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Development of a Device for Evaluating Media Injection State in Air-Type Shot Peening Nozzles

1. INTRODUCTION

Recently digital transformation (DX) initiatives have been increasing in the industrial world. It is not something special, but many of them are already implemented in our daily lives. Examples include cloud-connected smart devices and music and movie subscription services. These digital solutions are having a significant impact on our lives.

The steps to promote DX are digitization, digitalization, and digital transformation. The first step is the transition from analog to digital (digitization), which is required for both processes and facilities. After digitalization, it is expected to improve productivity and create new businesses by utilizing the data obtained from the digitalization.

In addition, simulation and analysis using data will eliminate the need for trial manufacture, which has been done in the past, and equipment settings can be set automatically according to the equipment and environment (automation and autonomization of equipment). If these are realized, the number of man-hours spent on work and the reduction of waste will be solved, leading to sustainable business.

From another perspective, what used to rely on the worker's experience, intuition, and know-how can now be visualized as numerical data, leading to technological improvement and the transmission of skills.

On the other hand, from a carbon-neutral perspective, it is possible to optimize energy consumption. If the current processing conditions can be quantified, it is possible to obtain optimal conditions through simulations in a virtual space and feed them back to the real world to optimize the processing.

Equipment manufacturers believe that digitization of processes and facilities is the first step in the process. The items include process condition monitoring and equipment operation status. This data can be visualized as numerical data, and the obtained data can be used to provide useful feedback for customers' facility operation.

However, it is difficult for a single company to achieve this, and we believe that companies and research institutes with knowledge in each technical section should work together to achieve DX as an industry.

2. CONCEPT

The flow of DX promotion in the shot peening process may include (1) sensing, (2) data accumulation, (3) data analysis, and (4) feedback to the equipment. These steps should be repeated to optimize the process and equipment.

For sensing, it is necessary to visualize parameters related to processing and equipment operation. Data accumulation and analysis can be done either on the site side (edge computing) or in the cloud, depending on the desired parameters. Analysis results are fed back to the facility (on-site) to achieve or maintain optimal conditions.

There are various methods to achieve these goals, and it is difficult to select a single method. We would like to discuss the optimal method in cooperation with users and partner companies.

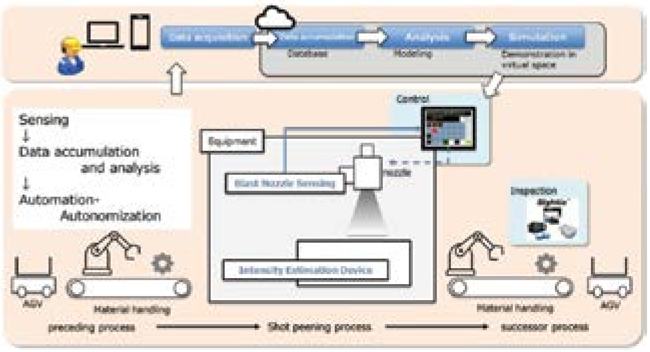

Figure 1 Concept Overview

3. OVERVIEW OF SINTOKOGIO'S INITIATIVES

The following is an example of Sintokogio's efforts to study sensing methods. In the past, our company has obtained a patent for this type of sensing (Suzuki-type nozzle sensing method: US patent 8375757). The purpose of this patent is to check the condition of shots passing through the nozzle. Although arc height and intensity are used to evaluate the peening process, they had not been linked to the peening process at the time the patent was obtained. One of the reasons for this is that it was difficult to extract the feature values that were associated with them from the sensor output using the technology available at that time.

However, recent technological advances have made it possible to extract parameters for intensity estimation. This can be done in real-time for continuous monitoring and control. This is accomplished in the following steps. (1) Attach a sensor to the nozzle and acquire its output waveform (2) Extract features from the raw waveform (3) Estimate the intensity from the features.

Experimental results are presented below.

Figure 2 shows experimental system of this study. A gravity suction type blasting machine was used with the sensor attached on the blast nozzle. It was connected to the measurement device by cable. The device acquires sensor output values and calculates parameters. Media used in this experiment are shown in Table 1.

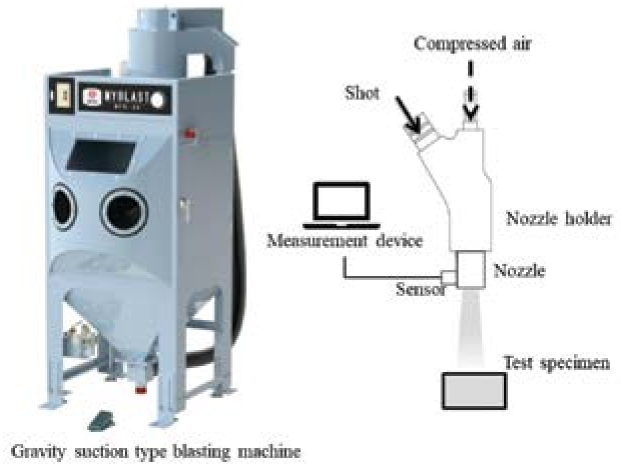

Figure 2 Experimental system

Table 1 Media used in this experiment

Media type	Diameter[mm]	Hardness[HV]
Cast steel	0.1	390~510
CCW	0.3	450~550
CCW	0.6	780~850

Figure 3 shows an example of the acquired waveforms: the compressed air injection starts at 0.8 seconds and the media injection starts at 1.2 seconds. Waveforms overlap each other, making it difficult to extract features from them.

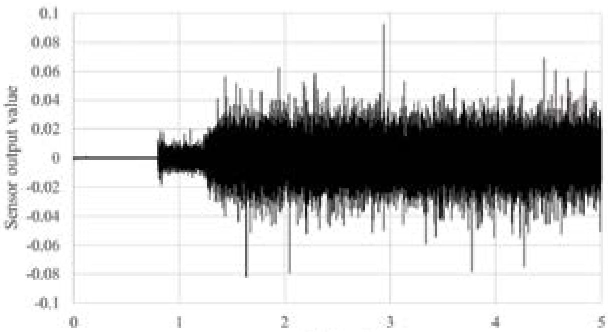

Figure 3 Sensor output waveform

Next, the results of the calculations to extract features from the acquired waveforms are shown below. The calculation result in Figure 3 is Figure 4.

The waveform is relatively stable in the time region where the media is injected. It can also be seen that the calculated values are different when only compressed air is being injected and when media is being injected. This can be used to confirm whether the media is coming out of the nozzle or not.

The parameter calculated by averaging the calculated values when the media is injected in the figure below is called the "mean value," and this value was compared with the intensity.

The results which compare with peening intensity and the mean value are shown. The dashed line shows the approximate line.

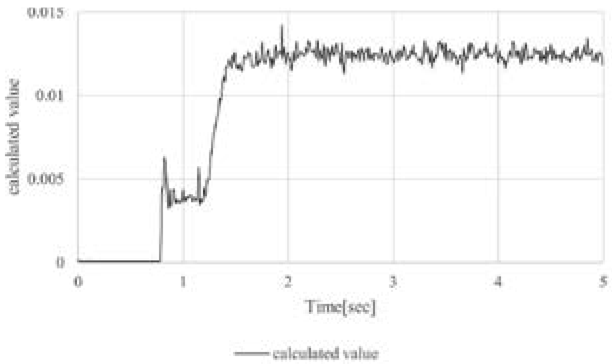

Figure 4 Waveform after calculation

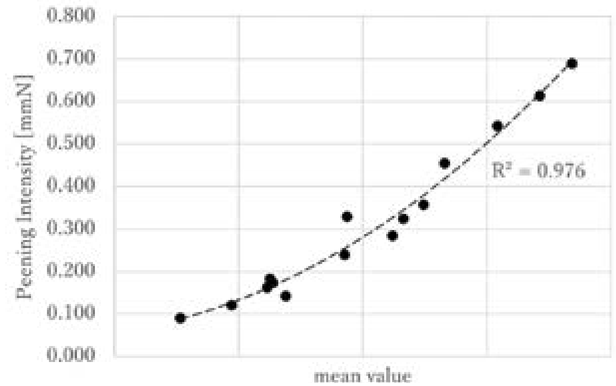

Figure 5 Comparison of peening intensity and the mean value

The result of drawing an approximate line for the parameters and intensity calculated from the acquired waveforms shows a very good fit. Intensity is estimated from this result. Then we consider that Intensity can be estimated from the relationship between Intensity and mean value.

Conventionally, arc height and intensity are checked before processing, but only indirect parameters such as pressure are available for monitoring conditions during machining. The ability to obtain numerical data on injection conditions during machining improves the certainty of the process and enables traceability.

4. CONCLUSION

Development of a device for evaluating the media injection state in air-type shot peening nozzles was introduced. Numerical expression of phenomena is important to realize DX. For this purpose, it is necessary to work on sensing technology for phenomena related to shot peening.

We are now working on the evaluation activities with the help of Electronics Inc. We also hope that the industry, not just single companies, will discuss the use of this data.

We would like to hear users' opinions on this technology and concept. If you are interested, we would be glad to hear from you. Please contact us via email:

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