Advancing artificial knee joint control mechanisms: achieving high performance using simple machines

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Abstract:
There is currently a lack of prosthetic knee joint technologies that are affordable, highly functional and can resist demanding environmental conditions. Such devices are needed in under-resourced countries, but also for children and adults wishing to participate in various recreational activities.

Specifically, this project aims to determine how certain technical and functional aspects of an emerging technology (LCKnee) can be improved. More generally, the objective of this research is to better understand and address the universal functional requirements of prosthetic knees in order to develop an optimal, globally applicable, prosthetic knee joint technology.

Biomechanical models of different knee joints are developed to optimize stability characteristics of the new design. Computer modeling and finite element simulations are used in testing our design for function and structural integrity. Finally, the construction and structural testing of prototypes will be carried out followed by a clinical pilot study to validate the results.

Preliminary results indicate that the stability characteristics of an expensive high-end knee can be mimicked with our more cost-effective design and that the simplified polymer-based construction can withstand the required loads.

The new design offers a number of potential improvements over existing technologies. However, as part of future work to be conducted with partner facilities around the world, these technical advancements will need to be evaluated in clinical field trials.

This research fits very clearly into the mission and values of the Hospital. A biomechanically functional prosthetic knee, whether being used as a primary prosthesis or a secondary ‘highly-active’ prosthesis, has the ability to drastically improve that patient’s quality of life and expand their world of possibility.

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Dominik is a Masters student at the University of Toronto working in conjunction with the Research Institute at Holland Bloorview Kids Rehabilitation Hospital. Supervised by Dr W. L Cleghorn and Dr Jan Andrysek has recently started the second year of his two year program for which he has been funded by both NSERC and OGS scholarships. Dominik graduated from Queen's University with a BSc in Mechanical Engineering in 2010.