Evaluation of the Human Detection System using UHF band TV waves for the Car Security

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***Abstract* - In this paper, we proposed and evaluated the human detection system using UHF band TV waves for the car security. The measurements were performed in the parking space by the human detection system using software-defined radio with four receiving antennas. As a result, it was confirmed that human detections measured by the one receiving antenna were limited to specific areas such as vicinities of receiving antennas. In order to improve human detection performances, we evaluated the human detection using multiple frequencies. As a result, we found that detection probabilities became higher in almost all areas, and the human detected area was expanded.**

***Index Terms* — Propagation, human detection, UHF, TV wave, car security.**

1. Introduction

It is important to avoid the car theft during parking the car. A lot of security systems have been studied [1]-[2]. We have been proposed the human detection system using UHF band TV waves to monitor intruders into houses [3]. Then, performances of the human detection system around a house have been evaluated [4].

In this paper, we proposed and evaluated the human detection system using UHF band TV waves for the car security. Further, using the human detection system based on software-defined radio module, we evaluated the human detection using multiple frequencies to improve the detection performance.

2. Measurement Methods

The human detection system consists of a monopole antenna, a software-defined radio module and a PC. Fig. 1 shows the configuration of the human detection system. The antenna receiving UHF band TV waves is connected to a software-defined radio module. They are controlled by a Raspberry Pi used as a PC.

The measurements were performed in the parking space of Hiroshima City University in Japan. We measured Ch. 27 (554MHz-560MHz) TV waves from the transmitting station that has 1.55km distance using four receiving antennas placed in vicinity to the tires of the car. There were no obstacles in the area around a car within about 10m square. The measurement area was divided into squares one meter on a side. On the examinations, a human walked around in each of the square and relative received levels were measured. Fig. 2 shows the measurement environment

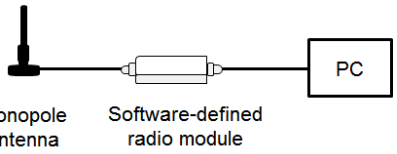

Fig. 1. A configuration of the human detection system using software-defined radio.

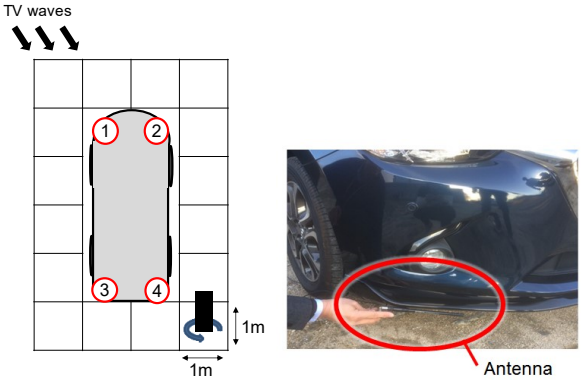

Fig. 2. Measurement environment and *locations* of the antennas (left panel), and an example of the place of an antenna (right panel).

and positions of receiving antennas. The numbers on the car in the left panel of Fig. 2 represent the antenna 1, 2, 3 and 4.

To evaluate the human detection system, we defined the detection probability. At first, the threshold level was measured in the condition of no human movement. Next, differential values between the relative received levels and that of one second before were computed. Then, the detection probability was defined by the time of the differential values exceed the threshold level in the measurement time.

3. Measurement results

(1) Results of single frequency measurements

In this section, to clear the characteristics of the human detection around the car, we evaluated single frequency measurements as with the human detection system for the indoor. Fig. 3 shows measurements results of the TV wave frequency at 557MHz. Upper-left, upper-right, bottom-left and bottom-right panels corresponds to the location of the antenna 1, 2, 3 and 4 shown in Fig. 2.

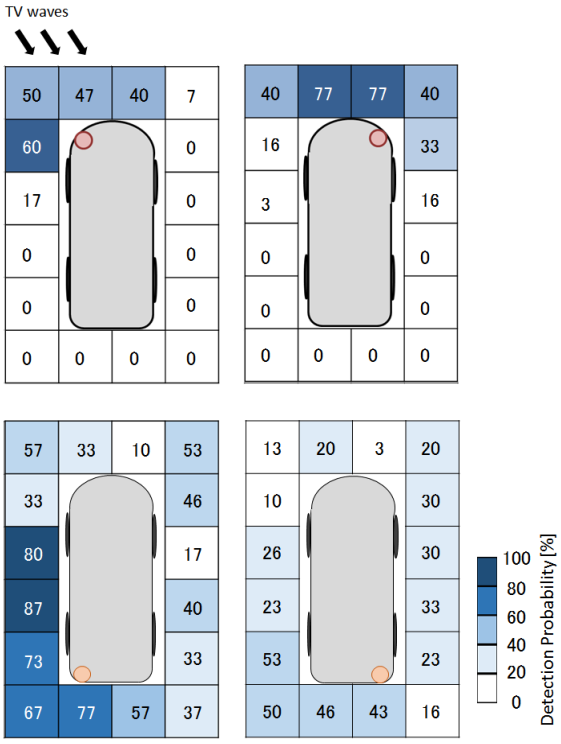

Fig. 3. Results of single frequency measurements.

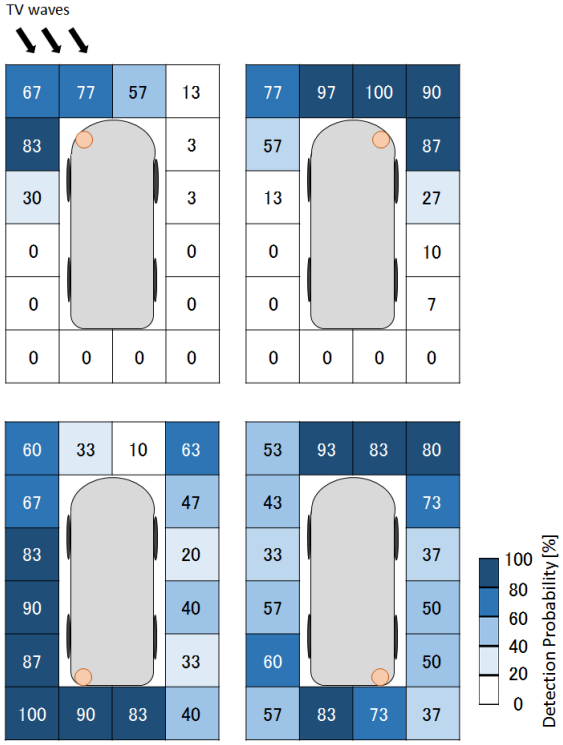

Fig. 4. Results of multi frequency measurements.

In the results of the antenna 1 and 2, human movements with high detection probabilities were measured around each antenna only. It was conceived that the result of shadowing was dominant in this conditions. In the areas distant from each antenna, there were little detection probabilities. As with the results of the antenna 1 and 2, the results of the antenna 3 show that high detection probabilities were measured around the antenna. Further, the every squares around the car detected the human movements. In the results of the antenna 4, there were no high human detected areas. However, most areas detected human motions as with the result for antenna 3. From these results, it was confirmed that human detected areas depend on the propagation direction of the TV waves. In the condition of the antenna 3 and 4, it was believed that the human detection system received TV waves reflected by the moving human across the car.

(2) Results of multi frequency measurements

As shown above, it was confirmed that the human detection system detect by the single frequency measurements. However, human detected areas were limited and most areas were low detection probabilities. To improve the detection probabilities, we evaluated the human detection using highest differential values in the measurement data of three frequencies. Fig. 4 shows the results of the multi frequency measurements by the frequencies of 555MHz, 557MHz and 559MHz.

In the results of the antenna 1 and 2, human detected areas expanded a little, however detection probabilities were improved. Further, detection profanities of almost all areas improved in the results of the antenna 3 and 4. From these results, it was found that propagation characteristics of different frequencies were important for the human detection system around the car.

4. Conclusion

In this paper, we proposed and evaluated the human detection system for the car security. As the measurement results, we confirmed that human detection measured by the one receiving antenna were limited to the specific areas. However, by using the multiple frequencies to the human detection, it was found that detection probabilities became higher in almost all areas, and the human detected area was expanded. From these results, we found the human detection system has a potential to use around the car.

References

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