

## Safety System with a Safety Glove

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According to the information of the Health Insurance Institution of Slovenia, there are more than 11 million working days per year in Slovenia lost due to work-related injuries. These injuries are also the cause for a 3% decrease in the gross domestic product (source: Delo, Nov.7.2011). It is mandatory for any employer to assure appropriate safe working conditions. Mostly, work-related injuries are due to high falls, smashing, contact with electricity or falling objects.

At the Laboratory for Bioelectromagnetics at the Faculty of Electrical Engineering (University of Ljubljana), four students decided to develop, under the mentorship of their professor, a system that would increase the level of safety when using powered machinery. At first, their main wish was to upgrade with safety features an already existing product. Since they found no such product on the market, they investigated the possibility of patenting our solution. They believe to have found a unique solution to the problem for which they recently applied for a Slovenian patent.

The students and a professor developed a safety system, composed of a central unit and a pair (or pairs) of gloves which incorporate an electronic circuitry and a pressure sensor (Figure 1).

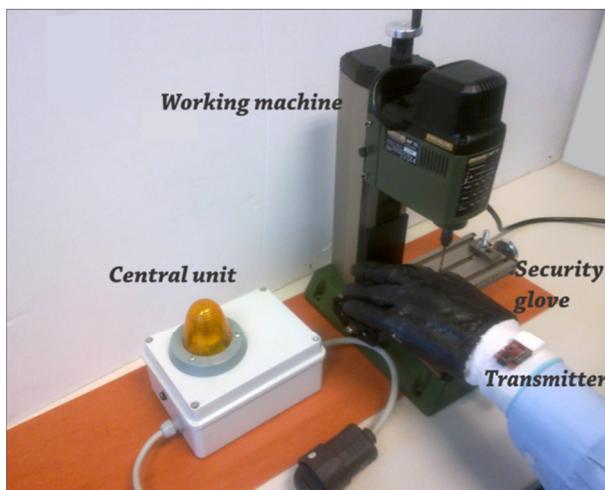


Figure 1. Safety system composed of a safety glove and a central unit which ensures an immediate shutdown of the working machine in case of a rupture or upon reporting a damage of the safety glove.

We developed a safety system for the users of powered machinery. The system is composed of a central unit and two (or more) gloves which incorporate electronic circuitry and a pressure sensor. (Picture 1).

The electronic part of the developed safety system uses wireless connections eZ430-RF2500T of the company Texas Instruments manufacture. The electronic circuitry of the glove consists of a microcontroller MSP430F2274 (whose advantage are a low power consumption and an integrated circuit with a radio transmitter enabling wireless connection to the second unit of the frequency range of 2.4GHz) and a UART/USB interface (connectable to the unit and enabling data sending and receiving using a USB protocol from and to the computer).

The electronic circuitry of the glove continuously checks the state of the pressure sensor, used as a panic button as well as any possible damage to the glove. If the circuitry detects damage to the glove or voluntary pressing the panic button, it immediately alerts the central unit using wireless connection. The central unit immediately shuts down the working machine and initiates a visible and audible alarm, informs the rescue service and reports the damage to the main computer. If the working machine is rotational, the central unit may also trigger extra brakes incorporated in the machine for fast stopping. The scheme of the safety system is shown in Figure 2.

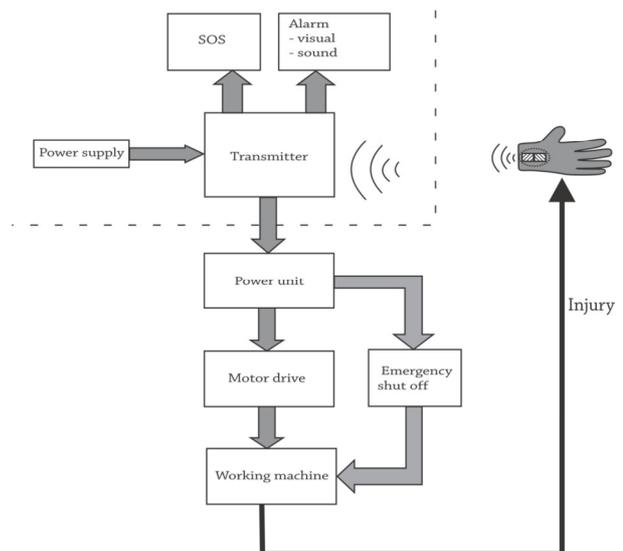


Figure 2. Scheme of the developed safety system

When researching the existing solutions through internet and patent-databases search, the students and a professor found several patents offering possible solutions to the problem. As most of them were impracticable due to technological and scientific deficiencies and since the state of the art allows for new innovative approaches, the students and a professor realized that their idea importantly differed from others mostly in using the modern electronic technology to detect the damage to the glove and transmit the report on the damage to the central unit, thus ensuring better miniaturization of the electronics part and smaller power consumption. Furthermore, besides detecting cutting the glove, their system also sensor its strong squeezing. Moreover, the glove is equipped with a pressure sensor (panic button) to be activated by the user to inform that some other part of her/his body has suffered an injury or that the working machine shows some abnormalities requiring an immediate shutting down the working machine. Another advantage of the developed safety system is its universality. Not being designed for a particular machine, it can be used with almost any other one and it can be quickly moved from one machine to another. The small size of the whole system and the wireless connection between the central unit and the glove enables the users to move quite freely. They can use one of several pairs of gloves (in case there are more users and more machines) on several different machines, because the electronic circuitry of the glove broadcasts the code that is unique to each pair of the gloves and machines. So, in case of damage, the central unit specifies which worker is risking danger and it only stops the machine causing a potential injury.

The students and the professor believe that the structure of their safety glove is the most complex and important part in their research, they will continue developing new ways for its realization. They have already tested several different materials (conductive thread and rubber, carbon fibers, latex), structures and methods of its manufacturing (sewing, gluing). At the moment they are trying to improve it by using a combination of conductive and insulating layers. Their structure is specified in the application.

How to go on? There is a long way from the idea to the development of a useful production prototype. The students and the professor have already gone through several processes, such as searching and studying of the existing patents, investigating possible solutions, looking for appropriate modern technological solutions, selecting and realizing the electronic circuitry and its programming, etc. Within the frame of their investigations they have contacted several industries (with some they have already signed nondisclosure

agreements) and searched for an appropriate unique solution that would be technologically viable and patentable. They have learnt the importance and advantages of team working and bringing together different knowledge and skills in their effort to reach their common final goal. Besides needed unavoidable technical competences, there are also other "softer" abilities that are important, such as the ability of expression, writing, searching for information, making compromises, collaboration, comradeship, etc. Being involved into this particular project, they have acquired the experiences that will serve them well in our future professional life.

Unfortunately, besides the many positive effect of their team working, the students realized that the declared support to the students innovation work is only of a formal character. Despite much talking about the importance of innovation and patenting, there is practically no support to the students' activities in this area. The University is the rightful owner of any intellectual work, accomplished at the University by students. Despite the established office for innovations, only innovations providing financial profit through commercialization of the patent are supported. To improve the current situation lacking on appropriate support, relatively small financial support (compared to that large research projects) would already motivate students and university workers to be more innovative. The current "support" to innovative work is in fact destimulating and even far from leading to an innovative society the whole country could benefit from.