DEVELOPMENT OF VEHICLE DETECTION SYSTEM USING GEOMAGNETIC LEVEL SENSOR

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Abstract. This paper describes about a detection system for vehicle using a magnetic sensor. This system is used for detection of presence and traveling direction. The magnetic sensor system measuring geomagnetic level signal of a vehicle and is used as one of the sensor detecting a vehicle on a point. In this paper, we focus on the new detection method for traveling direction of a vehicle. First the concept of proposed sensor is explained. A new detection method of the traveling direction of the vehicle is proposed by analyzing the results. Experimental examination on the road was carried out and the results supports that the proposed method is valid for the detection of the direction.

1. Introduction

Magnetic sensor systems measuring geomagnetic level signal have been already investigated as one of the sensor detecting a vehicle on a point [1]-[4]. In this paper, a new type of sensor system is proposed. The sensor system can be considered as it is corresponding to the loop coil or supersonic system. It may have advantages in size and power consumption. Installation, cost, and maintenance can be considered to be superior. In the following especially the traveling direction of the vehicle will be focused on. First the concept of proposed sensor is explained and the proposed sensor system is introduced. Some basic experiment using a geomagnetism sensor is examined. A new detection method of the traveling direction of the vehicle is proposed by analyzing the results. Experimental examination on the road was carried out and the results supports that the proposed method is valid for the detection of the direction.

2. Proposed sensor system

If a vehicle has one magnetization as shown in Fig. 1, the presence and the traveling direction can be detected. In Fig. 1, a geomagnetic sensor which is indicated as a red rectangle is installed under the ground. The magnet on the vehicle is assumed as it is put in a horizontal position and the N pole is in the front. The green arrows indicate the directions of magnetic flux. When the vehicle travels in the direction according to the blue arrow, the flux densities in the x and z directions at the sensor point vary as shown in Fig. 2. First flux in the z axis is downward. So the value of the figure is minus. It becomes zero when the center of the magnet comes to the position just over the sensor. And after this point flux has positive value. Flux in the x direction indicates leftward during the magnet traveling. So the value is always minus. When the center of the magnet is just over the sensor, the flux value has local minimum. This flux variation can be used for detecting the vehicle traveling direction.

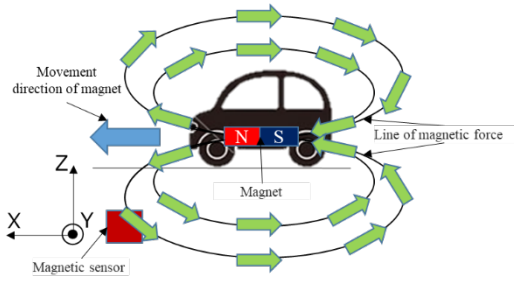

Fig.1. Basic concept of vehicle detection sensor using geomagnetic sensor

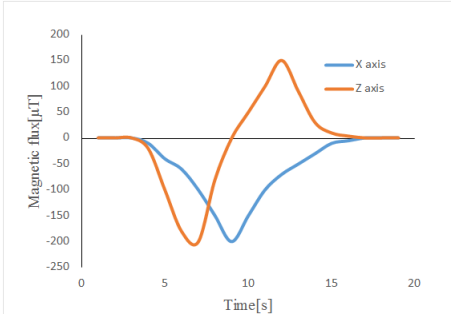

Fig. 2. Typical flux variation of z axis and x axis during vehicle traveling.

A basic experiment was carried out. The upper part of the experimental device is a path for a permanent magnet which is considered as a magnetized vehicle. A geomagnetic sensor is installed under the path. The magnet can be changed the pitch angle as it indicates various direction of the vehicle magnetism. A sensor measures the magnetic flux values in x axis and z axis.

We focus on the zero crossing points of each recorded line. At that time, we check the flux

value of the other direction indicates local maximum or local minimum. Combination of the direction at the crossing points and the extreme values can distinguish moving direction of the magnet.

3. Experiment on road

Using the proposed method, experiments on a real road were carried out. A photo of the vehicle which is examined is shown in Fig. 3. The sensor unit is buried just under the vehicle in the photo of Fig. 3. It is located about 10 cm under the ground. The positive direction x axis of the sensor is aligned as same as the vehicle in the figure travels. Sampling frequency of measurement is 100 [Hz].

The result of the Fig. 3 is shown in Fig. 4. As you can see in the figure, there are three zero crossing points. Two points are on the x axis line and one is on the z axis line. At the time of zero cross on x axis there are extremes. The moving directions can be determined and they were correct. However at the zero cross at z axis there is no apparent extreme. We ignored such a point without the extreme value.

The results of heavy vehicles have sometimes many zero crossing points, and they indicated unspecific variation and has small vibration. The reason is that the heavy vehicles have the middle part without ferromagnetic materials. The residual magnetism is very low level. As the magnetic flux of the middle part is very low. The data such one heavy vehicle may sometimes be recognized as two vehicles because the data is divided into the front and the rear.

We examined 81 cases on the road. As the results there is 8 cases that have wrong direction. These vehicles almost didn't pass through just over the sensor. More detail analyses of experimental will be provided in the final paper.

Fig. 3 A photo of experiment on road

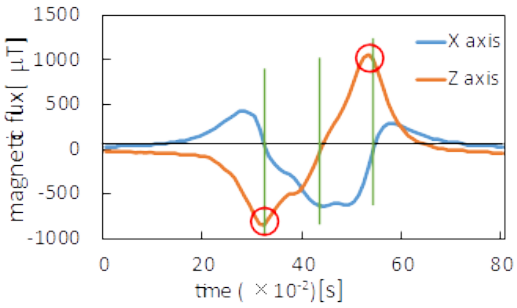

Fig. 4. Experimental result of vehicle shown in Fig. 3

Conclusions

A new type of the detection system for vehicle using a magnetic sensor has been proposed. This system is used for detection of the traveling direction. A prototype of the proposed sensor system has been introduced. Some basic experiments have been carried out and the detection method is verified that it was useful. Some experimental examination on the road carried out and the results supports that the proposed method is valid for the detection of the direction. However the system still has some problems. They are further study of this project.

References

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