Rehabilitation Research Institute of Singapore

Rehabilitation Research Grant 2020 Roadshow

Friday 17 Jan 2020

Rehabilitation Research Institute of Singapore

A Collaboration Between:

Nanyang Technological University Singapore
Agency for Science, Technology and Research
National Healthcare Group

Adding years of healthy life
## Programme

<table>
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<tr>
<th>Time</th>
<th>Event</th>
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<tr>
<td>5:00 – 5:15 pm</td>
<td>Registration &amp; Tea Reception</td>
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<tr>
<td>5:15 – 6:15 pm</td>
<td>Introduction of Rehabilitation Research Institute of Singapore</td>
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<td>Announcement of 4(^{th}) Rehabilitation Research Grant Call</td>
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<td>Q&amp;A</td>
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<td>Prof Ang Wei Tech</td>
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<td>Executive-Director, Rehabilitation Research Institute of Singapore</td>
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<td>6:15 – 6:30 pm</td>
<td>Networking</td>
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Committed Investment:
S$ 86.8M (S$27.8M cash) over 5 years (2016-2021)

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

Rehabilitation Research Grant (RRG)

- **RRG 1**
  - (Oct 2016 – Mar 2019)
  - 7 Projects
  - PIs: 1 Clinical + 1 Technical
  - ≤ $250k
  - 2 years

- **RRG 2**
  - (Apr 2017 – Mar 2020)
  - 6 Projects
  - PIs: 1 Clinical + 1 Technical
  - ≤ $500k + 1 RSS
  - 3 years

- **RRG 3**
  - (Jul 2019 – Mar 2021)
  - 9-10 Projects
  - Program PIs: 1 Clinical + 1 Technical
  - 1 Seed grant + 1-2 Complementary grants
  - ≤ $300k
  - Till Mar 2021

- **RRG 4**
  - (Jul 2020 – Dec 2021)

Data Driven Rehabilitation
Data Driven Rehabilitation

Medical Records

Rehab Team

AI, Data Analytics

Ability Data

Diagnosis & Assessment

Rehab Patients

Rehabilitation Training
Data Driven Rehabilitation

Key Research Question:
What is the movement recovery trajectory of individuals after trauma in terms of changes in function and impairment?

Deliverables:
1. Prediction of recovery
2. Establishment of more effective therapy protocols
3. Development of technology-based assessments for clinic and home use

Stroke  Knee Osteoarthritis
Ability Data

World’s largest database on physical ability of ...

Healthy People

Ability Data:
Healthy Adults (AD:HA) [21-80 years]
Healthy Youths (AD:HY) [<21 years]

Patients with Neurological & Musculoskeletal Disorders

Ability Data:
Stroke (AD:S)
Knee Osteoarthritis (AD:KOA)

Ability Data:
Traumatic Brain Injury (AD:TBI)
Spinal Cord Injury (AD:SCI)
Back Injury (AD:BI)
Shoulder Arthritis (AD:SA)

Ability Data:
Parkinson’s Disease (AD:PD)
Lower Limb Amputation (AD:LLA)
Neck Arthritis (AD:NA)

Ability Data:
XXX (AD:XXX)

Ability Data:
YYY (AD:YYY)
Ability Data: Stroke

Clinical Perspective:
11 tasks selected from > 100 standard rehab assessments

6 Upper Limb Tasks
- Touching back
- Folding Towel
- Grasping block
- Reaching across body
- Touching mouth/feeding
- Touching head/ combing hair

5 Lower Limb Tasks
- Stepping up
- Picking up an object
- Turning key in standing
- 10m walk test
- Timed Up and Go Test
Ability Data: Stroke

Technical Perspective:
The selected 11 tasks covering the joints space of most common functional activities of daily living

Upper limb tasks:
- block & box test
- towel folding
- grasping task
- lateral object shift
- hand to mouth
- hand to head
- key turning (sit)
- hand to back
- key turning (stand)
Ability Data: Knee Osteoarthritis

The same subset of 4 lower limb tasks

4 Lower Limb Tasks

- Stepping up
- Picking up an object
- 10m walk test
- Timed Up and Go Test
Ability Data - Marker-less Motion Capture

RGB-D + IR Cameras dataset collection

Large dataset for training a network to learn functional joint locations

Training Phase

RGB-D cameras

IR Cameras

Color image
Depth image
Joint Locations

Human 3.6M Dataset (2014)

Markerless mocap with only RGB-D cameras

Deployment Phase

RGB-D cameras

Color images + Depth images

Trained network

Joint Locations
Ability Data – International Collaboration

- **Singapore [1]**: Rehabilitation Research Institute of Singapore
- **China [2]**: Jianxiang Hospital Group, Southern China Medical University
- **Hong Kong SAR [1]**: Hong Kong Polytechnic University
- **Japan [1]**: Hyogo Rehabilitation Center
- **S Korea [2]**: National Rehabilitation Center, Descente Korea
- **Taiwan [1]**: Taipei Medical University
- **Thailand [3]**: Assistive Technology & Medical Devices Research Center (A-MED); Sirindhorn National Medical Rehabilitation Institute; Chulalongkorn University
- **Australia [1]**: University of Newcastle
- **Switzerland [1]**: ETH Zurich
Research Programs Overview
Research Programs & Lead Principal Investigators

- **Ability Data**
  - **Clinical PI**: Dr Phyllis LIANG (RRIS)
  - **Technical PI**: Dr Colin QUEK (RRIS)

- **Precision Rehab**
  - **Clinical PI**: Dr Karen CHUA (TTSH)
  - **Technical PI**: Dr Cyril John DONNELLY (RRIS)

- **Intelligent AT**
  - **Clinical PIs**: Prof WEE Seng Kwee & Mr Chris Kuah (TTSH)

- **Connected Ability**
  - **Clinical PI**: Dr LOH Yong Joo (TTSH)
  - **Technical PI**: Dr YAU Wei Yun (I2R)

- **Psychosocial Rehab & QoL**
  - **Clinical PI**: Dr Jimmy LEE (IMH)
  - **Technical PI**: Prof Andy HO (HaSS)
Precision Rehabilitation

Clinical PI
Dr Karen CHUA
(TTSH)

Technical PI
Dr Cyril John DONNELLY (RRIS)
Precision Rehabilitation Program

Neuromuscular Pathology X

Precision Rehab

Infrastructure

- Precise objective assessment
- AI enhanced automatic assessment

Precision Assessment & Intervention

- Personalized rehab protocol
- Intelligent & adaptive rehab training

Markerless Mocap

Ability Data

Stroke (AD:S)

Knee Osteoarthritis (AD:KOA)

Cloud

Interfaces

Ability Data

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Precision Rehabilitation – Assessment

Biomechanics Analysis Techniques

Problems:

- Movement is complex!
- Body parts are interconnected → Inter-component covariation
- Movement is dynamic! → Time varying statistics

Typical Kinematic Gait Report

Typical GRF Vector
Precision Rehabilitation – Intervention

*In-silico* Rehab – optimizing human movements via simulations

Performance

Original | Optimized

Injury/re-injury

Original | Optimized

Balance & Stability

A) Experimental

B) Optimized

Precision Rehabilitation Program

Precision Assessment

In-silico Rehab

Personalized & Targeted Intervention

Ability Data

Interfaces

Cloud

Patients with Neuromuscular Disorders

Stroke  Knee OA
A Collaboration Between:

Rehabilitation Research Institute of Singapore (RRIS)

Intelligent Assistive Technology

Clinical PIs
Prof WEE Seng Kwee (TTSH)

Clinical PIs
Mr Chris Kuah (TTSH)

Technical PI
Prof CHAM Tat Jen (SCSE)
Critical Gap in Assistive Robots

The Human-Robot Interfaces of assistive robots are not good enough!

The HRIs are unable to capture the users’ intent accurately

The assistive robots are unable to provide real-time adaptive assistance to the users

The assistive robots are not intelligent enough to perform ADLs collaboratively with the users in real environment

Personal Mobility & Manipulation Appliance (PerMMA) [UPitt, USA]

Lower limb exoskeletons
Data-Driven HRI for Assistive Robots

HRI: AI, Analytics, Data Science

User
Perception
- Multimodal
- User
- Robot
- Environment

Cognition
- User intent detection
- Task assessment
- User ability assessment

Environment:
- Task / Goal / Behavior execution performance improvement

Control
- Shared control controller
- Adaptive assistance
- Variable stiffness actuator
- Obstacle avoidance

Assistive Robot

Environment

HRI INPUT

HRI OUTPUT

adaptive assistance via shared control based on user's task performance

Haptic feedback

data
Intelligent HRI for Assistive Robots Program

**Group A: Low functioning**
(e.g. Frail elderly, moderate stroke)

**Group B: Moderate functioning**
(e.g. Healthy elderly with declining physical, sensory & cognitive abilities)

### Domain

- **Man-in-Machine**
  - Wheelchair
  - Fork lift / Truck
  - Group A: #1 ANG (NTU) Commute
  - Group B: #2 LYU (NTU) Heavy machinery operation

- **Machine-on-Man**
  - Lower-limb Exoskeleton
  - Upper-limb Exoskeleton
  - Group A: #3 YAU (I2R) Walking
  - Group A: #4 ACOTO (NTU) Upper-limb ADL

- **Man-with-Machine**
  - Integrated Robotic arms
  - Group A: #5 ZHANG (I2R) Balance
  - Group B: #6 ANG (NTU) Transfer

### Applications

- **Shared Control**
- **Anomaly Detection**
- **Intention Prediction**
- **Assessment & Adaptive Assistance**

### Technology

- **Component Technologies: Bio-signal interface**
- **LiDAR**
- **RGB-D Camera**
- **Joystick**
- **Voice Sensor**
- **Gaze Tracker**
- **EMG**
- **EEG**
- **Touch Screen**
- **IMU**
- **Force sensor**

### System Ability

- **DATA DRIVEN**
- **Cloud**

**Technology Management System (HRI Toolbox) [ROS 2.0]**

**Intelligent HRI for Assistive Robots Program**

**Group A: Low functioning**
(e.g. Frail elderly, moderate stroke)

**Group B: Moderate functioning**
(e.g. Healthy elderly with declining physical, sensory & cognitive abilities)
Rehabilitation Research Institute of Singapore (RRIS)

Connected Ability Platform

Clinical PI
Dr LOH Yong Joo (TTSH)

Technical PI
Dr YAU Wei Yun (I2R)

A Collaboration Between:

[Logos of Nanyang Technological University, Agency for Science, Technology and Research, and National Healthcare Group]
Rehabilitation Research Institute of Singapore (RRIS)

Psychosocial Rehab & Quality of Life (QoL)

A Collaboration Between:

Clinial PI
Dr Jimmy LEE (IMH)

Technical PI
Prof Andy HO (HaSS)
Psychosocial Rehab & Quality of Life (QoL)

Psychosocial Rehabilitation

Hard Science
Quantitative Methods

Soft Science
Qualitative Methods

Mental / Cognitive States
Motivation
Socio-economic Factors
Quality of Life

Serious Games
RRG1: IMH-MAE

Brain Computer Interface
IMH-I2R/SCSE

Video Analytics
RRG2: IMH-EEE

Computational Cognitive Models
Music Therapy

Music Therapy

Brain Computer Interface
IMH-I2R/SCSE

Computational Cognitive Models

Music Therapy

Serious Games
RRG1: IMH-MAE

Video Analytics
RRG2: IMH-EEE

Psychosocial Rehabilitation

Rehabilitation Research Institute of Singapore
Psychosocial Rehab & Quality of Life (QoL)

A Longitudinal Mixed-Method Study on Psychosocial QOL Trajectories of first time Stroke Patients and their family caregivers in Singapore
Dr. Jimmy LEE & Prof. Andy HO

Identifying Care Needs and Measuring Longitudinal Outcomes Holistically for Acute and Chronic Stroke Patients
Dr. CHAN Lai Gwen

Medical and social care professionals’ perspectives, needs and experiences in psychiatric rehabilitation for stroke patients
Ms. Audrey WONG & Prof. Michelle Chiang

A psycho-ecological framework for understanding the trajectories of stroke rehabilitation and recovery

A program of psycho-education and interventions to aid recovery, rehabilitation, reintegration and service provision
Research Programs Overview

Cloud

Ability Data

Application Interfaces

Connected Ability Platform

User Interface

Fog

User Interface

User Interface

Psycho-social Rehab & Quality of Life

Precision Rehab

Intelligent

Rehabilitation Research Institute of Singapore
RRG4 – Data Driven Rehabilitation

• Possible topics (but not limited to)
  • New dimensions (broaden or deepen) of the current RRIS data driven research programs
  • New applications of Ability Data, with potential to be developed into a full research program in RRIS
  • Outputs and Outcomes studies in rehabilitation or related fields

• Types of project (but not limited to)
  • Investigative studies, based on existing datasets (from healthcare/ILTC institutions, RRIS, NTU, A*STAR, etc.)
  • Collection of new data with specific research questions
  • Technology development in data science/analytics/mining with specific research questions
Eligibility

• All PIs must be full-time staff of NHG, A*STAR or NTU
• Each project is to be led by 1 Clinical PI + 1 Technical PI
  • Preferably from different institutions
• Composition of team members (Co-I and above) for each application should not be all from the same institution.
• Other research team members can include co-investigators/collaborators from local/overseas institutions or private companies.
Eligibility

Clinical PI:

a) Doctors who are clinically qualified (i.e. with MD/MBBS/BDS).

b) Allied health professionals, nurses and LKCMedicine faculty who are PhD holders or equivalent. LKCMedicine faculty must be full-time faculty; Visiting Professors (spending at least 6 months per year in Singapore) will be eligible; Adjunct Professors will not be eligible.

c) Principal/senior therapists and nurses without PhD or equivalent will require a mentor who meets criteria (a) or (b), with exemption for those who have prior experience in holding competitive research grant(s) as a PI.

d) For proposals involving patients and/or clinical trials, the Clinical PI would need to be either a SMC registered doctor or a licensed allied health professional.
Eligibility

Technical PI:

a) A*STAR: Independent investigators equivalent (BMRC and SERC). All other A*STAR researchers may be part of the research team as a co-investigator or collaborator.

b) NTU: Full-time faculty or Senior/Principal Research Fellow funded by core funding; Visiting Professors (spending at least 6 months per year in Singapore) will be eligible; Adjunct Professors will not be eligible.
Funding

• Up to S$250,000 funding over 18 months may be awarded for each successful project

• All budgeted items must be under the fundable list of items; details of the fundable list will be provided after the grant call opens
Application Details

• Grant call will be opened on 1 Mar 2020.
• Applicants are invited to submit a Letter of Intent (LOI).
• Submission of LOI will be via email to rris.grant@ntu.edu.sg
• The deadline to submit the LOI is 31 Mar 2020, 5 pm (Singapore Time).
• Applications must be endorsed by the applying entity prior to submission
• Shortlisted applicants will be invited for presentation to the selection panel in Apr/May 2020.
• Successful applicants selected by the selection panel will need to submit a full written proposals within 1 month.
• Awarded project shall commence in Jul 2020.
• Please direct all enquires to Dr Liu Huihui (rris.grant@ntu.edu.sg). More information will be available on RRIS Website when grant call opens.
Thank You!

Q & A

Website: http://rris.ntu.edu.sg

Grant-related Enquiries: rris.grant@ntu.edu.sg
Thank you!

Q&A