**Introduction**

Impairments of the upper limbs caused by neuromuscular diseases and aging affect a large number of people; hence, they become more dependent on caregivers. The majority of the commercially available electromechanical assistive devices that can compensate for movement impairment are mechanical devices. These devices take over the functions of the affected limbs instead of supporting and enhancing the still existent functions of the limbs. Among the assistive devices, arm support systems are an important class of assistive devices, since they provide support in most of the daily activities. Because the commercially available arm support systems have still restrictions and limited functionality, this project aims at the design of a novel arm support system allowing most of the daily living activities.

**Objectives**

The smart arm support system is placed on a conventional wheelchair and both enhancement and training of the still existent arm functions is required. Furthermore, the arm support system must be easy to use, cheap, flexible and energy efficient. Such a smart system requires an optimal combination of gravity compensation and actuation to provide the necessary human arm movements. Therefore, it consists of two layers, one passive layer to compensate for the gravity and one active layer to produce the dynamical behavior. In the final stage of the project these layers will be integrated into a single actuator.

Besides the facilitation of the activities of daily living, the novel arm support system will be applied for ambulatory training and rehabilitation purposes both in a rehabilitation center and in the home environment.

**Spherical gravity compensator**

The main challenge of this project is to mimic the shoulder movements using a single actuator. This actuator requires three degrees of freedom to mimic the shoulder joint. These three degrees freedom are shown in Fig. 2. Using spherical shaped permanent magnet a gravity compensator can be designed which is able to provide the required degrees of freedom as shown in Fig. 3.

To compensate for the gravity from the shoulder point of view, a sinusoidal torque characteristic is required. Using a combination of radial and parallel magnetization as shown in Fig. 4 a torque is generated as shown in Fig. 5.

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