REPORT

Report on participation of the ICMR International Fellow (ICMR-IF) in Training/Research abroad.

1. Name and designation of ICMR- IF: Dr. Dinesh Bhatia

2. Address: Associate Professor & Head
Biomedical Engg. Deptt.
North Eastern Hill University (NEHU)
Shillong-793022 Meghalaya, India

3. Frontline area of research in which training/research was carried out: Sensory Prosthetics and Tactile Sensing Robotics and Rehabilitation Engg.

4. Name & address of Professor and host institute: Dr. Ravinder Dahiya,
Reader & EPSRC Research Fellow,
Electronics and Nanoscale Engg.,
533a, James Watt Building (South),
University of Glasgow, G128QQ, UK

5. Duration of fellowship: 06 months (30th Jan to 31st July, 2015)

6. Highlights of work conducted:

i) Technique/expertise acquired:

During the ICMR research fellowship at the University of Glasgow, the emphasis was to learn new skills in the areas of fabrication of nano-devices, robotics, tactile sensation, biomedical instrumentation, rehabilitation and neuroscience. This helped in stimulating new research interests by learning to design and system integrate, fabricate nano-scale devices and electronics, artificial skin, robotic tactile sensing, micro and macro-electronics with help of inputs from the Bendable Electronics and Sensing Technologies (BEST) multidisciplinary research group of Dr. Ravinder Dahiya at the University of Glasgow. During this fellowship, I learned and worked on developing a simulated version of prosthetic hand (Figure 1) by employing COMSOL Multiphysics modeling software. This fellowship helped the undersigned to get acquainted with knowledge about 3D printing technology by designing and developing a prosthetic arm. During the fellowship, a Master's student was mentored by me for developing of sensorized prosthetic hand (Figure 2). This work would be further extended for the development of prosthetic hand with tactile skin. I regularly participated in the groups meetings to present my ongoing research and share research ideas with other members of the BEST group. This visit also provided exposure to advanced mathematical modeling and signal processing techniques for gaining new knowledge regarding development of neuro-muscular disorders for better diagnosis and treatment of motor impairments in people with common and prevalent neurological disorders such as spinal cord injury, stroke, cerebral palsy (CP) or Parkinson's disease which are line with my current areas of research. This would further support in better understanding and

development of improved rehabilitation tools and devices for the physically challenged persons for their welfare and improvement in quality of life.

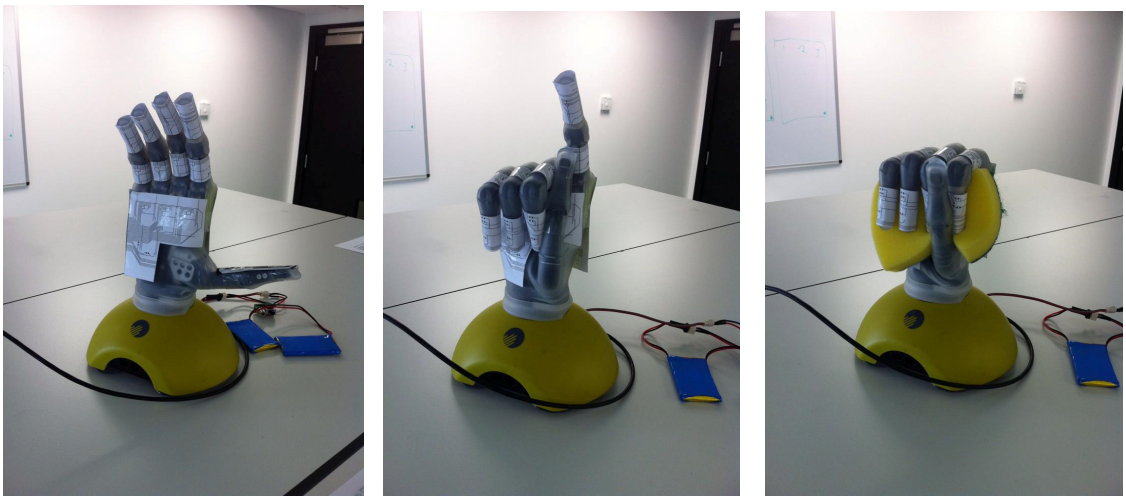

Figure 1: Prototype of Touch Bionics (iLimb) Sensorized prosthetic Hand with artificial Skin sleeve

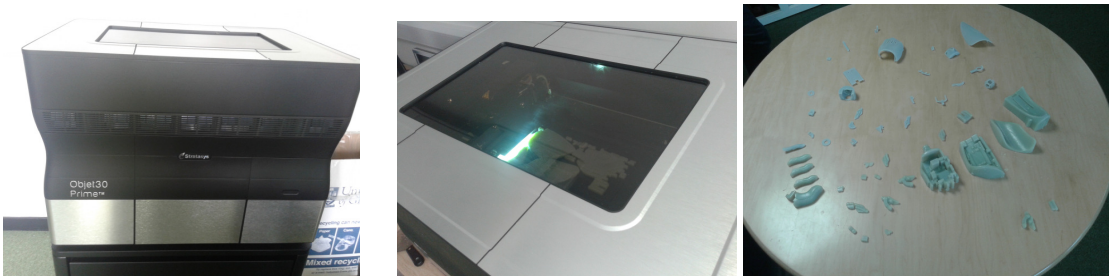

Figure 2: 3D Printer design set-up for prosthetic hand model

Apart from this, the undersigned also interacted and participated in research studies ongoing in the Biomechanics group (Biomedical Engineering) at the University of Glasgow. I participated as volunteer in number of ongoing research studies in this group related to Functional Electrical Stimualtion (FES), neuro-cognitive studies, EMG and ECG. I was a regular invited member to the weekly group meetings held on Thursday's during the duration of my stay in Glasgow. This helped in expanding my knowledge and horizon beyond the work and scope of my activties at the BEST group. I also visited Prof. Peter Macfarlane at Lister Hospital Building, University of Glasgow to understand his work in field of ECG and attened few lectures delivered by him at the University of Glasgow. A department visit was undertaken in July to the meet faculty in Electronics (Prof. James Irvine) and Biomedical Engineering (Prof. Phil Rowes and Prof. Phil Riches) at University of Starthclyde, Glasgow to understand their areas of expertise and research domain with interests to explore possibilities for collaborating in near future. I would like to acknowledge the support provided by ICMR and Govt. of India throughout the fellowship duration.

ii) Research results, including any papers, prepared/submitted for publication :

Conferences Presentations:

- Manvinder Kaur, Shilpi Mathur, **Dinesh Bhatia***, Suresh Verma, "EMG analysis for identifying walking patterns in healthy males", Oral Presentation, IEEE 11th Conference on PhD Research in Microelectronics and Electronics (IEEE PRIME), Glasgow, UK, 29th June- 02nd July, 2015. (published in IEEE Prime Proceedings pp. 65-68)
- William Taube, Hadi Heidari, Anton Polishchuk, Dhayalan Shakthivel, **Dinesh Bhatia**, and Ravinder Dahiya, "Prosthetic Limb Control Using Toe Gesture Sensors", IEEE Sensors, Busan, Korea, 1st -4th November, 2015 (Accepted- enclosed)).
- **Dinesh Bhatia***, Bablu Rajak, Protima Sudro "Efficacy of Pharmacological and Non-Pharmacological Strategies towards Cerebral Palsy induced Spasticity", Oral Presentation,25th Congress, International Society of Biomechanics (ISB), Glasgow, UK, 12th -16th July, 2015.
- Sudip Paul, **Dinesh Bhatia*** "Gender Differences among males and females while performing routine tasks- A Precursor to Osteoarthritis Risk", Poster Presentation, 25th Congress, International Society of Biomechanics (ISB), Glasgow, UK, 12th- 16th July, 2015
- Nitin Sahai, Sudip Paul, **Dinesh Bhatia***, Angana, Saikia, "Muscle Mechanics of Upper Limb involved in designing of prosthetic hand with moving fingers", Poster Presentation, 25th Congress, International Society of Biomechanics (ISB), Glasgow, UK, 12th- 16th July, 2015

Conference organized:

- Member, Local Organizing Committee IEEE 11th Conference on PhD Research in Microelectronics and Electronics (IEEE PRIME), Glasgow, UK, 29th June- 02nd July, 2015.

Papers under Progress:

- Bablu Rajak, Meena Gupta, Yoges Nivasan, **Dinesh Bhatia**, Ravinder Dahiya "Neural Control of Limb" paper under preparation for Journal

Seminars and demonstrations attended:

- Attended Lecture and Robo-Limb demonstration by Mr. Andy McDaid, Principle Software Engineer, Touch Bionics, UK on 02.03.15.
- Attended Knowledge Exchange seminar- Pathway to Innovation- organized by Innovation Centre, University of Glasgow on 20.03.15.
- Attended Annual Research Staff Conference at University of Glasgow on 17.04.15.

Papers submitted from ongoing research studies in India:

Due to ongoing sponsored projects (04 in number) from DST and DBT by the Government of India to the undersigned, it was important to coordinate and pursue research activities with research team in India to avoid delay in project progress and timely follow up of ongoing project status. As such, few publications were published or submitted while working at Glasgow. This work carried out was in addition to above

research activities carried out by undersigned while working at the University of Glasgow:

Papers in Journals:

- Manvinder Kaur, Shilpi Mathur, **Dinesh Bhatia***, April 2015, "Comparison of muscle activation patterns during walking in healthy males and paraplegic subject" International Journal of Electronics, Electrical and Computational System ISSN 2348-117X, 4(4), pp. 39-46.
- Manvinder Kaur, Shilpi Mathur, **Dinesh Bhatia***, Suresh Verma, 2015, Jan "siGnum: Graphical user interface for EMG signal analysis" Journal of Medical Engineering and Technology (JMET), Taylor and Francis Publisher, ISSN: 0309-1902 (print), 1464-522X (electronic); 39(1), pp. 19-25.
- Shilpi Mathur, Manvinder Kaur, **Dinesh Bhatia***, Suresh Verma, "Advancements in Functional Electrical Stimulator Technology" accepted in (Ref: 94556) by International Journal of Biomechatronics and Biomedical Robotics (IJBBR), UK (July '15)
- **Dinesh Bhatia***, Bablu Rajak, Meena Gupta, Arun Mukherjee " Applications of MEMS as a Neural Interface" under peer review Journal of Pharmacy and Bioallied Sciences (JPBS)
- Manvinder Kaur, **Dinesh Bhatia***, Suresh Verma "Influence of gender on muscle activity patterns during variations in walking speeds" under review JMET, Taylor and Francis (June'15)
- Manvinder Kaur, Sanjeev Nara, Dhananjoy Shaw, **Dinesh Bhatia*** "Gender and performance on EMG activity of selected knee extensor muscles during isometric contractions of fully extended knee in athletes" under review Journal of Electromyography and Kinesiology (JEK) submitted (May'15)
- Shilpi Mathur, Manvinder Kaur, **Dinesh Bhatia***, Suresh Verma "Comparison of muscle activation patterns among healthy males and females during different lower limb movements" submitted to IJMEI, UK (June'15)
- Manvinder Kaur, Sanjeev Nara, Dhananjoy Shaw, **Dinesh Bhatia*** "EMG Asymetricity of selected knee extensor muscles in sustained squat posture (a yogic posture) of athletes in relation to their gender and performance" submitted to Sports Biomechanics (July, 2015).
- Sanjeev Nara, Manvinder Kaur, Dhananjoy Shaw, **Dinesh Bhatia***, "Analysis of neuromuscular fatigue on co-activation ratio of selected knee extensor muscles during isometric contraction in athletes" (Under final revisions)
- Angana Saikia, Sushmi Mazumdar, Nitin Sahai, Sudip Paul, **Dinesh Bhatia,**Suresh Verma, Punit Kumar Rohilla "Recent advancements in prosthetic hand technology" submitted to Journal of Medical Engineering & Technology (JMET), Informa Healthcare Publishers. (June'15).
- Manvinder Kaur, Shilpi Mathur, **Dinesh Bhatia***, Deepak Joshi "Activity of Agonist-Antagonist muscles during maximum knee and ankle contractions" submitted to Journal of Musculoskeletal Research (July, 2015)

Conferences:

- Manvinder Kaur, Sanjeev Nara, **Dinesh Bhatia*** "Influence of gender on co-activation ratio of agonist antagonist muscle pair during maximum knee contraction" oral presentation in IEEE, NGCT 2015, Dehradun, UP, India (accepted).

- Sushmi Mazumdar, Angana Saikia, Nitin Sahai, Sudip Paul, **Dinesh Bhatia "**Microcontroller in Prosthetics: A Review" NCRABME-15, NEHU, Shillong, India (accepted)
- Bablu Lal Rajak, Meena Gupta, **Dinesh Bhatia***, Arun Mukherjee "Comparative study between r-TMS and standard therapy in spastic CP kids" NCRABME-15, NEHU, Shillong, India (accepted)
- Manvinder Kaur, Sanjeev Nara, Shilpi Mathur, **Dinesh Bhatia*** "Co-contraction of Tibialis and Soleus muscles during maximum ankle contraction" NCRABME-15, NEHU, Shillong, India (accepted)

New project proposals submitted/ approved for funding:

- PI, " Design of pulsed electrical stimulator for knee OA sanctioned (2015-17) by IDP, DST, Delhi (Rs. 39 lakhs)
- PI, "To study the effect of Hyperbaric Oxygen Therapy (HBOT) in children showing features of Autism Spectrum Disorder" submitted to Cognitive Science Research Initiative (CSRI), DST, Delhi on 30.06.15.
- Co-PI, "Design of Laser based catheter for treatment of ischemic cerebrovascular diseases (CVD)" submitted to Cognitive Science Research Initiative (CSRI), DST, Delhi on 30.06.15.

iii) Proposed utilization of the experience in India:

The proposed visit to the University of Glasgow would be beneficial for researchers from both the countries and help in burgeoning interest in applications such as robotics, prosthetics, bendable electronics, nano-devices, healthcare and surgical instrumentation. It helped in learning new ideas, tools and techniques in the area. This knowledge could be shared and passed on to other fellow researchers and students in the country. This may lead to exchange of ideas, technical know-how and improvement in current state of research in above areas. Possible future collaborations through means of joint collaborative research projects, MoUs, workshops, conferences, students and visitor exchange programs could be established which would help in developing this field further for betterment of mankind and society at large. This know-how could possibly be employed in aiding the disabled, handicapped people and developing relatively low-cost and optimized prosthesis/ orthosis devices for them in the near future which is line with ongoing research activities of both the laboratories as well as institutions. This expertise and knowledge can be discussed, shared and imparted to researchers working in this area globally. We are planning to apply for joint project and grants in near future such as Indo-UK and other related calls.

Signature of ICMR-IF

ICMR Sanction No. No. INDO/FRC/425/Y-29/2014-15-IHD dated 12th January, 2015