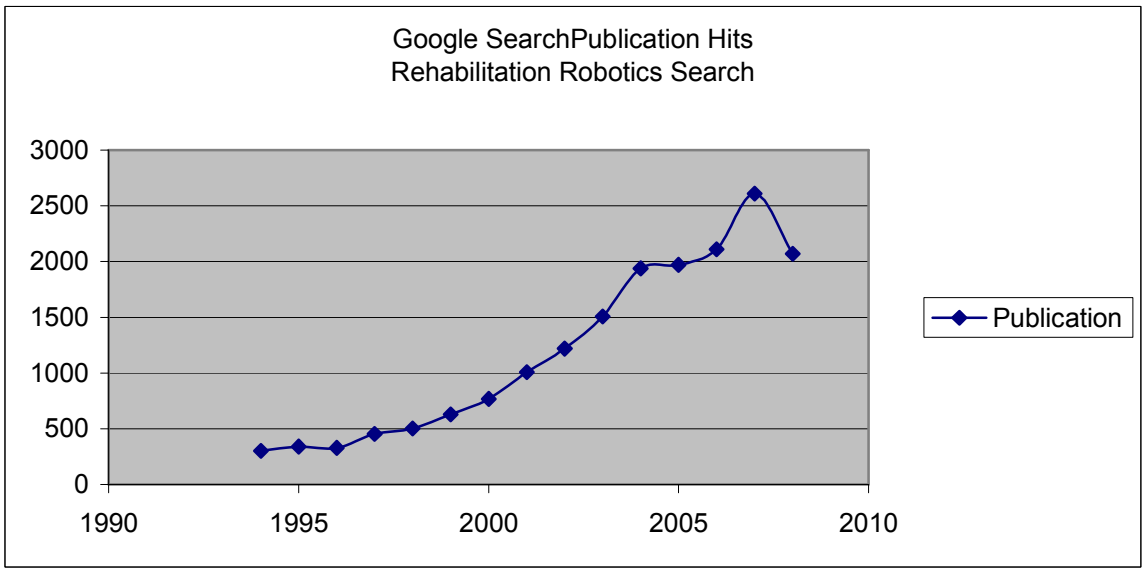
Date: April 21, 2009
Subject: IEEE RAS Committee Report and Assessment for TC-Rehabilitation and Assistive Robotics.

Dear Dr. Yasuhisa HASEGAWA,

Please accept this summary of our committee's activities over the past three years.

(1) Honest assessment of TC over past 3 years, goals for next 3 years, and the feasibility of retiring the TC

We have been quite active and have gained recognition last year as IEEE RAS most active technical committee. The committee has seen growth in the area of rehabilitation and assistive robotics. For example, the number of publications with a rehabilitation focus has increased over the last 15 years with continued growth up until 2007. A recent downturn was seen in 2008 but this may be reflective of the fact that researchers may not be using the term "rehabilitation robotics" and maybe moving toward the more general term "biomedical robotics." Figure 1 shows the trend over the past 15 years.



As a committee, we have worked to ensure that the interest and activity in rehabilitation and assistive robotics grow. We do not recommend retiring the committee just yet, but acknowledge that there may be a need to do so in the next ten years. We anticipate a growth in this area as the elderly population in the US increases. It is anticipated that elderly persons will represent at least 20% of the population in 2050. As such we anticipate that the number of persons living with disabilities due to stroke, dementia etc. will increase.

The committee's goals in the next three years will be 1) to increase the number of commercially available rehabilitation and assistive robots that are available to the rehabilitation/clinical community, 2) to increase the focus on creating rehabilitation robots and assistive

robots that are able to be used directly in community and under-supervised environments, i.e., systems that are able to operate in the patient's "real" environment and finally, 3) to increase the focus on robotic systems that are also Gerontechnologies for persons that are elderly to meet the potential needs in that growing population.

(2) List of activities during past three years (which should include, but not limited to, the expected activities listed above)

The committee was engaged in a variety of activities. These activities can be grouped into three main categories: Workshops, Special Issues, and Administration/Promotions. Below we highlight some of these activities and present a more detail list of activities at the end of the document.

Workshops:
In 2006, the committee co-sponsored a full day workshop at the IEEE ICRA conference in Pisa, Italy. This workshop was focused on promoting rehabilitation and assistive robotics. The workshop was entitled "New Perspectives in Rehabilitation Robotics".

In 2007, we also co-sponsored a workshop specifically focused on the area of therapy robots for stroke rehabilitation at the IEEE ICORR conference in Noordwijk, Holland. In the area of assistive robotics, we co-sponsored the Japan National Workshop on Assistive Technologies (June 2007) in Tokyo.

In 2008, we co-sponsored the first EURON Summer School on Rehabilitation Robotics (Elche Spain). The TC provided technical co-sponsorship to the first EURON School on Rehabilitation Robotics that will be held in Elche (Spain) next March 2008. The School is sponsored by the European Robotics Netowrk (EURON) but open to participants from any countries. We later sponsored workshop another workshop at the IEEE Biomedical Robotics Conference (BioRob 2008), Pheonix Arizona on Gerontechnologies and the Aging society.

All workshops were well attended and sparked interesting collaborations and awareness of the area. We are currently working on sponsoring workshops at ICORR and ROMAN.

Special Issues:
The committee decided to promote the area by sponsoring and/or promoting special issues on rehabilitation robotics. In the past three years, we have sponsored special issues in the IEEE Trans Neural Eng., JNER, Advanced Robotics, Autonomous Robots and IEEE T-RO. Currently in 2008, we are sponsoring the special issue on rehabilitation robotics for the IEEE Transactions on Robotics. The current special issue for the T-RO received over 65 submissions. The committee co-chairs are serving as Guest Editors.

Promotion/Administration:
We have been engaged in promoting our activities by making sure our announcements for the workshops and special issues have been widely circulated via key websites and email lists. These lists host most of our members. In addition, we seek to promote the field by sponsoring textbooks in the area, helping to organize new conferences and symposiums etc.

(3) List of outreach activities outside the RAS

Our outreach activities have been primarily accomplished through workshops at the ICRA, ICORR and BioRob conferences. The workshop often brings together clinicians, engineers, and other rehabilitation specialists. We promote the activities of the TC at these events.

(4) List of important publications over past 3 years in TC area.

As figure 1 indicates the number of publications in this area has increased. The following list several important papers in the areas covered by the TC.

Rehabilitation Robotics:
Socially Assistive Robotics for post-stroke rehabilitation. J Neuroeng Rehabil. 2007 Feb 19;4:5.

Veneman JF, Kruidhof R, Hekman EE, Ekkelenkamp R, Van Asseldonk EH, van der Kooij H. Design and evaluation of the LOPES exoskeleton robot for interactive gait rehabilitation. IEEE Trans Neural Syst Rehabil Eng. 2007 Sep;15(3):379-86.

Sugar TG, He J, Koeneman EJ, Koeneman JB, Herman R, Huang H, Schultz RS, Herring DE, Wanberg J, Balasubramanian S, Swenson P, Ward JA. Design and control of RUPERT: a device for robotic upper extremity repetitive therapy. IEEE Trans Neural Syst Rehabil Eng. 2007 Sep;15(3):336-46.

Nef T, Mihelj M, Riener R. ARMin: a robot for patient-cooperative arm therapy. Med Biol Eng Comput. 2007 Sep;45(9):887-900. Epub 2007 Aug 3.

Krebs HI, Mernoff S, Fasoli SE, Hughes R, Stein J, Hogan N.
A comparison of functional and impairment-based robotic training in severe to moderate chronic stroke: a pilot study. NeuroRehabilitation. 2008;23(1):81-7.

Banks MR, Willoughby LM, Banks WA. Animal-assisted therapy and loneliness in nursing homes: use of robotic versus living dogs. J Am Med Dir Assoc. 2008 Mar;9(3):173-7.

Galán F, Nuttin M, Lew E, Ferrez PW, Vanacker G, Philips J, Millán Jdel R.A brain-actuated wheelchair: asynchronous and non-invasive Brain-computer interfaces for continuous control of robots. Clin Neurophysiol. 2008 Sep;119(9):2159-69. Epub 2008 Jul 14.

(5) Number of members of each year in the past three years

We primarily track members via email lists that we use to advertise our activities. We estimate member count to be 500.

(6) Summary of top three technical innovations in the area during the past three years

We have seen great technological gains in the use of robots for gait rehabilitation and upper arm rehabilitation after stroke. Two examples

of such systems are the Lokomat are the MIT-Inmotion. The Lokomat is a lower limb exoskeleton robot used for training gait patterns in stroke and SCI. They have made a pediatric version of this system that is also commercially available. MIT-Inmotion robot is a planar robot initially developed in the 90s and has been retooled and revised for upper arm robot-assisted therapy in about 2006. Both these systems are involved in extensive clinical trials. These robots represent commercial examples of the growth of the field. In addition to these two systems, we believe the development of assistive robots that are mechatronic toys and wearable devices for early diagnosis of neurodevelopmental disorders.

(6) Recommendations (and alternates) for new co-chairs: one from each primary region.

We recommend the following individuals:

a. Robert Riener (Switzerland) or Rui Loureiro (UK) for Europe
b. Thomas Sugar (Arizona) or Rajiv Dubey (Florida) for Americas
c. Kiyoshi Nagai (Japan) or Kengo Onhisi (Japan) for Asia

Sincerely,

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Institute of Technology Zurich

Summary of Activities

Workshops:

Workshop on Robot-Assisted NeuroRehabilitation *Workshop* June 19, 2009 – ICORR 2009. This workshop will be entitled "Towards the standardization of robot/machine-aided stroke rehabilitation and assessment". Program chairs are Rui Loureiro, Jim Patton, Michelle Johnson

Workshop on Gerontechnology *Workshop* October 19, 2008 - BioRob' 08 Scottsdale Arizona. Contact Information: Michelle Johnson. We held a great workshop at the Biomedical Robotics conference. We hope to have similar workshops at ICORR '09 and RO-MAN '09. Program Co-Chairs and presenters: Silvestro Micera, Michelle Johnson, and Takanori Shibata.

Japan National Workshop on Assistive Technologies *Workshop* June 30, 2007 - Tokyo Japan
Contact Information: Takanori Shibata The TC provided technical co-sponsorship to this very successful national event was organized in Japan by Takanori Shibata. More than 400 participants (researchers, clinicians, end-users) attended the event.

IARP/IEEE-RAS/EURON Workshop on Technical Challenges for Dependable Robots in Human Environments *Workshop* April 16, 2007 - Rome Italy
Contact Information: Eugenio Guglielmelli
This workshop was organized in conjunction with ICRa 2007 and attended by 60 invited top experts from academia, industry and national research agencies. The programm included several contributions related to human-centred robot design and application to medical and rehabilitation robotics. International Programme Committee Chair: Eugenio Guglielmelli

Workshop on "New" Perspectives in Rehabilitation Robotics *Workshop*, April 14, 2007 - rome italy. Co-chairs: Michelle Johnson, Craig Carignan, Carlo Avizzano, Eugenio Guglielmelli and Takanori Shibata
A full-day workshop was held in conjunction with ICRA 2007 in Rome. More than 50 registered participants attended the event. The workshop proceedings were distributed to participants and are also available on-line through the ICRA 2007 website.

International Workshop on Motor Learning in Stroke Recovery 'Rehabilitation Think Tank' *Workshop* March 25, 2007 - Rome, Italy
This event gathered in Rome a selected group of top international experts in bioengineering and medicine for discussing the perspectives of the emerging rehabilitation technologies. More than 100 participants from 13 countries in Europe, USA and Japan attended the event. Eugenio Guglielmelli chaired the workshop

Organized of a workshop on rehabilitation robotics at ICORR 2007 Conference *Workshop* December 30, 2006 - Maastricht, Belgium.
Workshop entitled "Stroke Rehabilitation: New Perspectives in the Application of Robotic Technology". Program Co-chairs: Michelle Johnson and Rui Loureiro.

Organization of 5th IARP/IEEE-RAS/EURON International Workshop on Technical Challenges for Dependable Robots in Human Environments *Workshop* November 15, 2006 – Rome. This event was held in Rome,

Italy on April 14-16 in conjunction with ICRA 2007. Eugenio Guglielmelli chaired the International Program Committee.

First Symposium on Neuro-Developmental Engineering *Workshop*. May 30, 2006 – Rome. Contact Information: Flavia Salvadori

Workshop/Summer or Winter School

First EURON Summer School on Rehabilitation Robotics *Summer School*. September 30, 2007 - Elche Spain. Contact Information: Eugenio Guglielmelli. The TC provided technical co-sponsorship to the first EURON School on Rehabilitation Robotics that will be held in Elche (Spain) next March 2008. The School is sponsored by the European Robotics Netowrk (EURON) but open to participants from any countries. General Chair: Nicolas Garcia. Programme Co-chairs: Eugenio Guglielmelli and Hermano Igo Krebs.

Support to the organization of one summer school on Neuro-Robotics at Bressanone (Italy). *Summer School*. September 25, 2006 - Bressanone (Italy)

Special Issues:

Special Issue on Rehabilitation Robotics for T-RO *Publication - Journal Special Issue* October 29, 2008 – USA. Contact Information: Eugenio Guglielmelli. Reactions to the special issue for the IEEE Transactions on Robotics were great. We received over 65 submissions. The paper submission deadline was Sept 22, 2008. It is now closed. The paper submissions are being reviewed.

Special Issue on Rehabilitation Robotics of the JNER (Journal of Neuroengineering and Rehabilitation) *Publication - Journal Special Issue* January 31, 2007 – USA. Contact Information: Michelle Johnson

Special Issue on "Socially Assistive Robotics" for Autonomous Robots *Publication - Journal Special Issue* January 15, 2007 – USA. Guest Editors: Adriana Tapus and Maja Mataric

Special Issue on Robotic Platforms for Neuroscience of the International Journal 'Advanced Robotics' *Publication - Journal special issue* October 16, 2006 - Japan

Organization of a Special Issue on Rehabilitation Robotics of the IEEE EMBS Transactions on Neural Systems and Rehabilitation Engineering *Publication - Journal special issue* September 15, 2006 – USA. Contact Information: Maria Chiara Carrozza

Promotion/Administration

TextBooks

Contribution to the new ARS (Advanced Robotic Systems) book on rehabilitation robotics *Publication - Book* May 1, 2007 - Vienna, Austria. Contact Information: Loredana Zollo.
The book is intended to gather most recent results in Rehabilitation Robotics research field. Three chapters of the book have been edited by the TC co-chairs.

A new textbook on Neuro-Robotics *Publication - Book* December 1, 2006 – Italy. Contact Information: Paolo Dario

An initiative promoted by prof. Paolo Dario that is also the outcome of the Summer School held this year in Bressanone, Italy

Support to the organization of one summer school on Neuro-Robotics at Umea (Sweden). *Summer School*. August 20, 2006 - UMEA (Sweden)

Proposal for organization of an international joint workshop with NSF on 'Point of care robotic and automation technologies for stroke neurorehabilitation (proposal under evaluation) *Workshop*. September 21, 2006 – Spain. The event will be held in conjunction with the 2007 AAATE International Conference

Support to the organization and execution of "The first IEEE / RAS-EMBS International Conference" (BioRob 2006) -- Rehabilitation Robotics Track *Conference*. February 20, 2006 - Pisa (Italy)

Setup of a TC scientific support team *TC Team* February 1, 2006 – Italy, Contact Information: Eugenio Guglielmelli
Members of the TC scientific support team:
- Loredana Zollo (Post-doc fellow at the University Campus Bio-Medico in Rome (Italy))
- Duygun Erol, Vanderbilt University
- Dominic Nathan, Marquette University