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A Study on the Case of Sudden Car Accident Estimation of Frequency Slope Estimation Method

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Abstract

As automobiles become more common, accidents caused by sudden outbreaks are increasing every year. In this paper, we use a slope of the frequency change to analyze the vehicle. The values measured using these slopes are very important features for objective analysis. Therefore, in this paper, we propose a method to detect sudden emergencies by analyzing sound source of black box engine sound in order to identify suspicious accidents of vehicle type and to minimize damage caused by accident. Experimental results show that the fundamental frequency increased significantly from 90Hz to 180Hz for a short time unit (1 second) and showed the instantaneous slope graph. The slope of the sound source 1 and the sound source 2 corresponding to the medium-sized car was 50 to 100, and the slope of the sound source 3 corresponding to the semi-medium-sized car was 179.59. Therefore, this study can be continued to standardize the rapid acceleration limits of various vehicle types and to accurately identify the sudden acceleration.

Keywords: Spectrum, Slope, Frequency, sudden acceleration

INTRODUCTION

As the society and science and technology develop, the means of transportation are constantly evolving, giving the convenience of space movement. As the means of transportation develop, it is true that people's areas of activity have been diversified and travel time has been saved. This gives the advantage of being able to do a lot of work for people who are busy. Today, most of the things we use to move places in everyday life are cars, which is quite natural [2][10][11][12]. However, automobile accidents are increasing as automobiles become more common as a general means of transportation and usage, and in recent years, accidents caused by a sudden increase in automobiles are increasing rapidly every year. However, the cause of the sudden acceleration of the car still cannot be clearly identified, so many victims of accidents are increasingly receiving damages and responsibilities without receiving proper compensation. This is an urgent need for objective identification of the event data recorder (EDR), which is installed in the automobile in the case of a sudden accident victim, to the automobile manufacturer. Therefore, in this paper, in order to clarify the phenomenon of the sudden occurrence, it is necessary to analyze the characteristics of the unused sounds to be used for objective identification. In order to investigate this by the objective analysis method, it is analyzed by using the engine sound stored in the black box of the automobile which is increasingly used because the sound of the driver due to the inactivity of the driver or the internal defect of the automobile has sound characteristics[1][2][3][4][5]. The composition of this paper is as follows. Chapter 2 explains the rapidity of the car, Chapter 3 explains the rapidity through the sound analysis, and Chapter 4 concludes the paper.

STATUS OF SUDDEN ACCIDENT

A car suddenly refers to a phenomenon in which an automobile deviates from a driver's control range and thereby speeds up abnormally. Every year, sudden reports of such sudden emergencies are rising, but there are still many opinions among experts. Experts are making various claims as a cause of the sudden acceleration, and one of the causes of sudden emergence in many experiments is that an engine control unit (ECU) operation error occurs for some reason and the throttle valve becomes uncontrollable. At this time, the throttle valve controls the amount of air flowing into the engine, and the accelerator pedal controls the opening degree of the valve. As the accelerator pedal is depressed, the valve opens more and more. However, when the accelerator pedal is depressed, the throttle valve becomes out of control, so that a large amount of air is continually introduced, resulting in an abnormally increased speed. At this time, even if the driver presses the brake pedal, the throttle valve is already opened so that the speed does not decrease. The limit of the car is determined by the driver's intention and rapid acceleration due to the engine to be used and various parts, frame, and weight. But suddenly, as explained above, the explosive force appears instantaneously in

the car. This is beyond the limits of the car's existing rapid acceleration limits and can be a basis for judging sudden emergencies. However, even if a car has many cars and each car has a different engine and the same engine, the instantaneous acceleration limit range is determined by the influence of other parts and frame weight. Therefore, if you know the standardized rapid-emission limit range for each vehicle type, you can provide a basis for judging sudden emergence only by the sound source recorded in the black box[4][5][6][7][8][10].

EXPERIMENTS AND RESEARCHES ON SUDDEN OCCURRENCE

As described above, a sudden acceleration is a malfunction of ECU (Engine Control Unit) inside a vehicle due to some cause. Numerous studies have been conducted in order to clarify the cause of the sudden rise in mechanical engineering. However, there is no successful case in identifying the sudden occurrence. This is because automobile dealers who develop and manufacture all the parts inside the automobile from the sudden claims and suspicions are greatly advantageous. But in the end, suddenly, the RPM of the engine increases significantly beyond the maximum acceleration limit of the vehicle. RPM is the revolution speed per minute of the engine, which can be detected using the fundamental frequency that appears in the engine. Therefore, in this paper, we measured and analyzed the fundamental frequency of the engine sound recorded in the black box in order to detect the car engine RPM in case of the sudden occurrence of the car. For the analysis, we used the Adobe Audition CC 2015 program to measure the data of the black box sound source of two medium and two semi-midway cars among the suddenly claimed cases and to derive the gradient by processing the data using Microsoft Excel and MATLAB program.

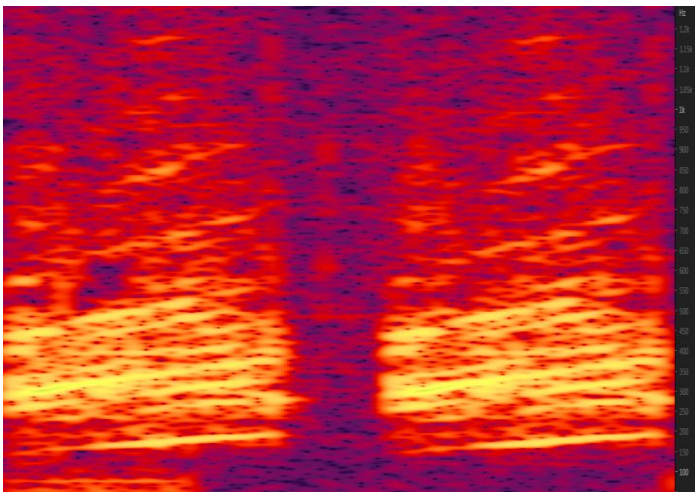

Figure. 1: Spectrogram of the suddenly sound source 1 (medium car).

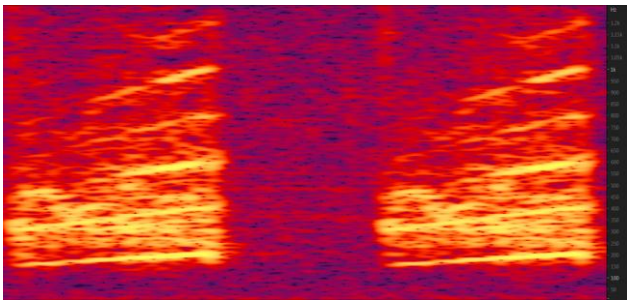

Figure 2: Spectrogram of the suddenly sound source 2 (medium car).

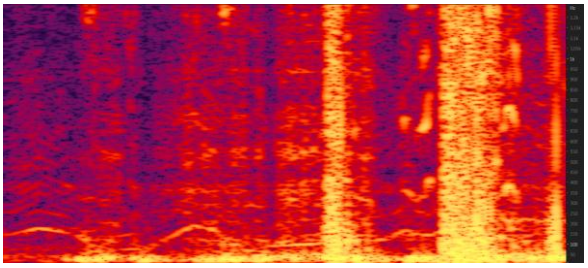

Figure 3: Spectrogram of the suddenly sound source 3 (semi-medium car).

[Table 1]: Data measurement of sound source 1,2,3 spectrogram

	Starting Frq.(Hz)	End Frq.(Hz)	Increasing(Hz)	Duration(sec)
Source 1	281.25	375	93.75	1.012
Source 2	156.25	218.75	62.5	0.984
Source 3	93.75	187.5	93.75	0.522

Figures 1, 2, and 3 show the spectrograms of each rapid-motion assertion interval in experimental sound sources 1, 2, and 3, and Table 1 is a measurement value of the data appearing in the spectrogram of experimental sound sources 1, Sound source 2 and sound source 3 measured the increase in the fundamental frequency, and in Sound source 1, the fundamental frequency at the starting point was not apparent, so the increase in the first resonance frequency was measured. As a result, the first resonance frequency increased from 281.25 Hz to 375 Hz in 1.012 seconds in Sound Source 1, which shows an instantaneous increase of 93.75 Hz. In Sound Source 2, the fundamental frequency increased from 156.25 Hz to 218.75 Hz for 0.984 seconds, which indicates that the instantaneous frequency increased by 62.5 Hz. Finally, in Sound Source 3, it increased from 93.75Hz to 187.5Hz in 0.522 seconds, which shows that the instantaneous increase was 93.75Hz. Based on the measured data, the following momentary slope graph was extracted using the MATLAB program.

[Table 2] Instantaneous slope data table

Sec / Source	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Source 1	0	9.26	18.53	27.79	37.05	46.32	55.58	64.85	74.11	83.37	92.64
Source 2	0	6.35	12.70	19.05	25.41	31.76	38.11	44.46	50.81	57.16	63.52
Source 3	0	17.96	35.92	53.88	71.84	89.80	107.76	125.72	143.68	161.64	179.60

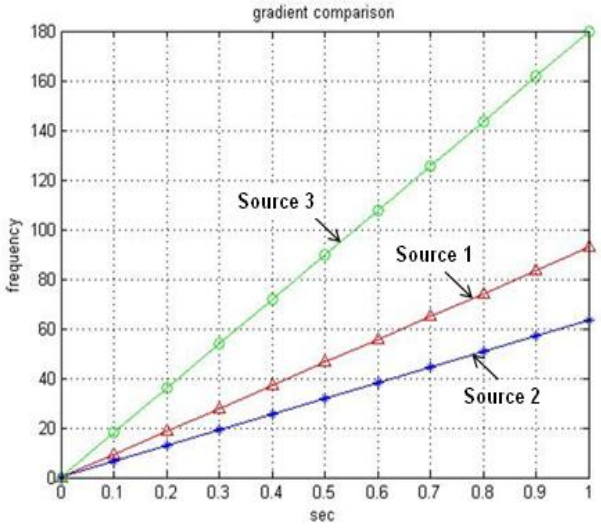

Figure. 4: Instantaneous slope for each sound source

In the instantaneous slope graph in Fig. 4, red indicates a sound source 1, blue indicates a sound source 2, and green indicates a sound source 3. Table 2 is a data table showing the component values at intervals of 0.1 second in Fig. The instantaneous slope of sound source 1 was 92.63, the instantaneous slope of sound source 2 was 63.51, and the instantaneous slope of sound source 3 was 179.59. Using a MATLAB program, a linear function with instantaneous slope of each sound source was measured from 0 to 1 Seconds. The slopes of the sound source 1 and the sound source 2 corresponding to the medium-sized car were 92.63 and 63.51, respectively, which ranged from 50 to 100. However, the slope of the sound source 3 corresponding to the semi-solid vehicle was 179.59, which was smaller than that of the sound source 1 and sound source 2. There was a big difference. Therefore, the instantaneous slope of the RPM can be estimated differently for each vehicle type in the case of a sudden acceleration.

$$When N = 10,\ 31.76 \le \frac{\sum_{n=0}^{N} y_n}{N+1} \le 46.32 \Rightarrow Medium\ Car \quad (1)$$

$$When N = 10,\ 89.80 \le \frac{\sum_{n=0}^{N} y_n}{N+1} \Rightarrow Semi-medium\ car \quad (2)$$

The above equations (1) and (2) show the range of the medium and semi-medium car using the mean value of the instantaneous slope data of each sound source. In the case of the sudden emergence, the instantaneous slope is about 1

$$\frac{\sum_{n=0}^{N} y_n}{N+1}$$

second, so the coefficient of N is set to 10. means an average value up to N samples. Based on the previous experimental results, we can derive equations (1) and (2) based on the slope comparison experiment data of three types of sound sources by vehicle type. If such a study continues and accumulates all the data of the past sudden allegations and the sudden allegations that occur in the future, it is possible to cluster through the big data processing. The error rate can be reduced by sampling the sophisticated range.

CONCLUSION

As automobiles become more common, accidents caused by sudden emergencies are rapidly increasing every year. Sudden acceleration can cause damage to the opponent vehicle, surrounding passengers, surrounding buildings, and the driver himself / herself, because the speed of the vehicle is out of the driver's control range and is abnormally accelerated. In this paper, we propose a method to detect sudden emergencies by analyzing sound source of black box engine sound in order to identify suspicious accidents by vehicle type and to minimize damage caused by accident. Experimental results show that the fundamental frequency increased significantly from 90Hz to 180Hz for a short time unit (1 second) and showed the instantaneous slope graph. The slope of the sound source 1 and the sound source 2 corresponding to the medium-sized car was 50 to 100, and the slope of the sound source 3 corresponding to the semi-medium-sized car was 179.59. The instantaneous slope of the mid-sized car and the semi-mid-sized car shows a large difference, and the instantaneous slope of the RPM can be estimated differently by vehicle type in the case of a sudden start. Therefore, if this study continues and standardization of the rapid acceleration thresholds for each vehicle type in the market is distinguished, it will be a basis for judging sudden emergencies in the case of sudden emergencies.

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