EXPERIMENT AND SIMULATION BASED SELECTION OF OSCILLATING BUOYS FOR RACK & PINION POWER TAKE-OFF WAVE ENERGY CONVERTORS

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Thesis submitted in partial fulfilment of the requirements for the
Degree of Master of Engineering in Manufacturing Systems Engineering

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The above candidate has carried out research for the Master of Engineering in Manufacturing Systems Engineering Degree under my supervision.

Name of the Supervisor: Professor M.A.R.V. Fernando

Signature of the Supervisor: Date:

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ABSTRACT

Wave Energy Converters (WECs) are explored on finding solutions to the energy sector as a renewable energy source for electricity and trying to convert the immense power available with ocean waves in the most efficient way. Many researches have been undertaken to improve varieties of WECs. However researchers have paid less attention towards the improvements of Rack & Pinion Power Take-off (PTO) WECs. Oscillating buoys are the most important part in most of the mechanical WECs which are used to absorb initial power from ocean waves. The aim of this thesis is to select the best performing oscillating buoys for Rack and Pinion PTO WECs by fulfilling the three objectives: (1) To identify Oscillating buoys suitable for Rack and Pinion PTO WECs, (2) To carry out simulation analysis to select the best performing oscillating buoys for Rack and Pinion PTO WECs, and (3) To conduct experimental analysis to select the best performing oscillating buoys for Rack and Pinion PTO WECs. The DMAIC (Define, Measure, Analyse, Improve & Control) cycle was used as the basis for the methodology. Six buoy types were selected based on the commonly available other types of WECs and this thesis focussed on simulation & experimental analysis to select the best performing oscillating buoys for Rack and Pinion PTO WECs. Simulations of all buoys were carried out with the help of Computational Fluid Dynamics (CFD) software X-Flow and three parameters, namely: Static Pressure, Vorticity & Liquid Phase, which were compared with each other. Proto type Rack and Pinion PTO WEC with regular wave making facility in a testing tank and six types of buoys in equal weight with the height to width ratio as 1 were fabricated and experimental testing were undertaken by creating four different wave heights for each buoy. Simulation and experimental results were analysed carefully and the best performing buoys for the proto type model of oscillating buoy operated, Rack & pinion PTO WEC were selected.

Key Words: ***Wave Energy Converter, Oscillating Buoy, Power Take-Off, Simulation, Experimental Analysis and Optimization***

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LIST OF ABBREVIATIONS

Abbreviation	Description
CAD	Computer Aided Design
CCD	Coastal Conservation Department
CEB	Ceylon Electricity Board
CFD	Computational Fluid Dynamics
LCOE	Levelised Cost of Energy
LHI	Lanka Hydraulic Institute Ltd
NWW	Noaa Wave Watch
OWC	Oscillating Water/Wave Column
PTO	Power Take Off
RAO	Response Amplitude Operator
RPM	Revolutions per Minute
UK	United Kingdom
WCD	Wave Converting Devices
WEC	Wave Energy Converter