic EV control system

## 4 Video Applications System on Platform

Figure 3 shows a system architecture of our proposed system. When the client device such as smart terminals and google glasses in vehicle receives the wave signal from the SRS, the signal identification module identify the ID which is equivalent to the objective tourist information. Then point of interest (POI) which is equivalent to the longitude and latitude coordinates information manager module sends the ID to the tourist information server and then receives the tourist information [8, 9]. Then POI information manager module sends the contents ID to the contents server and the equivalent contents are received and managed at the contents manage module. The contents animation module calculates the horizontal and vertical angles of the client device using various sensors and determines the coordinate to display the contents. At the AR viewer, the contents are displayed on the image from the camera. Thus, even though the tourist moves and rotates around the POI, the contents are automatically and correctly traced to tourist’s movement and rotation.

Figure 4 shows the directions of contents to be displayed and client device to display. The parameters to determine the coordinates from those sensor data are also defined.

In this case, the coordinate \((x, y)\) on which the contents are displayed is calculated as follows.

\[
x = \frac{\text{window}_x}{2} + (\theta_{\text{contents}} - \theta_x) \times \frac{\text{window}_x}{\theta_{\text{camera}}}
\]

\[
y = \frac{\text{window}_y}{2} + (90 + \theta_y) \times \frac{\text{window}_y}{\theta_{\text{camera}}}
\]
5 Disaster Evacuation Guide System

The Fig. 5 show a Disaster Evacuation Guide System using our proposed system for emergent case [10, 11]. When disaster occurred, the push typed disaster information, evaluation information are automatically delivered to those tourists by their languages. The autonomous EV system can be automatically conducted to the nearest safe evaluation place. Thus, the tourist can safely evacuate to the proper shelter from the current location. Through the mobility information infrastructure, the disaster state information, resident safety information, required medicine, feeds and materials are also collected and
transmitted by mobile nodes between the counter disaster headquarter and evacuation shelters as shown in Fig. 6.

Fig. 5. Disaster Evaluation Navigation System

6 Prototype System

In this paper, video applications including AR and VR contents for tourists on the autonomous vehicle in normal case are proposed. Automatic disaster information and road navigation systems from current area to safe evacuation area in urgent case are also considered. The system configuration, architecture of the autonomous driving road information platform and its presentation method are precisely explained. Finally, a prototype system using current available autonomous driving platform is discussed in order to verify the effects and usefulness of the proposed system, a prototype system which is based on the EV based is considered constructed and those functional and performance are evaluated. Figure 6 shows an autonomous EV system is based on electromagnetic induction line technology. The EV direction is inducted by the electro-magnetic induction line which is embedded in the ground and can be safely and reliably drive along the line. Only motor is needed to control the EV speed be considering the ahead road state data from SRS along the street. The EV of the prototype is made of YAMAHA, 7 limited persons and runs max. 12km/h.

The prototype also includes sensor server system and Communication server System, Smart Mobility Base station (SMB) for mobility and Smart Rely Shelter (SRS) for roadside station as shown in Fig. 6. We currently use WI-U2-300D of Buffalo Corporation for Wi-Fi communication of 2.4 GHz as the prototype of two-wavelength communication, and OiNET-923 of Oi Electric Co., Ltd. For 920 MHz band communication respectively. WI-U2-300D is a commercially available device, and the rated bandwidth in this
prototype setting is 54 Mbps. On the other hand, the OiNET-923 has a communication distance of 1 km at maximum and a bandwidth of 50 kbps to 100 kbps.

On the other hand, in sensor server system, several sensor including BL-02 of Biglobe as 9 axis dynamic sensor and GPS, CS-TAC-40 of Optex as far-infrared temperature sensor, HTY7843 of azbil as humidity and temperature sensor and RoadEye of RIS system and quasi electrical static field sensor for road surface state are used. Those sensor data are synchronously sampled with every 10 ms. And averaged every 1 s to reduce sensor noise by another Raspberry Pi3 Model B+ as sensor server. Then those data are sent to Intel NUC Core i7 which is used for sensor data storage and data analysis by AI based road state decision. Both sensor and communication servers are connected to Ethernet switch. Currently, we are evaluating the road surface decision function using the video camera to compare the decision state and the actual road surface state.

![Fig. 6. A prototype of autonomous driving system](image)

7 Conclusions

In this paper, we propose autonomous driving road information platform for EV and video application system for tourists to provide tourist information system by the augmented reality using the information based on the point of interests (POI). Basic system configuration of the platform and video application technology are introduced. With video application system, POI information and video contents triggered by wireless signal from SRS are downloaded and overlapped on the real image on smart device to realize augmented reality (AR) while running in tourist areas. A prototype system is constructed to evaluate its functionality. Currently, we are testing and evaluating the effects of our proposed system. We are also developing more sophisticated tourist contents such as 3D objects to realize more attractive tourist video services.

Acknowledgement. The research was supported by Strategic Information and Communications R&D Promotion Program (SCOPE) Grant Number 181502003 by Ministry of Affairs and Communication, JSPS KAKENHI Grant Numbers JP 20K11773 and Strategic Research Project Grant by Iwate Prefectural University in 2020.

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