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Six-phase Variable Reluctance Energy Harvester for Smart Bearing Hub Units

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ABSTRACT:
Within the LoLiPoP-IoT project, a variable reluctance energy harvester (VREH) is investigated for integration in a smart bearing hub unit for industrial vehicles. The intention is to supply power to condition monitoring systems that acquire essential data of the bearings, analyse the data in the smart sensing system, and communicate key information wirelessly. The proposed VREH is a six-phase structure with six m-shaped pickup units. Initial simulation results demonstrate power levels of the order of watts under the expected operation conditions.

Six-phase VREH design

The harvester design is based on the state-of-the-art in VREH research, using m-shaped pickup units. Existing structures have been further optimized with respect to structural dimensions and are adapted to the available space in the bearing hub unit.

A six-phase arrangement of pickup units is proposed, exploiting the increased output power of multiple pickups, while reducing the cogging torque through phase compensation.

The VREH is a robust transduction technology, which utilizes low-cost materials. This makes the harvester suitable for commercial applications.

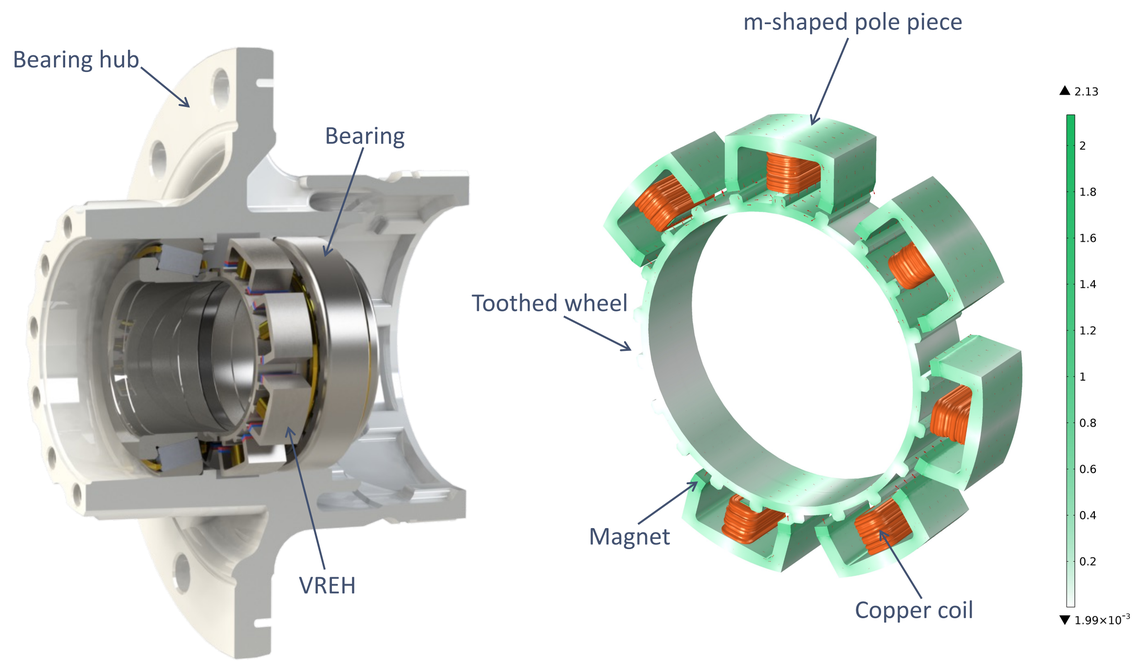

Figure 1 *– (a)* Rendering of the bearing hub unit with integrated VREH and (b) VREH simulation model.

Preliminary results

The VREH provides an AC voltage at each pickup unit, which are phase-shifted in time.

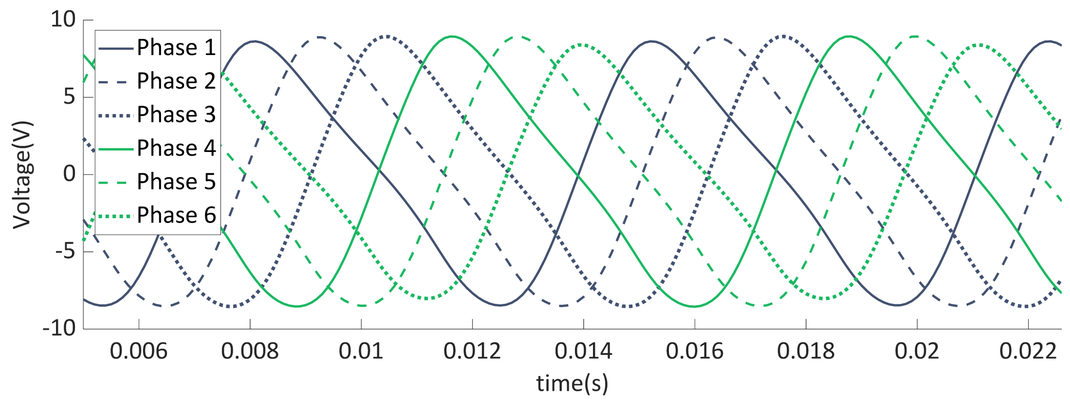

Figure 2 – Output voltages of the six-phase VREH at 400 rpm.

Under resistive load matching, the output power is approximately linear with the rotational speeds.

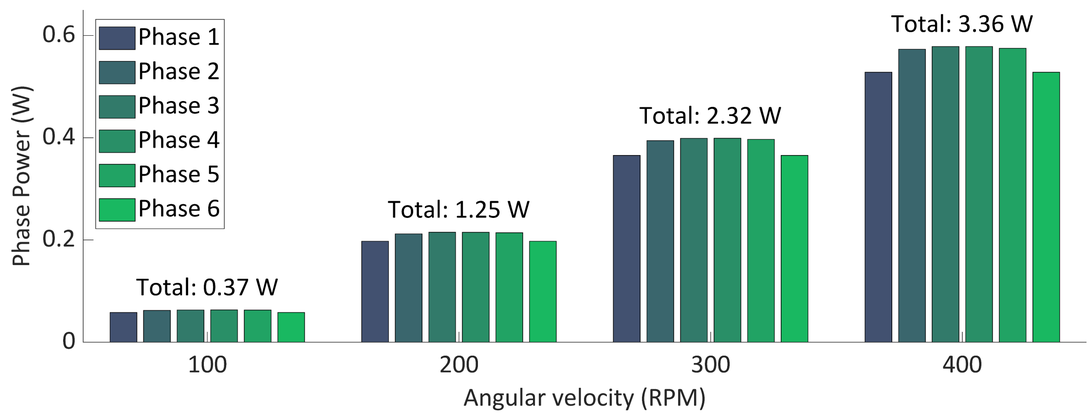

Figure 3 – Output power of the harvester at rotational speeds of 100-400 rpm (approx. 20-80 km/h).

Conclusions and future work

The preliminary results of the proposed harvester demonstrate that the VREH is a suitable technology for energy-autonomous smart bearing hubs. Simulations estimate watt-level output powers, which provides sufficient energies for the targeted application. However, it is expected that the output power will be affected by the system environment, such as the metallic surrounding and ambient temperature variations.
As next steps, the structure will be optimized further, and the effects of the surrounding environment will be investigated. Afterwards, a prototype will be implemented to verify the simulations through experiment.

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