IGF Project 17742N

An Ever-present Helper: The «AutoShoe»

Development of a self-lacing shoe was the goal set by PFI when it undertook the AiF Project «Self-Fastening Shoe – Mobility Despite Physical Limitations », or «AutoShoe»* for short. An innovative mechanism for automatic closing and opening of shoes was to be designed and built. The project could be accomplished thanks to microcontroller-based electronic circuitry, miniaturised PCBs for measurement and control tasks, integration of sensors into the shoe, and modern rapid-prototyping techniques. The project belongs in the areas of «Wearable electronics» and « Mobility in old age».

It was Germany's demographic development that prompted researchers to undertake this project: People are living longer and longer and wish to remain active and independent. The number of people who are beyond working age is increasing while at the same time the number of those of working age is decreasing. This demographic shift is challenging scientists, economists, and politicians to come up with ways of securing older people's social participation and mobility and thus to improve their quality of life and independence.

AutoShoe (running shoe version)

Mobility often becomes restricted in advanced age; for example, bending or stooping becomes difficult. Technical aids can frequently offer solutions in such cases. The self-fastening shoe could help to improve the independence of persons affected because they no longer have to manually tie their shoelaces and can therefore put on and take off their shoes unaided.

The principal task was to develop a shoe which can fasten automatically, that is without any manipulation by the wearer. A proximity sensor initialises the fastening process as soon as the foot enters the shoe. Alternatively, the shoe can also be controlled or parametrised by an app (which can be run on a smartphone or smartwatch). The app also visualises sensor signals such as humidity, pressure, temperature.

A DC motor fitted with a specially developed gear system serves to wind and unwind the wire responsible for fastening the shoe. In addition to the mechanism for tensioning the lacing, a system is needed for opening the shoe and keeping it open for the foot to readily slip in and out. This is accomplished by side-mounted carbon fibre clips.

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* *from classical Greek αὐτός,* autós, self

Use of a wire for lacing the shoe requires a suitable guide system to reduce frictional losses. In place of a traditional lacing system, miniature guide rollers attached to the upper improve the flow of forces. Use of appropriately optimised plastic components with a low coefficient of friction would be a viable alternative.

Control of the actuator and measurement of the sensor signals are accomplished by a PCB specifically optimised for this purpose. The embedded software permits adaptation of the system to meet the needs of individual user groups or specific applications.

The system is powered by modern lithium polymer batteries. They are simply recharged overnight by placing the shoes over an inductive charger coil on a charging mat. The recharging process is thus particularly user friendly because it requires neither cables nor complex procedures. An overnight charge provides sufficient energy to fasten and unfasten a shoe several times in the course of a day.

The project has culminated in the development of a shoe which opens and closes without any significant expenditure of effort by the wearer and thus offers an interesting option for older or physically challenged persons because they no longer require any help when donning their shoes. Of course, the shoe can also be worn by people who just don't like bending down – it is simply very practical. And it can also enhance wearer comfort: the lacing can be programmed to loosen during prolonged sitting phases and then to tighten automatically on standing up again, thus permitting the wearer to go his or her way surefootedly.

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The complete final report can be ordered from

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