Development of a Robotic System for Rehabilitation of Musculoskeletal Disorders

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Objectives

- Musculoskeletal Disorders (MSD) are the leading cause of lost-time injuries in Canada.

- Annual indirect cost: $22 billion.

- MSDs are injuries to muscles, ligaments, tendons, and nerves.

- Caused by repeated actions beyond fatigue.

Traditional Therapy
One-on-one patient-therapist sessions

Future of Therapy
Allow for remote rehabilitation using remotely-controlled force-feedback devices

Phase I: Hospital-based

Robot Assisted Therapy

- A robotic arm executes controlled pre-planned motion paths in 3D space.

- The robot adjusts the resistance the patient feels.

- The robot can assist the patient during an exercise which may involve rotation and movements all in the upper limb.

- With strong repeatablility, it ensures all exercises are consistent and accurate.

a) Simulation   b) Replaying simulation   c) Shoulder Exercise   d) Wrist Supination

Phase II: Home-Based

Doctor - Patient Remote Therapy

Using remote controlled haptic devices, a doctor in their office and patient at their home, can perform rehabilitation exercies just as effectively as if done in person.
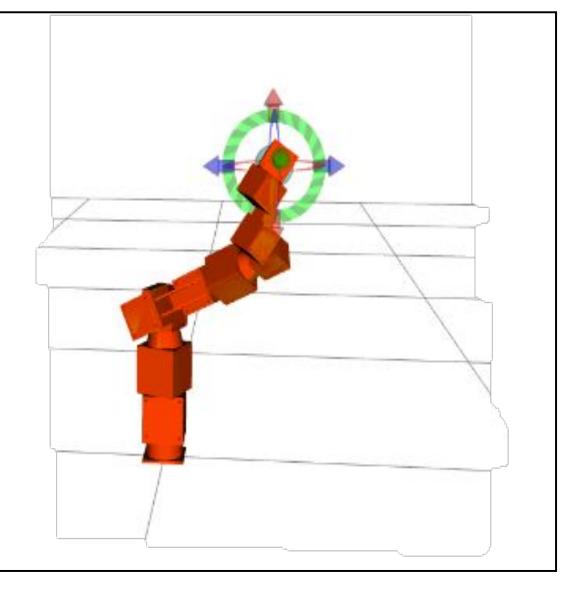

The devices can provide force feedback which allows the doctor and patient to feel a resistance if one or the other deviates from a motion path.
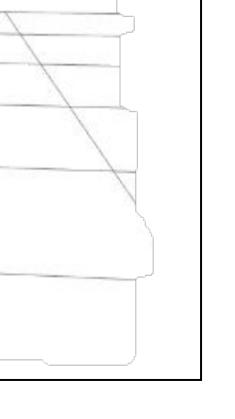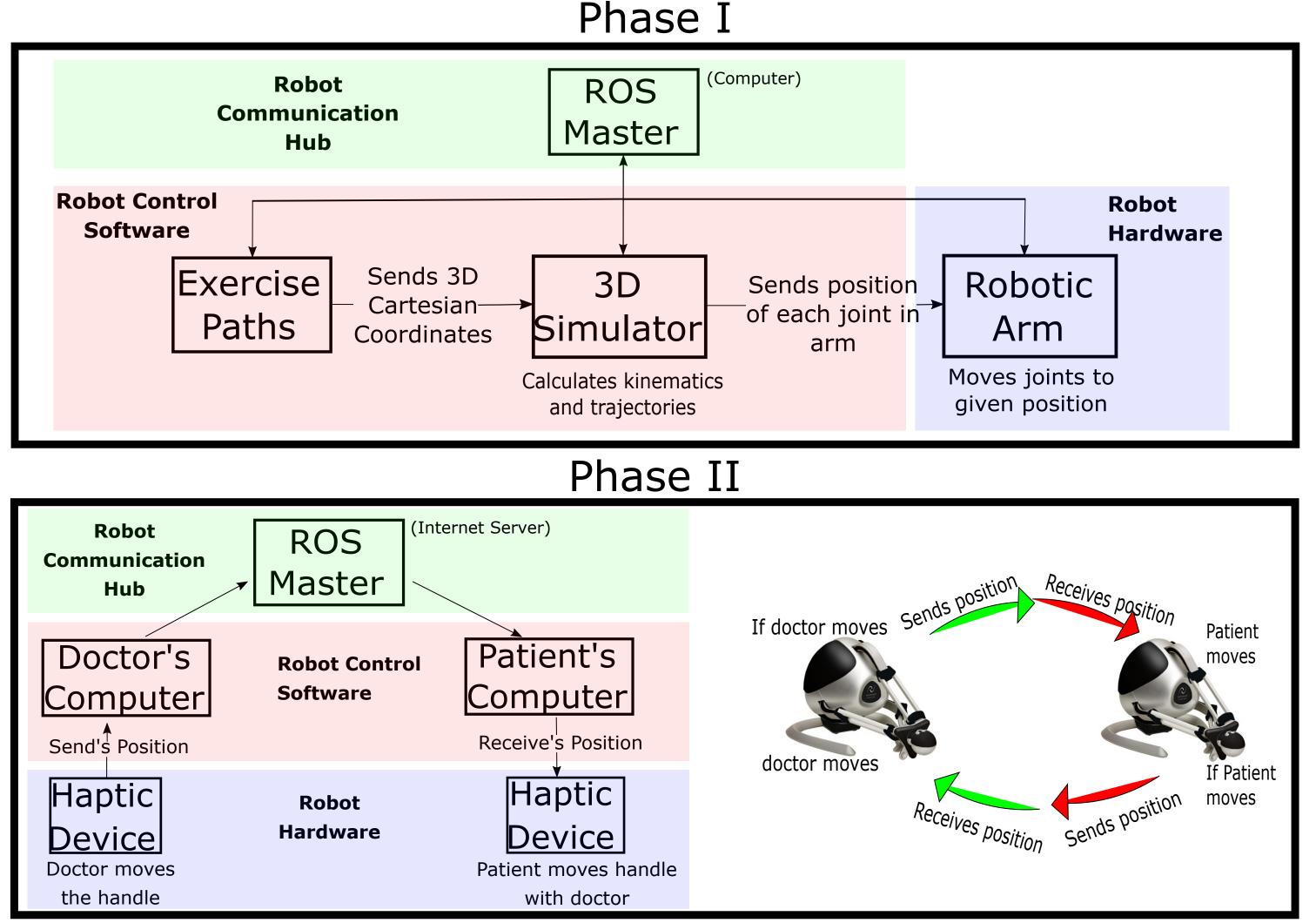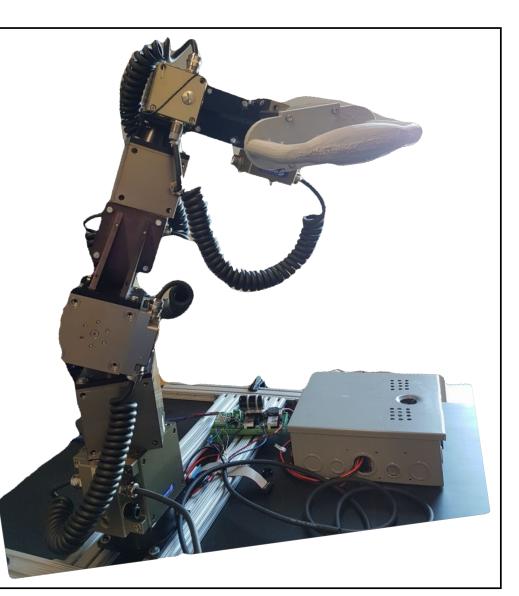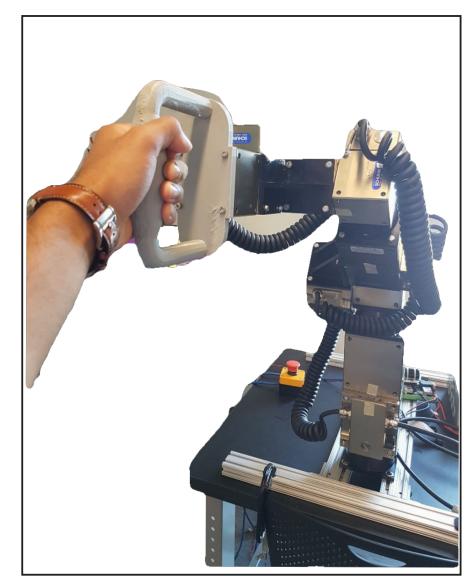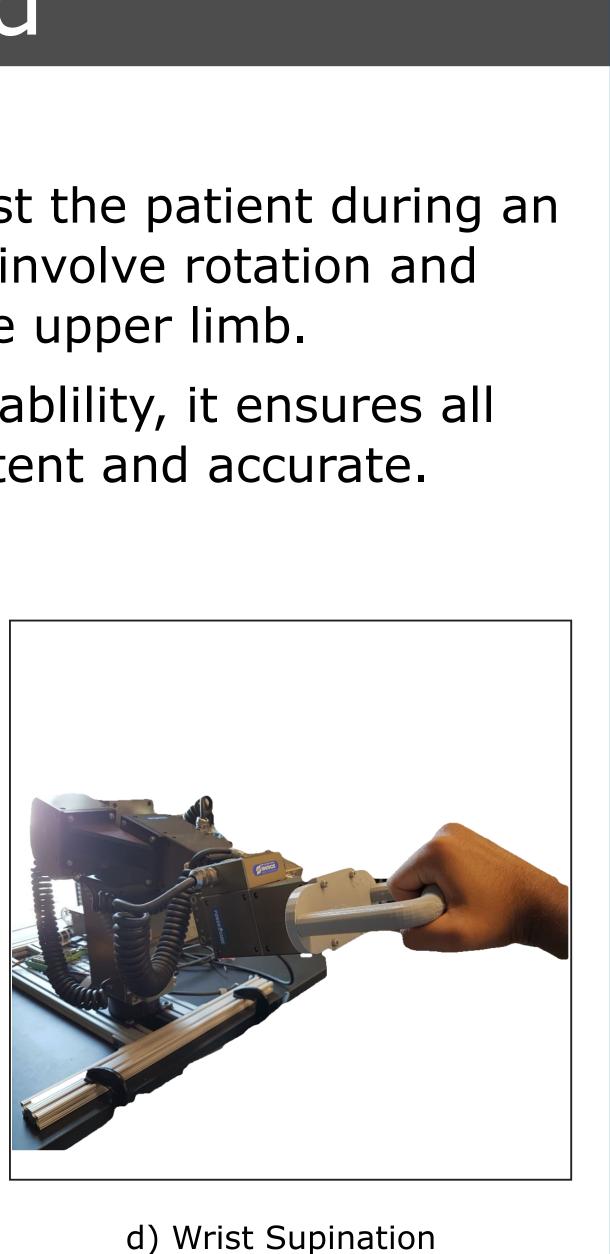
Remote Operation

Robot Operating System (ROS)

Phase I

Robot Communication Hub — ROS Master (Computer)

Robot Control Software — Exercise Paths — Sends 3D Cartesian Coordinates — 3D Simulator (Calculates kinematics and trajectories) — Sends position of each joint in arm — Robotic Arm (Moves joints to given position) — Robot Hardware

Phase II

Robot Communication Hub — ROS Master (Internet Server)

Robot Control Software — Doctor's Computer (Send's Position) — Patient's Computer (Receive's Position)

Robot Hardware — Haptic Device (Doctor moves the handle) — Haptic Device (Patient moves handle with doctor)

If doctor moves — Sends position — Receives position — Patient moves
doctor moves — Receives position — Sends position — If Patient moves

Conclusion

Advantages of this system:

- Provide access to therapy in remote locations.

- Increase availability of service.

- Shorten waiting time for therapy.

- Application to lateral epicondylitis.

- Experimentally evaluate the system and compare it with traditional therapy.