



**School of Mechanical Engineering in association with International
Relations & Research Collaborations
Organized online
International Guest Lecture
On**

**“3D Printing of Brain Phantoms & Coils for Transcranial
Magnetic Stimulation”**

School: Mechanical Engineering

Date: 10th February 2024

Description of Event:

The School of Mechanical Engineering in association with International Relations & Research Collaborations had organized an online international guest lecture for faculties, on the topic **“3D Printing of Brain Phantoms & Coils for Transcranial Magnetic Stimulation”** conducted on 10th February 2024 from 9AM to 10AM. The lecture was delivered by **Dr. Ravi L Hadimani**, Associate Professor, Department of Mechanical & Nuclear Engineering, Virginia Commonwealth University (VCU), USA.

About the Expert:

Dr. Hadimani an Associate Professor and the Director of the Biomagnetics Laboratory at the Department of Mechanical and Nuclear Engineering of Virginia Commonwealth University. He is currently on sabbatical as a **Visiting Associate Professor at Harvard Medical School, Harvard University**. He has founded the IEEE Joint Magnetics and Engineering in Medicine and Biology Society's Richmond Chapter, and he is the current vice chair of the chapter. He is an Associate Editor of the journals, Frontiers of Neuroscience and American Institute of Physics (AIP) Advances. He is a member of US National Academy of Inventors.

Dr. Hadimani's research focuses on biomagnetic materials and devices for biomedical applications, magnetocaloric heating/cooling, and energy harvesting. He has developed a first-of-

a-kind anatomically accurate brain phantom for validating neuromodulation procedures that are commercialized through the university spin-off company RAM Phantoms LLC. Dr. Hadimani has received several international awards, including the UK Energy Innovation Award and the International Young Scientist Fellowship from the National Natural Science Foundation of China (NSFC). He also received the Engineer of the Year award from the Richmond Joint Engineers' Council in 2021. He has authored more than 110 peer-reviewed original research journal papers, more than 225 international conference papers, 15 current and pending patents, several invited trade magazine articles, a book, and 3 book chapters to date.

Dr. Hadimani has a 'first class' honors degree in Mechanical Engineering from Kuvempu University, India, an MS in Mechatronics from the University of Newcastle, UK, and a Ph.D. in Electrical Engineering from Cardiff University, UK. He has served as a Project Scientist at the Institute of Materials Research and Innovation of the University of Bolton, UK. He was an Adjunct Assistant Professor and Associate Scientist at Iowa State University and was also an Associate at Ames Laboratory, US Dept. of Energy.

Description of Talk:

Transcranial Magnetic Stimulation (TMS) can tune brain functions non-invasively, safely, and effectively without the need for surgery or drugs. Thus, it can enable the treatment of several debilitating neurological and psychiatric disorders and enhance cognitive capabilities. My lab has designed and fabricated an anatomically accurate human brain phantom that can be used to test the feasibility and safety of several TMS protocols. We have investigated a feasibility study of combined TMS and surgical Deep Brain Stimulation treatment using brain phantom in collaboration with the VCU Department of Neurosurgery. We have also designed and fabricated novel focal stimulation coils based on novel soft ferromagnetic materials that can stimulate only a local region of the primary motor cortex. We are currently working to experimentally verify the results from coil design in rats in collaboration with the Dept. of Neurology at VCU. My team has also designed a TMS coil configuration that can stimulate multiple sites simultaneously and vary sites of stimulation without moving the coils physically. These new TMS techniques will enable the future development of effective TMS protocols for the diagnosis and treatment of several neurological and psychiatric disorders. We are also working to *establish an accurate mechanism underlying TMS by investigating the neuronal firing patterns in several brain regions induced by*

cortical stimulation and by establishing the role of individual nuclei in affecting other nuclei of the motor circuitry.

Outcome: After attending the technical talk participant will be able to

CO1: Understand the importance of additive manufacturing and its application.

CO2: Identify the application of ML algorithms to optimize the additive manufacturing process for the benefit of bio-medical devices.

CO3: Know the procedure of developing the medical devices for the benefit of human patients suffering from tremors happening from Parkinson's disease.

Photographs:

International Guest Lecture on "3D Printing of Brain Phantoms and Tools for Transcranial Magnetic Stimulation"

Neurological Disorders in the US

- An adult human brain has about 80 billion neurons each connecting to 10,000 other neurons
- National Institute of Health estimates that one in four Americans above the age of 18 suffer from diagnosable neurological disorder*
- There is a critical need for an effective, non-invasive and safe treatment. US BRAIN Initiative Project, European Human Brain Project \$1.6billion; an NIH report suggests an investment of \$4.5 billion is needed in the US
- Transcranial Magnetic Stimulation (TMS/TMSi) is a neuromodulation technique that can alter the brain functions non-invasively and safely without the need of surgery or ionizing radiation.

*U.S. Census Bureau Population Estimates by Demographic Characteristics: Table 1. Annual Estimates of the Population by Sex, Race, and Hispanic or Latino Ethnicity for the United States: 2017. (U.S. Census Bureau, 2018)

Participants:

- Pradip Gunakoti
- C. Rajesh Babu
- Dr. Shanthi V
- Dr. Shanthi V
- Dr. Veenkatesh
- Dr. Balaji S
- Dr. Mahesh L
- Hadimani, Ravi
- Hanumantharaya R
- Himanshu K

VIRGINIA COMMONWEALTH UNIVERSITY

- Largest Public University and Second Largest University in the State of Virginia
- An Urban Premier Research-Intensive Tier 1 University
- Noble Prize in Chemistry in 2002: John B. Fenn
- Established in 1838
- \$1,242 students and 14,300 employees
- \$2.5 Billion Endowment and Research Expenditure of \$495 million/annum
- 3 researchers among the world's most highly cited authors (top 1%)

Other Random Facts

- VCU has 188,745 Alumni Association Members
- 226 Degree and Certificate Programs
- One of only 54 universities to be designated by the Carnegie Foundation as "Very High Research Activity"
- 23% growth in sponsored awards in a 10-year period
- One of the 20 teams selected internationally for Hyperloop Competition Finals

Home to 36 Research Centers

- Nano Characterization Center (NCC)
- Virginia Wright Microelectronic Center
- Massey Cancer Center
- Center for Molecular Imaging
- de Vinci Center for Innovations
- Harold F. Young Neurosurgical Center

US Ranking of VCU Programs-2017

- 1st Fine Arts - Sculpture
- 1st Nurse Anesthesia
- 2nd Fine Arts
- 1st Health Care Management
- 4th Rehabilitation Counseling
- 1st Pharmacy
- 24th Nuclear Engineering

Mechanical and Nuclear Engineering

- Faculty members: 28
- Undergraduate Students: 550
- Graduate Students: 100

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CONTACTS:

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 Dept. of Mech. & Nuclear Engineering: <https://coe.vcu.edu/departments/mechanical>
 For general inquiries, email us at: mhasrath@vcu.edu

Participants:

- Dr. Balaji S
- Dr. Mahesh L
- Dr. Shanthi V
- Pradip Gunakoti

