Project Title

Intelligent Assistive Technology (AT)

Project Lead and Members

Mobile Balance Robotic Assistant (MRBA)	**Intelligent Shared Control Interface for Intuitive & Safe Wheelchair Control**	**Lower Limb Exoskeleton**
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Organisation(s) Involved

Rehabilitation Research Institute of Singapore (RRIS), Nanyang Technological University (NTU), A*STAR, Tan Tock Seng Hospital

Project Period

Ongoing project

Aims

By making the assistive robotics more intelligent while keeping the costs affordable, this:

- Enables patients to be independent while having good Quality of Life (QoL)
- Moves rehabilitation to home to reduce pressure on hospitals
- Returns an elderly, injured, disabled, or temporarily impaired worker to the workplace

Background

RRIS was established in Singapore in April 2016, as a joint research institute by Nanyang Technological University (NTU), Agency for Science, Technology and Research (A*STAR) and National Healthcare Group (NHG). RRIS' projects are led by pairing clinicians, scientists and technical experts as co-principal investigators.

Our research strategy is to adopt data-driven and patient-centric approaches to confront issues in rehabilitation.

While life expectancy has increased in the last decade, those years are sometimes marred by disease and disability. Whether due to injury, illnesses or the body's natural wear and tear, the elderly are especially vulnerable to potentially immobilising conditions like stroke and knee osteoarthritis. Taking care of its rapidly ageing citizenry is therefore a high priority for Singapore, where the elderly currently make up 15% of the nation's population in 2020, up from 9% a decade before. This requires a proactive shift towards health promotion and disease prevention.

The vision of RRIS is to drive rehabilitation science and technology for restoration and enhancement of human ability.

At RRIS, there are 3 pillars of research focus – Intelligent Assistive Technology, Ability Data and Precision Rehabilitation. In this article, we shall focus on Intelligent Assistive Technology which can aid patients to recover in their rehabilitation journeys.

Methods

As technology becomes more user friendly, smarter and affordable, development of assistive device is one of the most promising mobility options available today to prepare for the future ageing society. The Intelligent Assistive Technology Programme aims to enable Assistive Technology (AT) to be more effective in serving the needs of users by employing a Data-Driven Robotics approach. This is to make assistive devices more intelligent in detecting human intents and to provide adaptive assistance in the accomplishment of Activity of Daily Living (ADL).

This programme covers three types of assistive robots -

- Man-with-Machine: mobile robotic balance assistant
- Machine-on-Man: upper & lower limb exoskeletons
- Man-in-Machine: man in robotised wheelchair

Aside from the development of robotics system, the Intelligent Assistive Technology programme focuses on the development of a user-centered intelligent Human Robot Interface (HRI) framework for assistive robots, including a series of HRI solutions that encompasses an AI-enhanced shared control approach to enable assistive robots to provide effective assistance to help humans accomplish their targeted tasks.

Results

As the organisation progresses to RRIS 2.0, we are strategising a framework to seek and work with suitable industry partners to boost RRIS' technology adoption and commercialise our robot prototypes. The collaborative work shall include but not limited to 3 areas:

- Application – for use case development and test-bedding of the assistive robots in rehabilitation and ADL settings
- Technology – for augmentation of robot functionalities, outer-shell design, safety and connectivity, manufacturing and distribution
- Investment – for funding support on tech start-ups

Lessons Learnt

The improvement of our robot protypes is an ongoing process. When one phase is completed, there is the next phase to add features to the product, to enhance its useability. Technological advancements move rapidly and therefore our scientists have to study industrial needs closely and scope their work accordingly.

Conclusion

Research must be translated into solutions that meet real world needs. Delivering the above rehabilitation solutions require an integrated ecosystem that bridges academia, clinical practice and industry.

Project Category

Technology, Robotics

Keywords

Technology, Robotics, Medtech, Rehabilitation Research of Institute Singapore, Nanyang Technological University, A*STAR, Tan Tock Seng Hospital, Assistive Technology, Mobile

Robotic Balance Assistant, Shared-Control Wheelchair, Human-Robot Interface, Transfer Assistant Co-Bot, Kerb-Climbing Wheelchair

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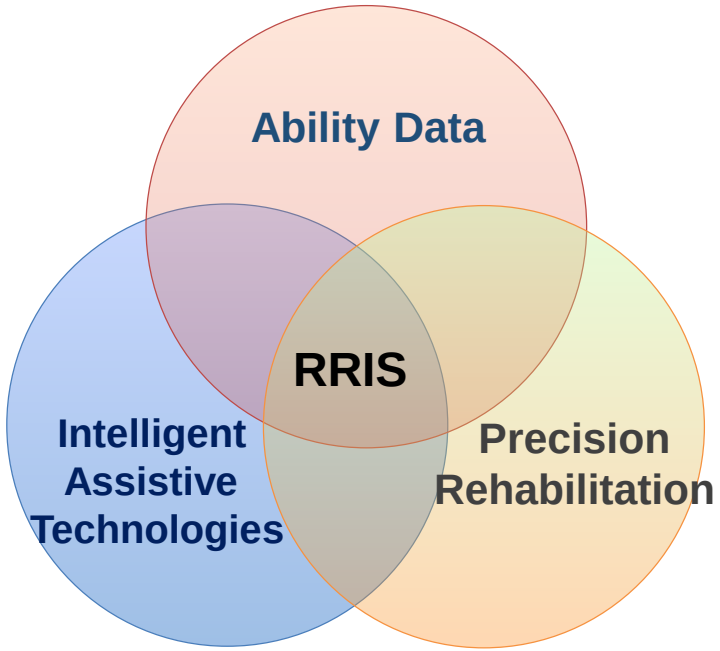
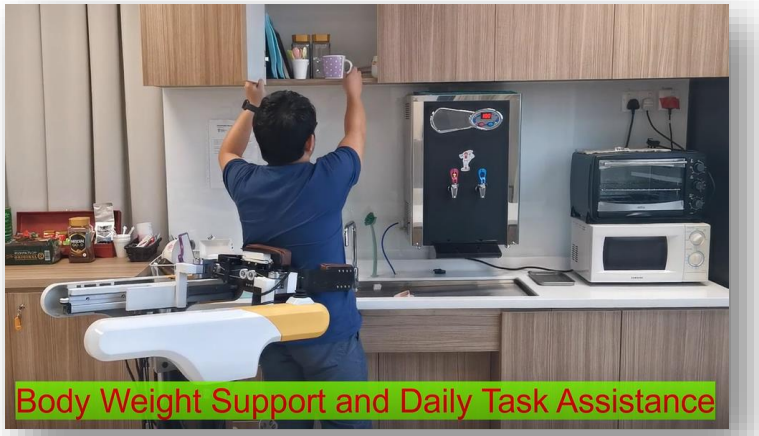
Vision:

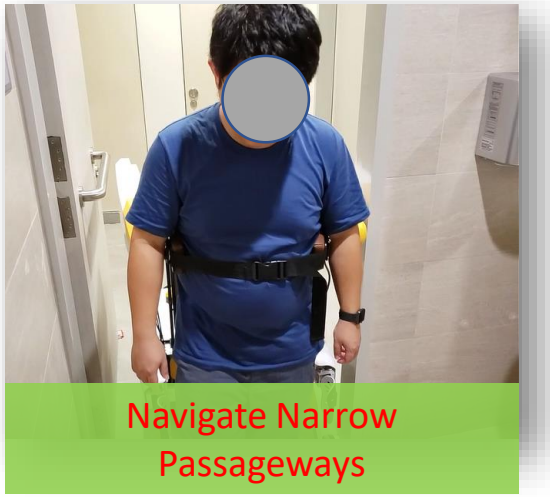
A world-class **Asian-centric** research institute with focus on interdisciplinary research and innovation in rehabilitation science and technology for quality healthcare delivery

Data-driven Human Ability

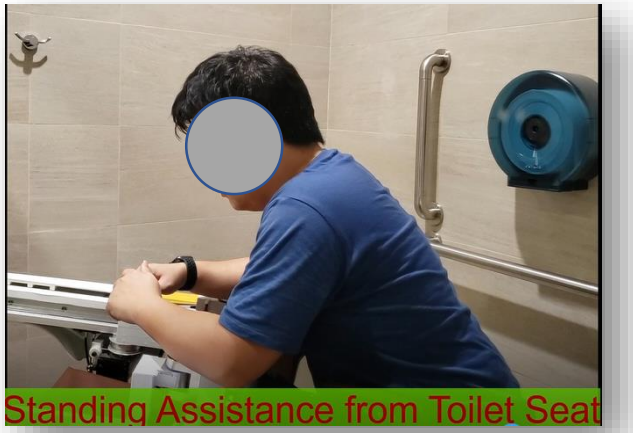


- Establishment of world's largest physical ability database
- Integrated human movement analysis and optimisation
- Data-driven assistive robotics to augment human ability
- Collaboration between NTU, A*STAR and NHG





Man-with-Machine:
Mobile Robot Balance Assistant (MRBA)



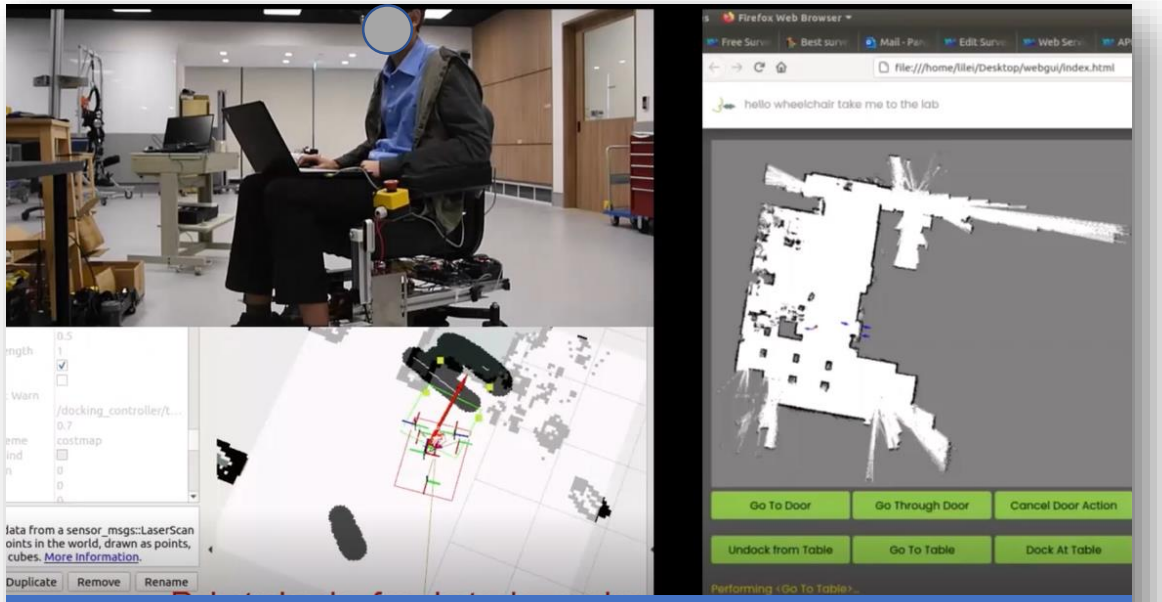
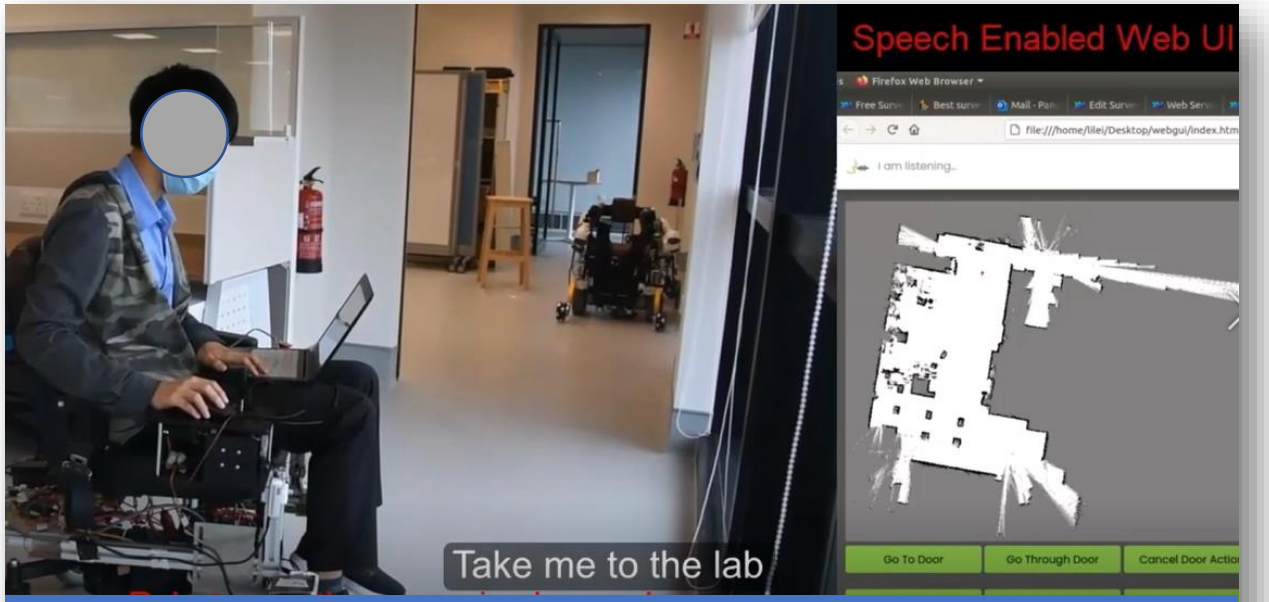


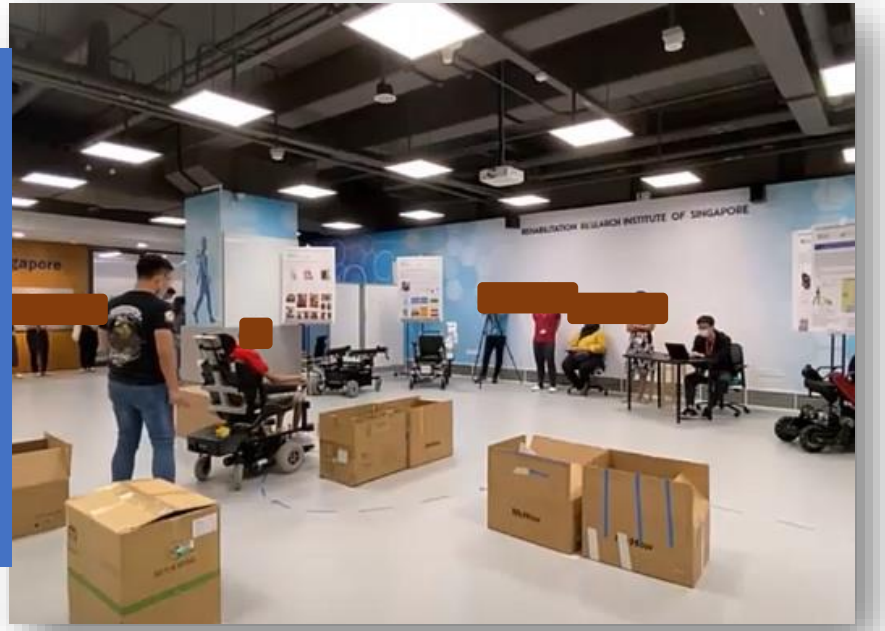
Table Docking & Capabilities:
Robot parks a user at desired locations



Robot uses speech recognition to define a goal waypoint

Man-in-Machine:
Shared Control Wheelchair

Safe navigation with robotic shared-control assistance



Machine-on-Man:
Lower Limb Exoskeleton

Human-Robot Interface (HRI) software to enable better personalization and useability

- Suitable for use by hemiplegics (eg: stroke patients)
- Works in different scenarios - Compliant surfaces (soft carpet), Slope, Step-over (gaps and objects)
- Supports smooth transition from sit to stand and vice versa
- Suitable for personal use as an assistive device in indoor environments without requiring assistance from another person in order to put on the device

The intelligent shared control software is flexible for deployment across various exoskeleton platforms.

Stair Climbing

Obstacle Crossing