Data Transmission for Infrared Images via Earphone Jack on Smartphone

Sang-Bong Byun and Yong-Hwan Lee

***Abstract*—Recently, a variety of external accessory devices have been developed for smart phone. Among them, external devices which communicate via earphone jack on smartphone are prominent because they are small and compact and can be fixed on smartphone. This method is ideal for devices that do not require high-speed data transfer. In this paper, we present data transmission via smartphone earphone jack for infrared depth maps. Depth map is an image or image channel that contains information relating to the distance of the surfaces of scene objects from a viewpoint. And it can be measured using IR camera. We are now developing a compact image sensor that produces depth map of image.**

***Index Terms*—IR, depth map, earphone jack, triangulation.**

I. Introduction

IR computer vision has recently attracted some interest with the advent of lower cost sensors. Applications have included person detection, human face detection and head tracking, human posture analysis, and occupant sensing. The applicability of IR cameras in dark environments is the most motivating factor for using IR imaging in computer vision applications [1]. Depth estimation from an image means to predict the relative distance information with respect to different objects in the scene. It is essentially a question of depth perception. Depth perception can construct the space position information which expresses the distance from observer to the object surface detected in the scene [2]. An example of the depth map is shown in Fig. 1.

Infrared cameras are used for autonomously driving vehicle. In the context of situations with bad light conditions, IR cameras are a useful asset in a multi-sensor system. IR cameras do not rely on visible light but capture IR radiation instead. Given that the ultimate objective of any autonomously driving vehicle is to avoid harming any living objects (humans or animals), IR cameras are of potential interest, since living objects will show up very decisively [3]. As an example of IR camera, Google self-driving car is shown in Fig. 2.

In recent years, most of connections between the smartphone and external devices are established using Bluetooth [4]. However, the earphone jack can be used, although the transfer speed is slow. The external devices using earphone jack can be mounted easily on the smartphone and the price is cheap.

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The authors are with the School of Electronic Engineering, Kumoh National Institute of Technology, 1, Yangho-dong, Gumi, Gyungbuk, 730-701, Korea (e-mail: sb5816@kumoh.ac.kr, yhlee@kumoh.ac.kr).

Fig. 1. Example of the depth map.

Fig. 2. Google self-driving car.

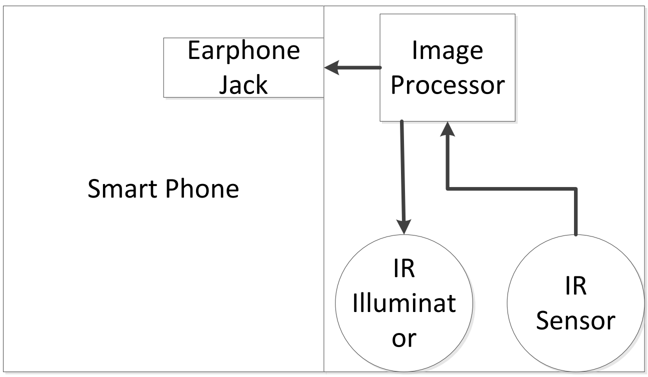

Fig. 3. Data flow.

II. Architecture

In this paper, we present data transmission via smartphone earphone jack for infrared images. IR cameras produces image of distance depth. Then, the image of depth will be transmitted to the smartphone via earphone jack. In Fig. 3, data flow is illustrated.

Depth map is an image or image channel that contains information relating to the distance of the surfaces of scene

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objects from a viewpoint. The depth map is made using the time difference between the infrared emitted from the infrared illuminator reaches the infrared sensor. IR camera overview is described in Fig. 4.

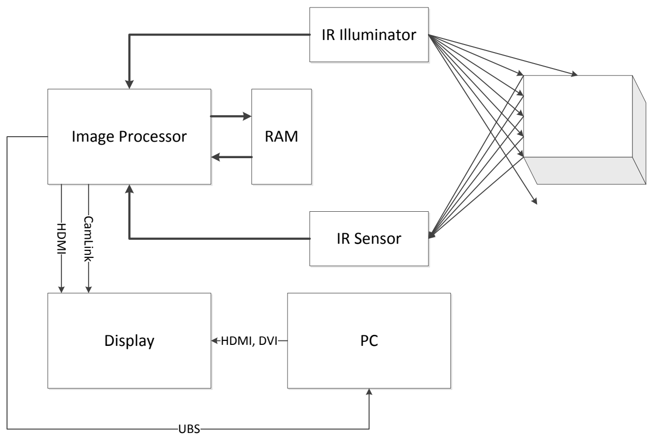

Fig. 4. IR camera overview.

For the distance measurement, the triangulation method is used. In trigonometry and geometry, triangulation is the process of determining the location of a point by measuring angles to it from known points at either end of a fixed baseline, rather than measuring distances to the point directly (trilateration). The point can then be fixed as the third point of a triangle with one known side and two known angles [5]. Triangulation method to measure distance is illustrated in Fig. 5.

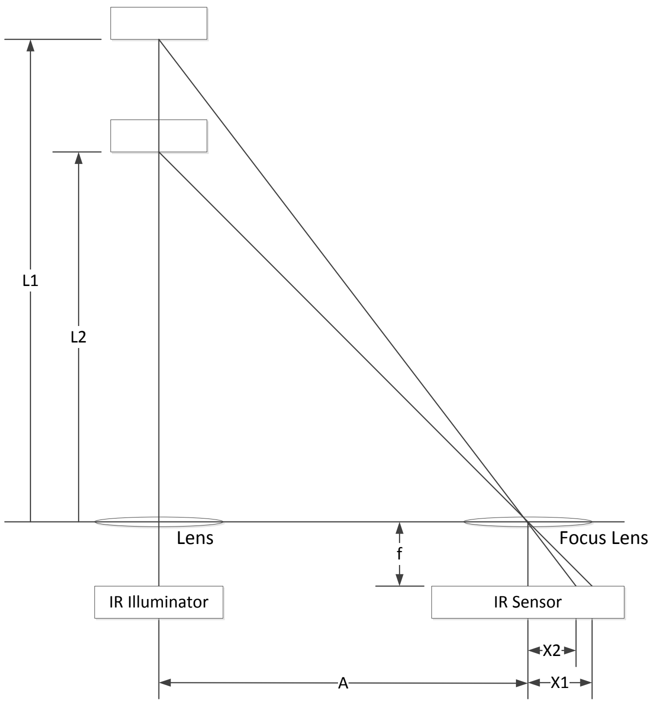

Fig. 5. IR camera overview.

Equation (1) can be interpreted as triangulation.

$$L2 : A = . f : x1 \tag{1}$$

where, $L2$ is distance of the obstacle, A is the emitting/receiving distance between sensors, f is the focal length between PSD and focus lens, $X1$ and $X2$ is incident on the IR sensor position of infrared [6], [7].

Depending on the distance between the sensor and the obstacle by being the change of reflection, IR sensor is changed to the incident location.

Data transfer is set up via the earphone jack. Then the data is transmitted via the microphone connector on the earphone jack. Depth map that is transmitted via the earphone jack is displayed to the screen of the smartphone. Fig. 6 shows the earphone jack connectors which can be used to transmit and receive the data.

Fig. 6. Earphone jack connectors

III. Application

A. Night Vision

Most developed countries have a growing population of aging drivers whose ability to see at night is significantly impaired. In darkness the probability for a severe accident is much higher. Pedestrians are the most vulnerable road users and are four times more likely to be fatally injured at night compared to day time. Data show that nearly 70% of pedestrian fatalities happen at night, while nighttime driving only accounts for 20% of total traffic. Even after decades of continuous improvement to road safety, it is estimated that each year over 3000 pedestrians are killed at night in the United States alone [8]-[10].

Fig. 7. Night vision in the Benz S-Class.

Improving nighttime road safety and pedestrian protection is one of the main safety targets for government authorities responsible for road safety. A vision enhancement system that helps drivers to see lane markings, roadside reflectors, signs, and to identify potential hazards (such as parked cars, pedestrians and bicyclists) earlier may increase nighttime road safety. The need for such a system also presents a great market penetration opportunity for OEMs and automotive suppliers to develop an effective and affordable night vision system [10]. Night vision in the Benz S-Class is illustrated in Fig. 7.

Pedestrian detection is an important research field for a number of applications such as smart video surveillance, driver assistance system, content based image/video indexing, robotics and military applications. Driven by the decreasing cost of infrared (IR) sensors, night vision systems have gained more and more interest in recent years, and thus increasing the need of pedestrian detection at night [11]. Pedestrian detection using night vision is illustrated in Fig. 8.

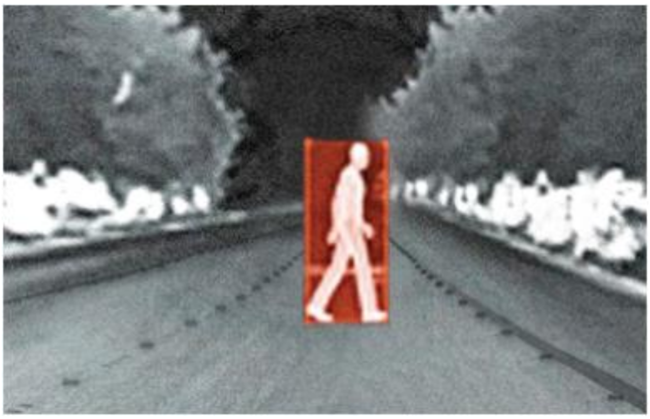

Fig. 8. Pedestrian detection using night vision.

B. Depth Map Creation

The ability of autonomous systems to understand and navigate in uncertain environments is heavily dependent on the sensors for detecting both moving and stationary obstacles. Of the sensors available, sonar sensors [11], [12] are relatively low cost, but have poor angular resolution and are susceptible to false echoes and reflections. Infrared [13], [14] and laser range finders [15] are again relatively low cost, but typically provide measurements from only one point in the scene. The advent of low-cost digital cameras has therefore generated renewed interest in vision-based systems for autonomous vehicles [16], [17] but the disadvantage of this approach is that distance has to be inferred either from stereoscopic cameras [18], or from the motion of objects within the image. The recent release of the Microsoft Kinect addresses this issue by providing both a camera image and a depth image within a single low-cost package. Though intended primarily for the entertainment market, the Kinect has excited considerable interest within the sensing and robotics community for its powerful capabilities [19]. Depth map of Microsoft Kinect is illustrated in Fig. 9.

C. Credit Card Reader

Existing credit card reader is a large size and expensive equipment. Existing credit card reader is illustrated in Fig. 10.

However, if you use a credit card reader using the earphone jack, mounting possible simply by plugging into the earphone jack credit card reader only. Credit card payment is possible through the application of smartphone. Credit card reader using earphone jack is illustrated in Fig. 11.

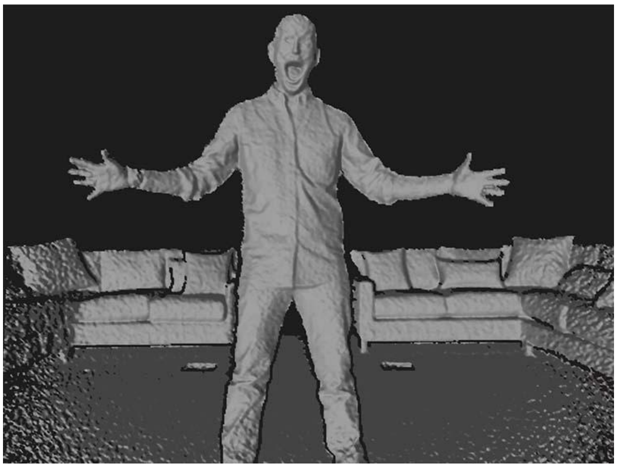

Fig. 9. Depth map of Microsoft Kinect.

Fig. 10. Existing credit card reader.

Fig. 11. Credit card reader using earphone jack.

D. Universal Remote Control

Recently a variety consumer electronics device, use the remote control. Usually home appliances such as TV, radio, video/audio players, home theater, air conditioner, and room lighting come with remote controls that are used to select items and change status [20]. Nowadays, the number of appliance provides multi services or complex functions increases. As a result, users need to get familiar with the different features and the operations of many remote controls. For some manufacturers, they have built these remote controls into one controller, which is called universal remote control [21]. A universal remote control is a remote control that can be programmed to operate various brands of one or more types of consumer electronics devices. Universal remote control is illustrated in Fig. 12.

Fig. 12. Universal remote control.

Used by mounting an IR transmitter to smartphone earphone jack. Using the Mobile App, operation is easily a smartphone one various devices. Smartphone universal remote control is illustrated in Fig. 13.

Fig. 13. Smartphone universal remote control.

In order to use the smartphone apps, support of new products early.

E. External Sensor

External sensor used in mounting the sensor to the smartphone earphone jack. Light sensor [22], tilt sensor, etc., is already the smartphone, it is possible to use more high performance sensors. When the sensor attached, gas sensors, temperature sensors, and humidity sensors may be indicative of the measured value to the smartphone.

IV. Conclusion

We have presented data transmission via smartphone earphone jack for infrared images and the device which can measure the distance using the IR sensor. The triangulation method is used to determine the distance to object. The depth map image is sent to the smartphone via earphone jack connector. Eventually, the earphone jack can be used to easily connect the smartphone and the proposed infrared distance measuring device.

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Yong-Hwan Lee received the PhD degree in electronic engineering from the Yonsei University, Korea, in 1999. He is working as a professor of electronic engineering at the Kumoh National Institute of Technology. His interests include hardware architecture for multimedia, high performance computing, design of SoC (system on a chip), and embedded system.

Sang-Bong Byun received the master degree in electronic engineering from the Kumoh National Institute of Technology, Korea, in 2010. He is working as a section chief of Total Solution. His interests include hardware architecture for multimedia, image processing, design of SoC (system on a chip), and computer vision.