Digital Twin of an Internal Combustion Engine

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Abstract: Major marine engine companies such as Wartsila have developed both their new 4-stroke and 2-storke using gas and hence strongly believe that Internal Combustion Engines (ICE) have place in marine power propulsion and auxiliary units. A recent announcement that Mazda sees a bright future for ICE is also indicative of automotive industry has not lost hope on the future of ICE. This paper reports on recent developments to construct a digital twin of these power units with a view to improve their performance and also as a means of monitoring their behaviour when changes are introduced. This paper is composed of two parts. Part 1 is the digital half of an Internal Combustion Engine (ICE) which concerns the development of the mathematical model of the ICE and a suite of computer simulation programs which would allow the effects of various design and operational changes to be reliably and accurately predicted with the ultimate aim of producing cleaner engines and/or more efficient power units. The model has been tested against the experimental results of the TUDEV Engine (2015) and Paxman engine at Newcastle University and earlier against the Atlas engine at Ricardo, Brighton, UK. Part 2, currently been written, contains the other digital half of the ICE which describes the rig development viz., the physical model of the Engine. The key features of Part 2 will be presented at the conference but to limit the length of the paper has not been included in this paper. However, the idea is to match the two parts using an earlier model developed by Ziarati (2009) to produce a finger print of both the mathematical model and the physical model. The matching of both parts would enable the mathematical model to be used for various design and operational changes with a view to reduce fuel consumption or engine harmful emissions. The predicted results and the experimental data are in good agreement.