Evaluation of Energy Harvesting from Door Closer and Solutions for Assisted Opening

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Energy harvesting is the practice of small-scale capturing of energy from external sources such as solar power, heat or motion. With an increasing demand for clean energy, research into harvesting energy from everyday appliances has been expanding. One product that most people use everyday, but without noticing, has been the focus of numerous energy harvesting attempts in the past years. The door closer can usually be found on the top of a door and makes sure that doors are closed in a controlled manner after they have been opened. Today, the most common type of door closer uses hydraulic fluid to brake the motion of the door. By instead using an electric generator, it would be possible to harvest energy from the movements of a swing door that would otherwise go to waste.

With expanding markets regarding smart buildings and homes, it is of interest to investigate whether the energy that can be harvested could be used for added functionality and thus eliminating the need to connect the door to an external power source. This could, for example, include automation regarding indoor climate, access control, and alarm systems. One service that there is an expanding demand for since regulations surrounding accessibility are increasing is door automation. While the energy harvested from the movement of a swing door will not be sufficient to power a fully automated door, an assisted opening might be more suitable. The idea is to only supply some helping opening force to weaker users.

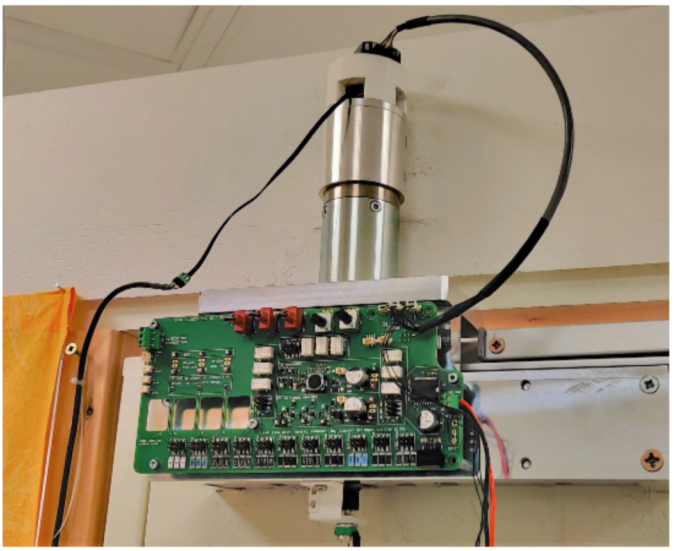

Figure 1. Electromechanical door closer prototype.

The base concept of the electromechanical door closer consists of a generator and an energy harvesting circuit, see Figure 1. The generator converts the mechanical energy to electrical energy while the circuit multiplies the voltage ratios and stores the energy. A flyback converter is used to achieve this and is controlled by a pulse-width modulation signal that switches between storing and releasing energy, which in turn charges a capacitor. To evaluate how efficient this system was, three prototypes with different motor gear box combinations were tested and analyzed. The tests measured how much mechanical energy that could be found in the system, how much of this could be converted to electrical energy and finally how much of this that could be harvested. It was also tested how much energy that was required to open a swing door automatically contra with assisted opening.

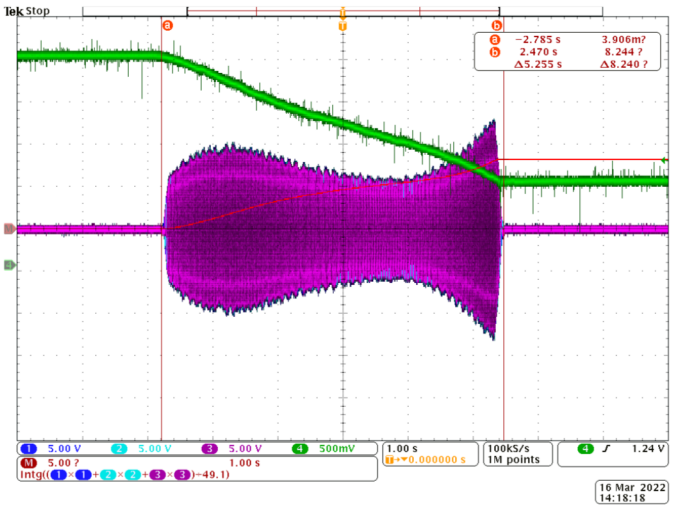

Figure 2. Generated energy from one closing.

It was found that around 8 J (Figure 2) could be harvested with regular settings regardless of which prototype was used but that they all had "sweet spots" with different closing speeds. In comparison, an automatic opening required about ten times as much energy. When analysing how much energy would be needed for an assisted opening solution, it could be seen that while assisted opening was more energy-saving, it would not be possible to assist every person that would walk through the door. However, a solution where the system could differentiate between users in need of assistance and others could be promising. On top of this, it appeared as if energy harvesting during the opening phase could have even more potential than just harvesting when the door was closing.