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Report of low power noise monitoring system using solar panel

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ABSTRACT

Last year, we have reported an overview of a new compact noise monitoring system of low power consumption with solar cell, multi-point noise monitoring system in wide areas, to monitor such as environmental noise, road traffic noise and aircraft noise. We report experiment results with the system in detail. The system is different from a conventional system in point of charging the battery with solar power. Therefore, we conducted experiments on acoustic effects of the solar panel. Also, we measured the temperature inside of the system and the outside air temperature, and examined what battery to use by the system.

Keywords: noise monitoring, low power, solar panel I-INCE Classification of Subjects Number(s): 71.3

1. INTRODUCTION

A conventional noise monitoring system requires a lot of time to install the system and start operation. We have to think about some issues, for example, supply of a power supply and infrastructure such as telephone line to send measurement data to the host system, installation of cubicle containing the measurement instruments, and modem. When installing of the stand to fix microphone, a lot of cost and effort was necessary. In case of a long term noise monitoring for several years, the initial cost is not a major problem. However, in case of short or middle term noise monitoring such as during one week to two months, the low initial cost is very important. The data can be obtained by using a sound level meter of a handy type, but it is not possible to obtain measurement data and to operate the sound level meter without visiting the site, what more, there power supply issue. So, we developed a prototype of the noise monitoring system that combines the rechargeable battery, solar panel, the communication module and the low power consumption sound level meter to operate with easy installation. The system is different from a conventional system in point of charging the battery with solar power. Based on that, this paper describes important point to operate the system which is powered by the solar panel.

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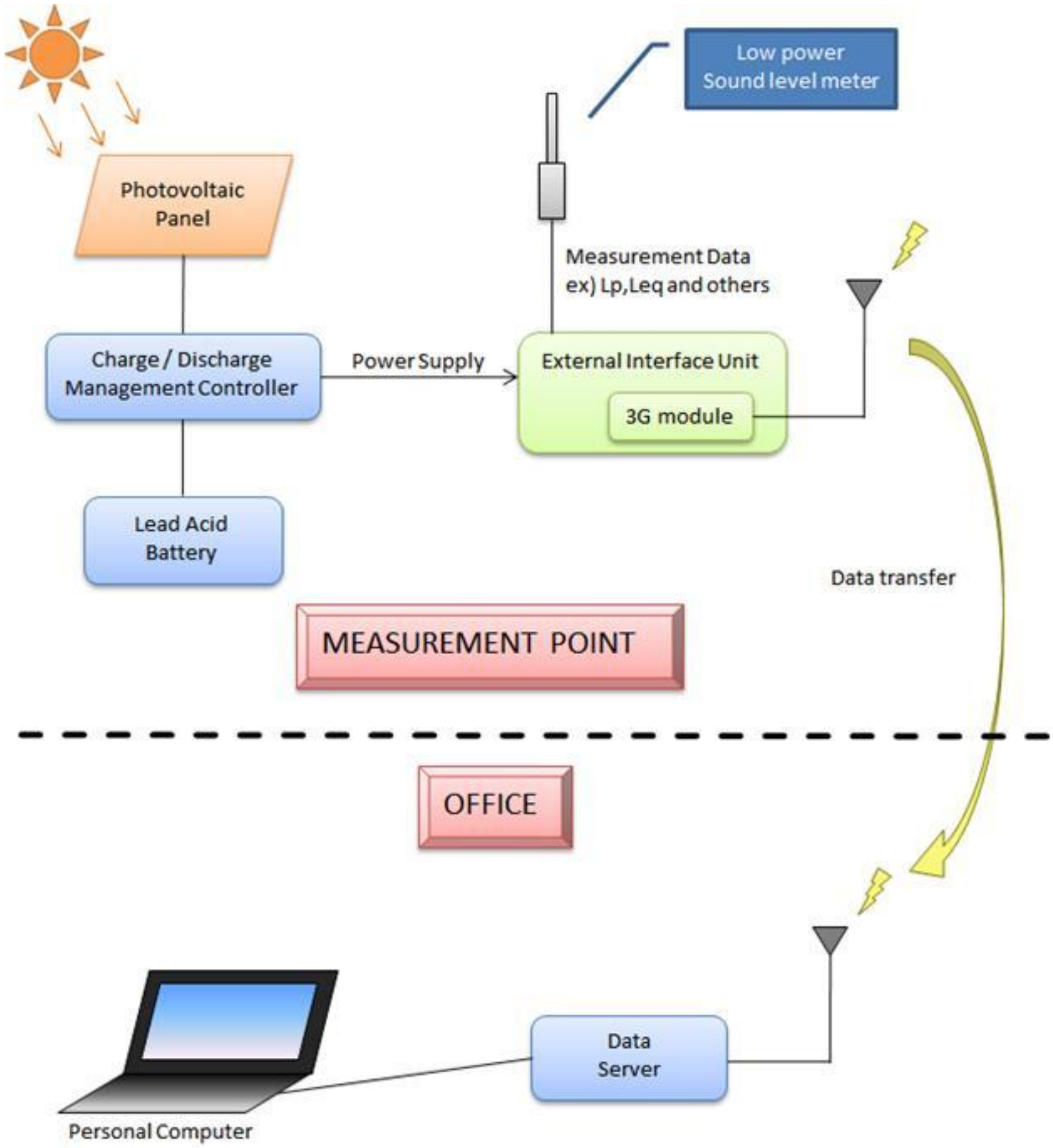

Figure 1 - Components of low power noise monitoring system

2. MEASUREMENT EXPERIMENTS

The system is similar to the conventional system for the most part. However, it is necessary to caution about several points. First point is the acoustic effects of the solar panel. Second point is the temperature rise of the system by irradiation with sunlight, and rechargeable battery to be used.

2.1 Acoustic effects of solar panels

2.1.1 Experimentation

The measurement configuration is shown in figure 2 and the measuring equipment is shown in table 1. We generated white noise from a loudspeaker and measured using the microphone which was installed under 0.65m of the solar panel, and we analyzed frequency spectrum. In order to simulate the upright pole, the pole was toppled over on its side in anechoic room. In this examination, it was decided not to consider the effects of ground reflection. We defined as zero degree horizontal position relative to the microphone. We moved the loudspeaker with 15 degrees interval, and measured sound from zero degree to 90 degrees.

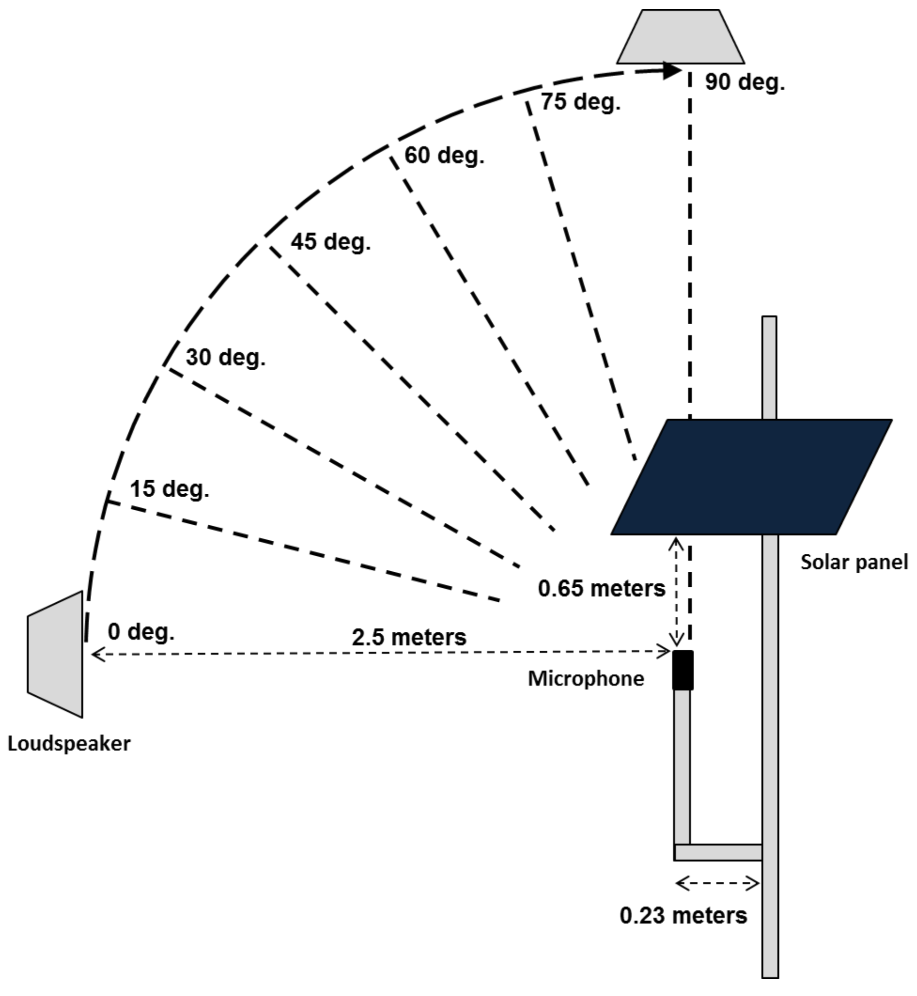

Figure 2 - Measurement configuration of acoustic effects

Table 1 - Measuring equipment

Components	Maker	Type/Model	Notes
Microphone	RION	UC-59	Condenser microphone
Preamplifier	RION	NH-22	
FFT Analyzer	RION	SA-A1	With FFT software
Solar panel	K.I.S.	GT20	20Watts, 350mm×530mm
Loudspeaker	BOSE	101MMW	
Amplifier	BOSE	1705	
Noise generator	RION	SF-06	

2.1.2 Results and discussion

The measurement result is shown in figure 3. The result below shows relative attenuation to the absence of solar panel. The graph shows relative attenuations, which are the difference between power spectra with solar panel and without solar panel. From the result of zero to 60 degrees, it is possible to see the effect of solar panel for frequency above 500 Hz. It shows that the positioning of microphone and solar panel must be taken in account when measuring the environmental noise. In addition, influence of the sound insulation by the solar panel was large and it was confirmed at frequency more than 1 kHz as 75 degrees and 90 degrees.

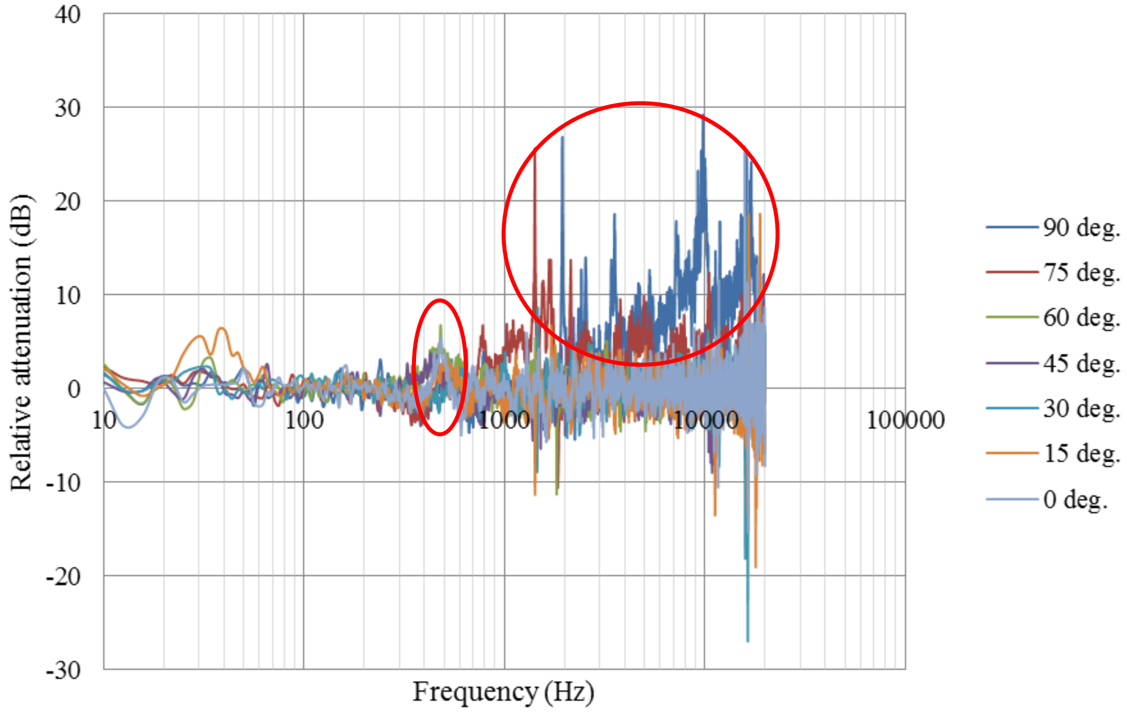

Figure 3 - Measurement results of acoustic effects

2.2 System Temperature and rechargeable battery

2.2.1 Experimentation

In most cases, noise monitoring system is used in outdoors. Therefore, the temperature of the system is increased significantly by direct sunlight, and particularly in summer. We have measured the temperature inside of the system and the outside temperature. The measurement system is stored in a plastic enclosure, and the plastic enclosure is installed outdoors.

2.2.2 Results and discussion

In Figure 4, we show the measurement results of temperatures inside the system and temperature outside the system. To see the effect of sunlight alone, we conducted this with system switched off. When the system is in direct sunlight, the temperature inside rose by about 6 degrees. This means that in real measurement, this heat will be added to the heat generated from the system. Amount of heat generated will differ with the size and the material of the body but with system the size of a trunk case, it is about 5 to 7 degrees. In Tokyo Japan, maximum temperature during summer can rise up to 37 degrees, 6 degrees from direct sunlight and 7 degrees from the system which adds up to 50 degrees. Table 2 shows the specification of various batteries. Performances such as power density and temperature range. The size varies according to a kind of the battery. Figure 5 shows an example of a battery. The battery with largest size is Lead acid battery, the smallest size is Li-Ion battery and Ni-MH is the size of the middle. The capacity of Lead acid battery is 26.4Wh, Ni-MH battery is 44.4Wh and Li-ion battery is 41.4Wh.

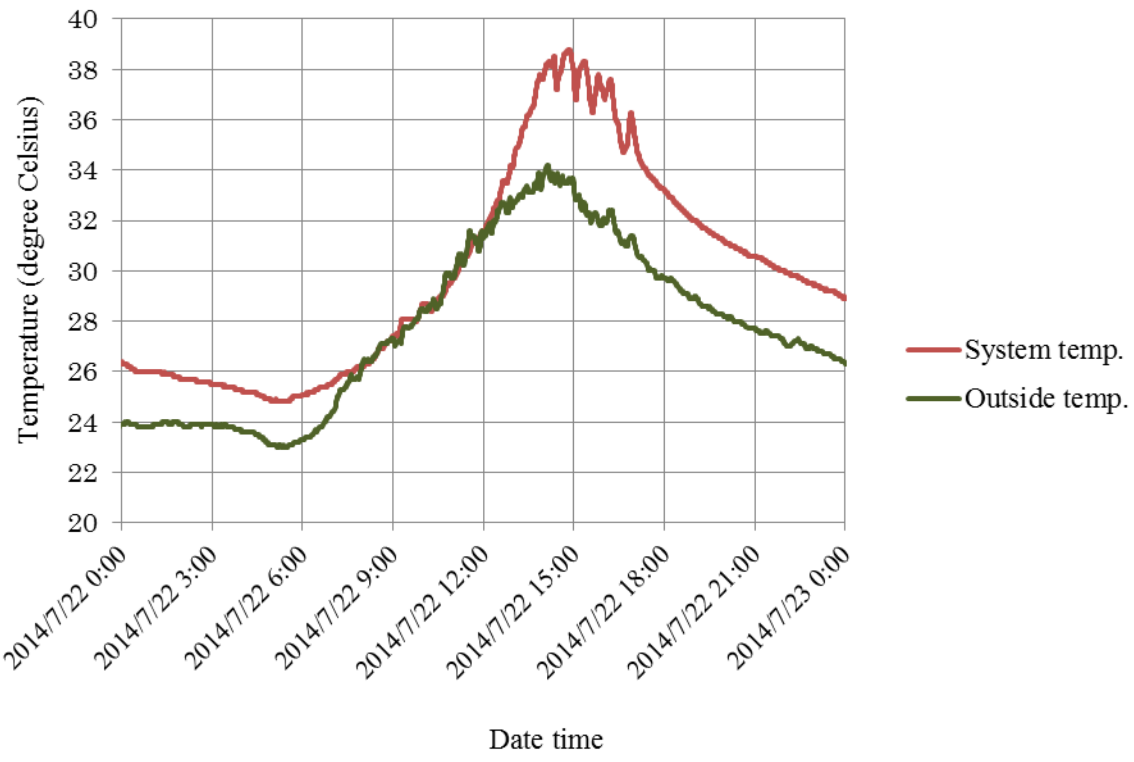

Figure 4 - Relationship of system temperature and outdoor temperature.

Table 2 - Specification of various batteries

Battery chemistry		Lead Acid		Li-Ion	NiMH		NiCd	
Type		Normal	Heavy duty	N/A	Normal	Heavy duty	Normal	Heavy duty
Temperature Range, degree Celsius	Discharge	-15 to +50	-40 to +80	-20 to +60	-10 to +65	-10 to +65	20 to +60	-40 to +60
	Charge	0 to +40	-40 to +80	0 to +45	0 to +45	-10 to +60	0 to +45	-40 to +60
Volumetric energy density, Wh/L		100 and under		500 and more	Approx. 200 to 400		Approx. 100 to 170	
Gravimetric energy density, Wh/kg		40 and under		200 and more	Approx. 60 to 100		Approx. 40 to 55	

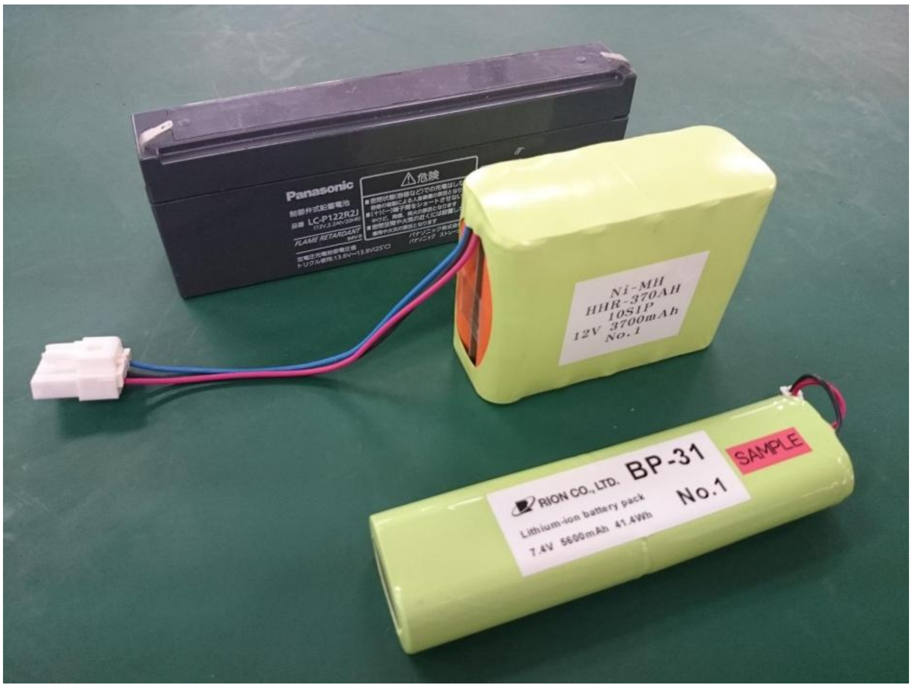

Figure 5 - Batteries of various types

3. CONCLUSIONS

The effect of solar panel can be seen from 500 Hz even when the angle of microphone was zero to 60 degrees. Furthermore, when the angle is greater than 75 degrees, large insulation was confirmed for frequency above 1 kHz. This strongly suggests that positioning of the solar panel must be considered. Further experiment should be done with smaller angle as the change in angle with this experiment was large.

When using this system during the summer of Tokyo with direct sunlight, there is a possibility that the temperature inside can rise up to 50 degrees. Each battery has different pros and cons so appropriate battery should be used for different environments.

REFERENCE

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