About the use of magnetically hard flexible membranes for tactile interfaces

Svenja Hermann*[1], Dr. Laure Arbenz[1], Prof. Christophe Espanet[1]

[1] *Moving Magnet Technologies (MMT), 1 Rue Christiaan Huygens, 25000 Besançon, France*

Introduction

During the last years, machines have become an integral part of our lives. Consequently there has been an increase of attention given to the subject "Human Machine Interface" (HMI), inter alia containing tactile interfaces. The existing functional principles of tactile interfaces are mostly susceptible to humidity and can be used only with bare hands (resistive, capacitive) or are quite costly (NFI) and offer only optical feedbacks. The introduction of flexible magnetic material to the technical domain of tactile interfaces offers an alternative functional principle that can overcome these deficiencies.

Physical effect

The possibility of using composite membranes for tactile interfaces is based on the material's composition. Rare earth magnetic material particles of NdFeB are dispersed in a silicone membrane. The composite is magnetized in the direction perpendicular to its surface and, as a result, possesses a magnetic field. The flexibility of the hyperplastic material enables a change of the form of the membrane easily. A consequence of this change in form is a change of magnetic field created by the membrane (*Figure 1*). The membrane represents a passive primary sensor: without an external energy supply it is capable of creating different information which can be captured by a secondary sensor.

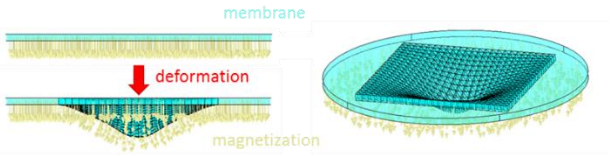

Figure 1: Functional principle

Development of a prototype

To demonstrate the usability of this effect in a device, a prototype of a tactile interface was developed. On the membrane's surface, a square was divided in 9 regions comparable to a 9 key keyboard (*Figure 3*). The prototype is expected to recognize the region in which the membrane is deformed by the user.

Numerical simulations of the membranes behavior concerning the magnetic and mechanical domain have been performed for a circular shaped membrane. It was deformed at three different positions and the changes in magnetic field were evaluated in a plane parallel to the membrane at a fixed distance. Simulations show, that the magnitude of the magnetic field decreases at the position where the membrane is deformed. In an experimental study, the cases of numerical simulation were reconstructed and confirmed the tendencies of the simulations as shown in Figure 2..

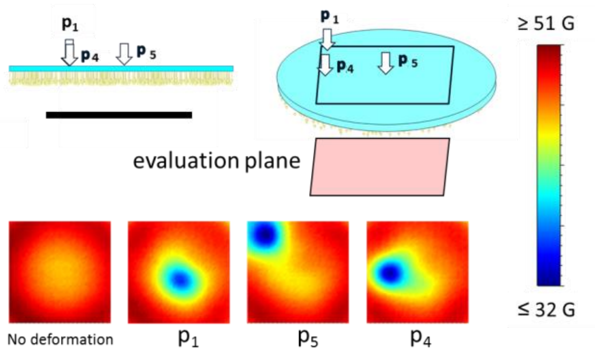

Figure 2: Scheme of the deformation of a membrane at different positions and experimental results

In order to reduce the number of secondary sensors in the prototype, the spatial components of the magnetic field have been analyzed. By using a unidirectional magnetic field sensor placed between two regions (*Figure 3*) the change in magnetic field takes place in opposite directions. According to an optimization process that was used to find the smallest possible number of secondary sensors, not more than five magnetic field sensors have to be used to assign a deformation to one of the 9 regions.

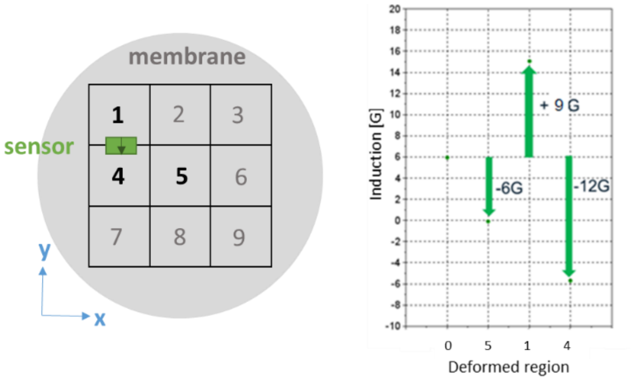

Figure 3: Regions to distinguish on the membranes surface and experimental result for one position of a sensor sensible in y-direction

Conclusion and Perspectives

The possibility of using magnetic composite membranes for tactile interfaces has been demonstrated. The next steps are on the one hand the improvement of the secondary sensor aiming a completely self-sufficient generation of information by the help of electromagnetic induction. On the other hand, the possibility to give tactile feedback to the user by actuation the membrane will be studied.

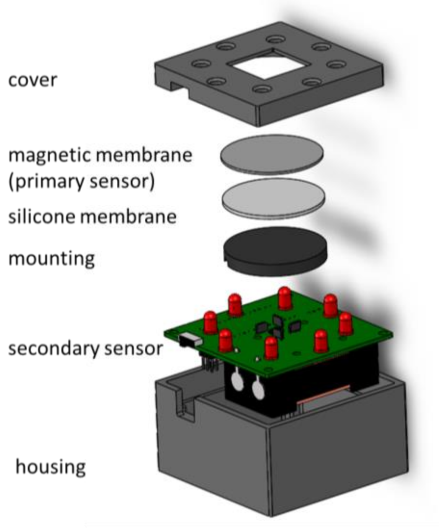

Figure 4: Exploded view of the prototype

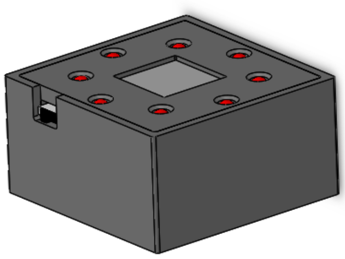

Figure 5: Prototype

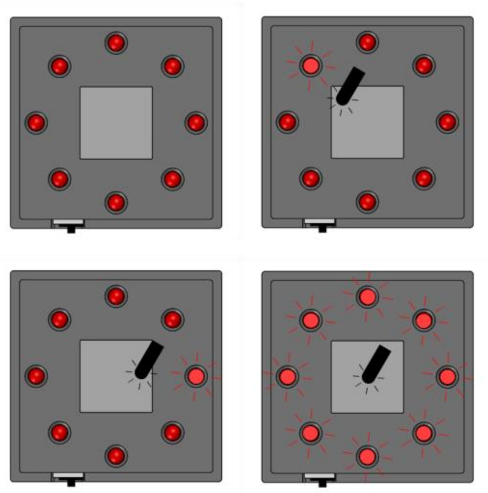

Figure 6: Working principle of the prototype