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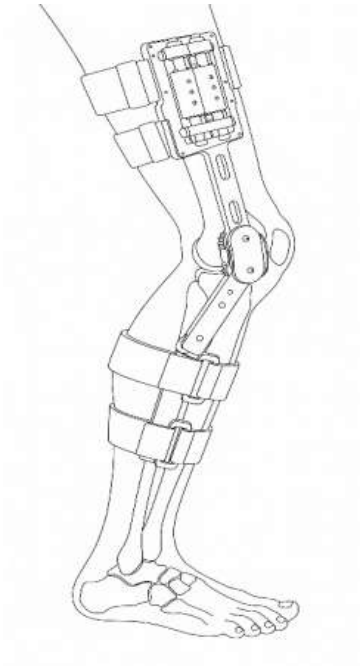
# A Magnetic Lift:
## *A New Hope for Knees Burdened by Osteoarthritis*

For the millions of people living with knee osteoarthritis (KOA), even simple movements like walking or rising from a chair can be a daily battle. This debilitating condition causes chronic pain, limits mobility, and chips away at one's quality of life. While doctors often recommend weight loss and exercise, this advice presents a cruel paradox: the very pain and stiffness caused by KOA make physical activity incredibly difficult.

To bridge this gap, many turn to knee braces designed to unload mechanical stress on the joint. However, conventional solutions that rely on springs, pneumatic pumps, or electrical systems are often a compromise. They can be bulky, inefficient, and fail to provide adequate support through the most critical range of motion, particularly from a straight leg to a 90-degree bend. Mechanical springs lose their force over time, variable stiffness actuators (VSAs) often add complexity, and pneumatic systems require continuous power, limiting their everyday practicality.

Addressing these mechanical shortcomings, researchers at the Bionics Laboratory at the University of Moratuwa introduced a novel passive magnetic actuator, a potentially advantageous approach for orthotic design. Unlike traditional mechanical components, permanent magnets offer near-frictionless movement, reliable performance across varying temperatures, and rapid dynamic response [1].

Their key operational advantage lies in their ability to generate a non-linear magnetostatic force whose magnitude changes exponentially with proximity, rather than linearly, as in standard mechanical springs [2]. As magnets move closer together during knee flexion, the force increases rapidly. This unique magnetostatic property en-



ables the creation of an assistive torque profile that aligns with knee joint biomechanics: delivering gentle support during level walking (lower flexion) and substantial lift during high-demand movements such as standing up from a seated position.

To evaluate joint forces and determine the required assistance, researchers formulated a detailed theoretical model based on magnetostatic interaction equations and knee joint kinematics. The model targets a 10% to 20% reduction in body weight, a magnitude established in the literature as sufficient to yield clinically meaningful improvements in pain, function, mobility, inflammation, and knee joint loading [3]. Theoretical calculations indicate that by tuning magnet geometry and alignment, peak assistive torque can be targeted to high-flexion states without requiring active external power.

When benchmarked theoretically against contemporary unloader braces, the magnetic concept demonstrates comparable support within the normal walking range (0°–60° of motion and at higher flexion angles (>60°), where the magnetic actuator's exponential force trajectory maintains high assistive torque output.

Furthermore, the calculated force curve maintains a vital biomechanical balance, providing higher assistance during deep flexion while avoiding excessive torque in the swing phase that could disrupt natural gait or paradoxically increase articular cartilage wear [4].

This research establishes a solid theoretical proof of concept for a passive magnetic actuator for knee unloader orthoses. Translating these theoretical insights into clinical practice will follow a structured, three-phase roadmap.

With Phase 1 of prototype fabrication & bench testing successfully completed, future work will focus on integrating the validated magnetic actuator into a lightweight wearable knee orthosis and evaluating its fit, alignment stability, and user comfort across diverse users. This will be followed by clinical trials involving knee osteoarthritis patients to quantify reductions in muscle activity, changes in ground reaction forces, and improvements in pain and mobility.

By advancing from theoretical modeling to systematic empirical testing, passive magnetic unloading offers a promising, power-free path to unburden aching knee joints and restore quality of life.

**References:**

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