Study on Virtual PM Sensor of Construction Machinery by utilizing Machine-Learning Algorithm

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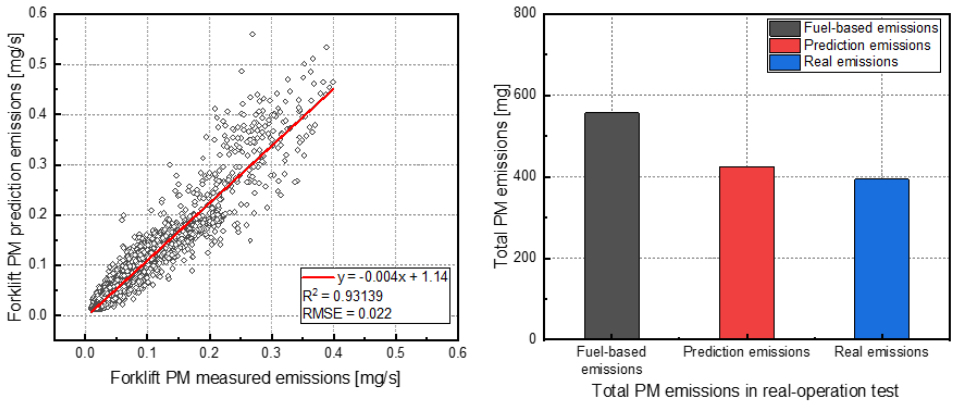
As environmental issues are continuously concerned all over the world, there is a growing focus on researching developing methods to manage and monitor the emissions from various forms of mobility. In the case of on-road vehicles such as light-duty vehicles (LDV), heavy-duty vehicles (HDV), quite accurate emissions management and monitoring are being implemented by utilizing a portable emissions measurement system (PEMS) and on-board diagnostics(OBD) system. As the emission management and monitoring methods for on-road vehicles demonstrate successful performance, the adoption of such techniques for non-road mobile machinery(NRMM) is expected.

The OBD system provides many information that effects to emissions such as engine speed, engine load, fuel rate, and Air/fuel ratio. The construction machineries equipped with a selective catalyst reduction(SCR) provide NOx emission information from the sensors at the upstream and downstream sections of the SCR. However, a particulate matter (PM), major emissions of diesel engines, is not provided by OBD system. So that, in this study, we aim to develop a virtual PM sensor utilizing machine-learning algorithm for construction machinery.



The input data for this study consists of engine characteristics which have relationship with PM emissions and PM emissions measurement data. Engine characteristics contains fuel rate, The Engine characteristic data were logged on the OBD and the emissions measurement data were logged using PEMS during the real-operation test of construction machinery. Among various types of construction machinery, we selected three types of construction machinery, such as forklift, excavator, loader, based on number of registered construction machineries in Korea. In the process of PM prediction for three types of construction machinery, each of type had different major variable in the prediction process and shown different accuracy. A PM prediction in a forklift shown the best accuracy, over 0.9 R^2 value, and remaining types shown strong correlation with actual measured emissions. Finally, to verify the feasibility and practicality of the method presented in this study, we compared PM prediction result with actual emissions and fuel consumption-based emissions that calculate emissions through emission factor

provided by EMEP/EEA. As a result, both error range and correlation value of construction machineries were more accurate than fuel consumption-based emission calculation method. Through the result of this study, we checked the validity of the PM predictive monitoring method and by conducting further research, we can expect precise and cost-effective virtual PM sensor development.

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