Research for Automation and Labor-saving in Airport Snow Removal — Analysis of Work Patterns and Development of Evaluation Methods for the Effect of Labor-saving and Automation Technology Introduction —

(Study period: FY2020 to FY2022)

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1. Purpose and Background of the Research

As we look to welcome 60 million international visitors to Japan in the years to come, we are making efforts to enhance airport functions to maintain an environment to receive airline passengers. On the other hand, as Japan's working-age population decreases, it is anticipated that it will become difficult to secure operators in the future due to a fall in the number of and the progressing aging of operators of snow removal vehicles. This poses a problem in maintaining the necessary framework for snow removal at our airports. In order to address this issue, the introduction of automation and labor-saving technologies for airport snow removal is under consideration as part of the "Aviation Innovation" utilizing advanced technologies and systems in the aviation field[1].

Photo 1: Example of airport snow removal vehicle (snowplow)

2. Analysis of Work Patterns and Examination of Feasibility of Automation and Labor-saving Technologies

In order to ensure stable operation of aircraft, airport snow removal demands high requirements in terms of snow removal accuracy (coefficient of sliding friction of road surface when snow removal is completed) and target working time. It is necessary to examine the applicability of automation and labor-saving technology to airport snow removal, because the operation requires know-how of skilled operators.

First, we collect data on the driving position, route, driving speed, and the operator's operation of each snow removal vehicle in the current snow removal work to identify routine works which are prospective subjects for introducing automation and labor-saving technology in airport snow removal[2]. For example, in the case of a snowplow, the longitudinal inter-vehicular distance is 50 to 300 m, the lateral distance 3.5 to 8.0 m, and the distance to the runway lights approximately 6 to 7 m. (Figure)

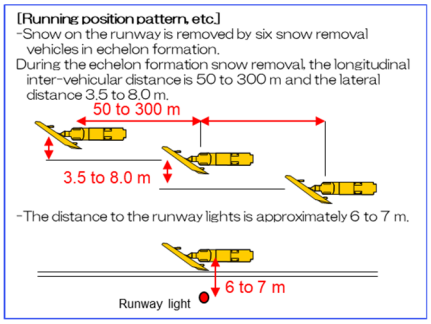

Figure: Travel pattern of snowplows

Based on the analysis of the above work pattern, we also organize the feasibility of automation and labor-saving technologies through a questionnaire given to airport snow removal operators. For example, regarding the feasibility of a driving support guidance system (a device for measuring the vehicle position with sensors or the like attached to the vehicle and displaying the positional relation with surrounding facilities and approach notification on an on-board monitor) (Photo 2) to snowplows, the highest percentage of respondents who indicate that guidance is necessary was for snow removal work when approaching lights such as runway lights and taxiway lights, and a certain number of respondents indicated that guidance is necessary in grasping the positional relationship with other vehicles. (Table 1)

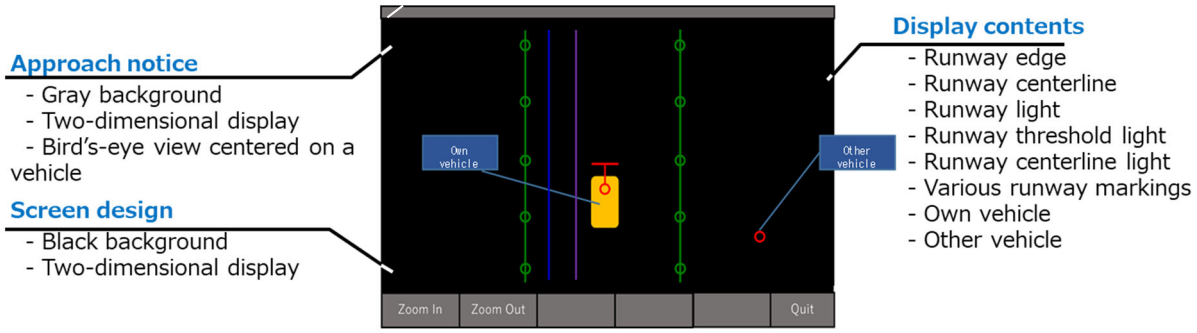

Photo 2: Driver assistance guidance system (on-vehicle monitor)

Table 1: Results of questionnaires to airport snow removal operators

When grasping the positional relationship with other vehicles during echelon formation snow removal (on runway)	When grasping the positional relationship with other vehicles other than during echelon formation snow removal (on apron or taxiway)	When operating the equipment when approaching the runway threshold light	When snow removal is carried out by approaching lights such as runway lights and taxiway lights	When moving the vehicle backward (backward operation)
41.7%	41.7%	54.5%	63.6%	58.3%

*The numbers in the table represent the percentage of respondents indicating that guidance is necessary.

3. Development of an Operational Method of Automated and Labor-saving Airport Snow Removal and a Method for Evaluating the Introduction Effectiveness

For the stable operation of aircraft, we are revising operational regulations (such as airport snow removal work plans) necessary for the introduction of automation and labor-saving technologies to airport snow removal, and developing methods to quantitatively and qualitatively evaluate the effect of introducing labor-saving and automation technologies.

On the assumption of the introduction of automation and labor-saving technologies, a revision of the operating regulations is to be carried out from the viewpoint of organizing the operating rules, reducing the number of assistants and others associated with the introduction of the technologies, and measures to ensure safety in spaces where both the technology-introduced and conventional vehicles are intermingled.

With regard to evaluating the effect of the introduction, we aim to develop quantitative and qualitative evaluation methods from the following perspectives: working hours and costs associated with snow removal work, total working hours, late-night and early-morning working hours, usability of automation and labor-saving technologies (visibility of screen display of driving support guidance system, etc., monitor update speed, accuracy of map display, accuracy of hazard notification), application conditions (adaptability to visibility conditions, climate (wind, temperature, etc.), quality and quantity of snow), improved safety in snow removal work, and ensuring the quality of snow removal. (Table 2)

Table 2: Evaluation index of introduction effect

Item	Perspective	Details	Evaluation index
Quantitative assessment	Manpower saving effect	Working hours and costs associated with snow removal work	- Reduction of workforce and working hours by saving labor - Reduction of the number of people waiting
	Improvement in working environment	Total working hours, late night and early morning working hours	- Reduction of long working hours, late-night and early-morning workers
Qualitative evaluation	Usability of introduced technology	Visibility of screen display	- Monitor size and brightness - Excess or lack of displayed information and ease of viewing
		Monitor update speed	- Monitor update speed - Presence or absence of display's delay
		Accuracy of map display	- Presence or absence of deviation between the display position and the actual position of road signs and aeronautical lights - Presence or absence of deviation between the indicated position and the actual position of other vehicles
		Accuracy of hazard notification	- Presence or absence of delay/omission of notification - Presence or absence of discomfort with the notification method
	Applicable conditions	Feasibility to visibility conditions, climate, quality and amount of snow	- Feasibility under low visibility, snowfall, and snow cover
	Contribution to work safety	Improved safety in snow removal work	- Near-misses, accidents, etc. that are suppressed or eliminated by the introduced technology
	Effect on snow removal quality	Assuring quality of snow removal	- Difference in snow removal work hours (difference in finish during continuous snowfall) - Difference in road surface finish

✓ Click here for more information.

1) Demonstration Experiment Review Committee for Labor-saving and Automation of Airport Snow Removal
https://www.mlit.go.jp/koku/koku_tk9_000038.html

2) Paper presented at the 23rd Airport Technical Meeting
https://www.mlit.go.jp/koku/content/001578595.pdf