Approach Warning System for Snowplow Using Aerial-High-Power Ultrasonic Wave with Radio Wave

Manabu Aoyagi\textsuperscript{a}, Yuta Amagi\textsuperscript{b}, Hiroaki Miura\textsuperscript{a}, Ryota Okeya\textsuperscript{a}, Hideki Tamura\textsuperscript{b} and Takehiro Takano\textsuperscript{b}

\textsuperscript{a} Graduate school of Engineering, Muroran Institute of Technology, JAPAN
\textsuperscript{b} Graduate Department of Communication Engineering, Tohoku Institute of Technology, JAPAN

Research Background

Under bad weather, a driver on a rotary snowplow working cannot see a guide keeping safety of a passer-by. Hence, injury accidents happens on guide. Urgent to ensure safety of guide.

Objective

Distance measurement under worse condition. Inspection of influence in snowfall, snow accretion, icing, and rainfall.

Overview of system

Features: Combination of aerial-high-power ultrasonic and radio waves. Large transmit signal level even under worse environment.

Outline of system.

Influence of snow accretion

Rear

Little artificial snow

Side

Front

Natural snow

Influence of Icing

Much Icing

Large Uneven Icing

Admittance declines

Resonance freq. increases

Uneven icing

Small

Little

SPL attenuation

Large

Much

Necessary to prevent Icing

Sound pressure level (dB)

-5.4 °C

Temperature:

Mean wind speed: 2.0 m/s

Density of snow: 0.083 kg/m³

No load

Little snow

Much snow

Natural snow

SPL under snow accretion.

SPL declined as snow accretion increases. No effect of little snow accretion.

Distance measurement results in the case of transducers set on snowplow.

Admittance characteristics under icing.

Summary

Developed warning system is effective to prevent the accident on a guide. Reasons are described below:

- Key point is to utilize flat face side of stepped radiation disk! Flat face is still effective to radiate directive ultrasonic wave.
- Hard to correct water, uneven icing and much snow which make SPL lower.
- Little snow accretion and even icing, which are easy to appear on flat surface, have small influence upon transducer performance.
- Double transducers enable to measure distance all over warning area.

Admittance characteristics under icing.

SPL under icing.

Sound pressure level (dB)

Mean wind speed: 0.4 m/s

No load

Little icing (2.705 g)

Holey icing (1.169 g)

Even icing (4.790 g)

Rough icing (3.920 g)

Frequency [kHz]

Admittance (mS)

2.2

2.0

1.8

1.6

1.4

1.2

1.0

0.8

0.6

0.4

Error

2 m

3 m

4 m

Distance measurement results in the case of transducers set on snowplow.

Admittance characteristics under icing.

SPL under icing.

Mean wind speed: 0.4 m/s

No load

Little icing (-7.5°C)

Holey icing (-8.8°C)

Even icing (-6.1°C)

Rough icing (-8.6°C)

Frequency [kHz]