Real-time Surface Quality Monitoring for Adaptive Manufacturing Process Parameters with Embedded Deep Learning Method

In recent years, the development of advanced manufacturing technology has been continuously pushed towards a higher demand for specification due to a need for better and more consistent product quality, reduced product cost and shorter manufacturing process. The advancement of manufacturing process equipped with an intelligent method open possibilities to answer the existing challenges. An application of intelligent method to monitor the quality of component and manufacturing process parameters in real time has not been presented and devoted to date. The existing research is focused on the prediction of tool life in manufacturing process [1][2]. To date, the surface quality monitoring of abrasive processes such as grinding and polishing relies on visual inspection and is typically conducted in offline mode once the entire process completed. It has more activity to monitor surface quality from the abrasive process and is judged to be less efficient. The surface quality measurements such as thickness, surface roughness and material removal rate require a considerable amount of time and skilled operators, because of the repetitive process (de-mounting and mounting) of the component/work coupon to the fixture. steps that are currently applied in manually measuring machine tool life include component preparation, initial measurements such as thickness, installing component / work coupon to the robot fixture, then surface finishing processes such as grinding and polishing, re-installing component / work coupon from the robot fixture, then checks the surface quality measurement such as thickness, if the surface quality meets the requirements, it will go into a further process, whereas if the surface quality does not meet the requirements, it will start again from the installation stage of the component / work coupon to the robot fixture. The concept in this study is intended to automate the quality measurement output of surface finishing process or abrasive processes. So, that monitoring of the life tool of the machine can be done when the engine is in working condition even though. The results of this study will be used to application at any surface finishing processes of parts or components such as grinding and polishing. The research was conducted because it has the potential to be able to reduce measurement time, minimize the inconsistency of manual measurement, real-time measurement system. This research proposes an intelligent measurement method for surface quality component of abrasive processes such as grinding and polishing based on deep learning method to predict thickness or material removal rate (MRR). This research will develop a real-time monitoring method for abrasive process by connecting sensor, robot and DAQ device in the hardware setup; and embed a deep learning method into the system integration. General description of this study is as follows, the input signal obtained from the accelerometer AE sensor in the form of analog signals and digital signals obtained from the ABB robot controller will be processed into deep learning to be studied and the results of learning in the form of experience will make the system able to classify input signal to explain the life tool condition on the machine being applied and display it on the monitor in real time. To implement this research idea, the researchers used the Convolutional Neural Network (CNN) method. Convolutional Neural Network was chosen because in many previous studies CNN was used as a method for classifying signals originating from sound or vibration. This, according to researchers, is sufficient to be the basis for using the CNN method in the case currently being discussed. The vibrations which becomes data enters will be learned by the system to gain experience of what has been learned. The experience of the program is expected to be able to read the vibration value to monitor

the life tools of the machine being applied. This research have some motivation to solve the problem, motivation 1 is to remove the repetitive measurement, the meaning is when the engineers want to check prediction of tool life they don't need to stop the machine process. If the results of this study can be applied to the machine then, the three stages currently carried out such as surface finishing process up to the stage of surface quality measurement will be replaced by an automatic measurement process using deep learning. As for the stages - these steps include digital and analog signal input, deep learning processing using the CNN method and displaying the conditions in real-time with a monitor connected to the GPU and the machine being applied. So, that the time spent monitoring machine life tools will be more efficient and does not require special workers to carry out such monitoring. Motivation 2 is to replace the manual measurement, the main idea of propose online abrasive process monitoring was turn the vibration signal of abrasive process into the useful information to quantify the product quality of the surface finishing parameters such as thickness, and MRR based on a deep learning method. Previously to find out the vibration signal on the engine the technicians measured the vibration manually with a vibration meter. Whereas, in this research we will use sensors to calculate vibrations in the form of digital and analog signals, so that monitoring will continue even if the machine is working as usual. Motivation 3 is to obtain consistent product quality, The developed deep learning method is used to transform the raw vibration signal into the useful features (information) that correlate to a certain surface quality parameters e.g. thickness and MRR. The prediction result of the intelligent method is also useful to provide a feedback to the robot to adaptively adjust the manufacturing process parameters such as RPM and feed rate. By adaptively alter the manufacturing process parameters, a consistent product quality will be maintained. This research intends to automate real-time life tool machine monitoring work to improve efficiency. With the application of the results of this study there is no need for special technicians to conduct monitoring. It is hoped that the results of this study can be useful as the purpose of this study, namely to automate the performance of life tool machine monitoring using Deep Learning with the Convolutional Neural Network method.