GHENT UNIVERSITY

HIGH-EFFICIENT, HIGHLY ROBUST POWER-TAKE-OFF FOR WAVE ENERGY CONVERTERS BASED ON AN ELECTROMECHANICAL POWER SHARING TRANSMISSION

EnerGhentIC, the interdisciplinary community of Ghent University of researchers working on the energy challenge, is seeking partners interested in the further development and commercialization of a novel type of power-take-off (PTO) for a wave energy converter, patented under "US9,784,238. - WAVE ENERGY CONVERTOR." (WEC)

Introduction

Due to the high energy of waves in the ocean, wave energy has a high potential to become part of the energy mix. To obtain electrical energy from wave energy, a wave energy convertor (WEC) is used. The part of this device responsible for transforming absorbed wave energy into electrical energy is typically referred to as the power-take-off (PTO) system.

Efficiently transforming the energy comprised in the movements (pendular or oscillatory) of the movable element directly into electrical energy is hard. Indeed, such oscillatory movements cause the rotor of the electric generator to undergo a bidirectional rotational movement, i.e. to consecutively come to stand-still to accelerate to a maximum rotation speed in a first direction, to decelerate and to come to stand-still one more, to accelerate to a maximum rotation speed in a second direction, opposite to the first direction, etc. Nevertheless, direct electromechanical PTOs have several advantages such as high level of controllability, the potential to benefit from economy of scale, robustness, …

Several attempts to transform the oscillatory movement of the movable element in a unidirectional movement of the rotor of the generator have been reported (e.g. special types of gearboxes such as planetary gearboxes). These devices use at least one (typically two) clutches, freewheels or other anti-reverse mechanisms, which are then continuously engaged and disengaged to ensure the wave-induced oscillatory movement is converted and inverted to realize a unidirectional movement of the rotor of the generator. However, the continuous engagement and disengagement of such freewheels or anti-reverse mechanisms cause mechanical losses in the PTO system, as well does it cause the wave energy converter's PTO system to be prone to mechanical wear reducing its lifetime. Therefore, there is still a need for more efficient and/or more robust PTO systems.

Technology

Researchers at Ghent University have developed an innovative PTO device which converts wave motion into a one directional rotational movement based on a so-called power-sharing or power-split transmission (PST). A power split transmission has at least three ports.

The innovative PTO is arranged between a movable element interacting with the waves (i.e. one axis is connected to one of the three ports) and a main electric generator (i.e. the second axis is connected to a second port). The device further comprises an electromechanical control means such as a variable speed auxiliary electrical machine connected to the last, i.e. the third port of the three ports of the PST. The control unit is adapted for controlling the power distribution in the power split transmission as to realize a one-way rotation of the main electric generator despite the oscillatory movement of the movable element.

Applications

PTO system for the conversion of wave energy to electrical energy. The PTO includes an PST; several implementations of the PST are feasible:

- Implementation via a planetary gear box with all three axes operational.
- Implementation via a differential.
- Implementation through a so-called EVT (Electromechanical Variable Transmission). In preparation of a H2020 project this has been studied in more detail and lead to the proposal of a generic versatile PTO approach for wave energy devices

Advantages

The main advantage of the device is that a wave motion which is a movement in substantially two different directions, e.g. a substantially upward and substantially downward movement, is efficiently transferred into electrical energy. We have shown in simulation the basic potential and advantages of the technology. The main benefits are a result of the fact that the PST provides an additional degree of freedom to optimize and control the PTO. Hence:

- For a nominal seastate (SS) more electrical energy can be extracted (+25% yield for the same installed power compared to a direct drive system)
- The power quality of the produced electricity is increased (better power flatness factor)
- The PST introduces an inherent over-power protection (de-tuning of the WEC is possible)
- At several sea states, the energy yield is less sensitive to the actual settings
- In the case an EVT is used to implement the PST there is no mechanical wear. In case a mechanical implementation is opted for, the torque levels in the PST gear box remain much acceptable.

Status of development

We estimate the current technology status to be at TRL 3: Concept validated in lab on a relatively low power scale (see figure 1).

A simulation tool has been developed wherein the technology has been evaluated and a control algorithm has been established. The tool simulates a real wave energy input (irregular waves).

Partnership

We are looking for two types of partners:

- OEM Wave energy developers in need for an effective electromechanical power-take-off (PTO)
- System integrators willing to develop a generic, versatile PTO

Intellectual property

US Patent **US9,784,238. - WAVE ENERGY CONVERTOR**
European Patent **EP3066333 – WAVE ENERGY CONVERTOR**

GHENT UNIVERSITY

Figure

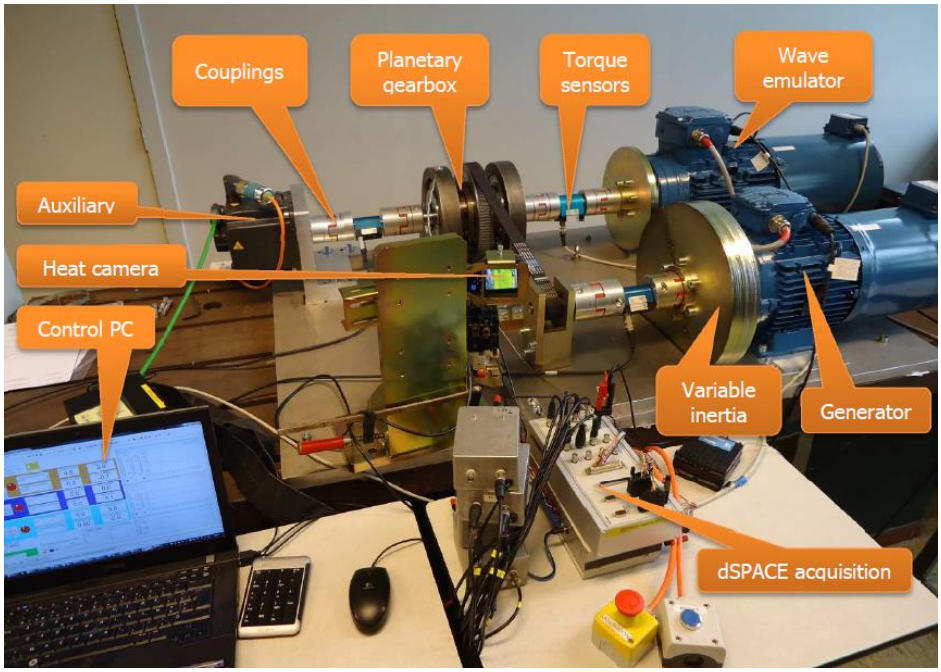

Figure 1: Experimental setup

Keywords

Wave energy convertor, WEC, PTO, EVT

Contact

dr. Jeroen De Maeyer, Business Developer EnerGhentIC (IOF)
Technologiepark Zwijnaarde 913
9052 Zwijnaarde
jeroen.demaeyer@ugent.be