

AMRITA  
CENTER  
FOR  
WIRELESS NETWORKS &  
APPLICATIONS



AMRITA  
VISHWA VIDYAPEETHAM



AMRITA CENTER FOR  
WIRELESS NETWORKS  
& APPLICATIONS

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## CHANCELLOR'S MESSAGE

One of humankind's biggest mistakes has been the separation of science and spirituality. Through this we created two sets of people—the so-called “rationalists” and the so-called “religious.” Religion and spirituality were then said to be based on blind faith, whereas science, which is proven through experimentation, is fact. The question then became: “Which side are you on—faith or proven fact?” This segregation has created an unnecessary and unhealthy rift in society, resulting in tremendous conflict, both in the individual as well as in the world as a whole. Even the depletion of our natural resources and the disappearing harmony between man and nature can ultimately be traced back to this mistake. If we want the world to continue in a sustainable and balanced manner, science and spirituality must unite. The present age and the world around us demand this transformation. Indian spirituality has never considered science and spirituality at odds, but more like two wings of a bird. Science deals with the objective world, whereas spirituality deals with the subjective—the ultimate essence of one's existence. The former is about the seen; the latter about the seer—the pure consciousness that is the indwelling self. Thus, there are areas where science cannot penetrate. If we want answers in these spheres, we must be willing to investigate spiritual and religious texts. The opposite is also true. Such an open-minded approach will enable us to have a proper balance in all areas of action, both internally and externally. May our teachers and students have the discernment to strive for this.

Mata Amritanandamayi Devi  
Chancellor, Amrita Vishwa Vidyapeetham



# AMRITA VISHWA VIDYAPEETHAM

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Headquartered at Ettimadai, Coimbatore, Tamil Nadu, Amrita Vishwa Vidyapeetham is a multi-campus, multi-disciplinary research university accredited 'A' grade by NAAC. Managed by Mata Amritanandamayi Math, the University is driven by the thoughts and vision of the humanitarian leader Sri Mata Amritanandamayi Devi (Amma), the Chancellor of Amrita Vishwa Vidyapeetham. Amma's cornerstone of educational tenets is Her focused impetus on applied research across all domains of humanities, medical,

technical and geo-sciences. This principle is ingrained in Her commitment to nurture mutual respect, and love for all living species, nature and environment. Amma's concept of education which stresses on research and commitment to instill universal values, have converged to shape Amrita as an institution of advanced scholarship, where knowledge is deployed for salutary human development embedded with compassion and selfless service.



★ “2018 nirf ranking” ★ Campuses-as of 2018.



**#1**

Private university  
in india

**8<sup>th</sup>**

Best university in  
india

**5**

Campuses

**20250**

Students

**12,000+**

International  
Publications

**207**

Programs Offered

**5 Billion<sup>+</sup>**

Research Funding

**800+**

Ph.D. Faculty

University in Numbers

# AMRITA CENTER FOR WIRELESS NETWORKS & APPLICATIONS

Amrita Center for Wireless Networks and Applications (AmritaWNA) is a research center utilizing leading edge technologies in the field of wireless and mobile networking technologies; 5G, IoT and Big Data and wireless sensor networks (WSN). Guided by our Chancellor Sri Mata Amritanandamayi Devi, AmritaWNA develops scientific and technological applications for practical

humanitarian benefit. AmritaWNA integrates interdisciplinary areas such as Computer Science, Electronics and Communication, Electrical Engineering, Mechanical Engineering, Information Technology, Geology, Hydrology and Environmental Engineering, to develop cost effective solutions to solve common man's problem.

## QUICK STATS





Years of Transforming the World

Digital Shiksha



# RESEARCH AREAS

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## COMMUNICATION SYSTEMS FOR EXTREME ENVIRONMENTS

for natural disasters like Landslide, Tsunami, Floods and Avalanches.

## WEARABLE MEDICAL SYSTEMS

for Patient Monitoring and Alerts



## INTELLIGENT INFRASTRUCTURE

for Smart Building, Smart Energy, Smart Environment.



## **GLOBAL KNOWLEDGE NETWORK**

for knowledge sharing without Walls or Borders

## **IoT & BIG DATA**

for Real-Time and Remote Monitoring of Environments



## **EXPLORATORY RESEARCH AREAS**

in 5G & Climate Change



# COMMUNICATION SYSTEMS FOR EXTREME ENVIRONMENTS

# WIRELESS SENSOR NETWORK FOR REAL-TIME LANDSLIDE MONITORING AND DETECTION

The Center has developed, and deployed the world's first WSN system for continuous surveillance and real-time detection of landslides at Munnar, Kerala. This research was initiated as part of WINSOC (Wireless Sensor Networks with Self Organizing Capabilities for Critical Emergency Applications) project, funded by the European Commission under FP6 program. This field-deployed prototype system has successfully issued alerts of possible landslides during the annual monsoon season. The center has developed a similar system for Chandmari in Sikkim, at the request of the Government of India. Various Indian Government agencies have invited the Center to deploy this system at other landslide prone areas in the Western

Ghats and the North-Eastern Himalayan regions of India. Over the years, this project has been funded by various government agencies including Department of Science and Technology, Department of Information Technology, Ministry of Earth Sciences. AmritaWNA has been accepted as a member of the prestigious International Collaboration on Landslides (ICL) and as a partner to other organizations like the British Geological Society, King's College London, Newcastle University etc. for landslide related research projects. The International Programme on Landslides (IPL) has recognized AmritaWNA as the 'World Centre of Excellence on Landslide Disaster Reduction'.





# MOBILE INFRASTRUCTURE FOR COASTAL REGION OFFSHORE COMMUNICATIONS & NETWORKS - OceanNet



The prime objective of the OceanNet project is to deploy cost-effective mobile infrastructure for coastal regions of India to facilitate a communication system for fishermen over the sea. Initial applications are to enable ubiquitous communications

and connectivity when fishing vessels are beyond the range of terrestrial cellular towers. The project involves cutting edge wireless communication technology from the physical to the transport layers of the ISO-OSI model . Initially co-funded by Information Technology Research Academy, Ministry of Electronics and Information Technology, Government of India, this project was a collaboration of three institutions in which AmritaWNA was designated as the lead institution in partnership with Indian Institute of Space Science and Technology (IIST) and Indian Institute of Information Technology and Management, Kerala, (IIITM-K) as partner institutions.



## MONITORING & MANAGEMENT OF URBAN FLOODING USING CROWD-SOURCING



Urban flooding has become a common worldwide phenomenon due to many factors such as unplanned growth in urban and suburban areas, improper maintenance of drainage and sewage facilities, indiscriminate conversion of many water bodies into building areas, unseasonal rainfall due to global warming, etc. Amrita Center for Wireless Networks and Applications (AmritaWNA) is a partner in an Indo-German joint research initiative on urban flooding codenamed FloodEvac. Their work involves monitoring and management of urban flooding using crowdsourcing and computer vision. This trend has been observed during

the recent floods in Chennai, India and also in Philippines and China. Smart phones equipped with high speed data connectivity and high resolution cameras are ubiquitous these days especially among the urban community. During flooding, local communities are involved in multimedia data gathering. The images are analysed using computer vision techniques to assess the severity of the flood situation and determine the response from aid agencies in relief and rescue operations. This data will also be used in assessing the effectiveness of the action being taken and to plan for future needs.



# WEARABLE MEDICAL SYSTEMS

## VITAL PARAMETERS MONITORING USING WEARABLE SYSTEMS



This project aims at design and development of a low cost multi-sensor wearable device which measures vital parameters such as Blood Glucose, Blood Pressure, Blood Oxygen Level and Pulse rate. This system will be integrated with opportunistic networking to cover a large area for efficient delivery of health care access. The effective opportunistic communication helps easy access. The doctors, laboratories and local dispensaries. The system will be unique due to the integration of edge computing, mobile clouds and cloud architecture for decision support system development. The whole system will be integrated with an existing Hospital Information System(HIS).

## AMRITA IOT-BASED MEDICAL SMART-EDGE

The Amrita IoT-based Medical Smart-edge is a software that is specially designed to run on IoT-gateways serving healthcare IoT devices. Our Smart-edge consists of severity detection, data summarization, and alert generation techniques that convert voluminous medical data coming in from the IoT devices into clinically interpretable and useful summaries in the form of Personalized Health Motifs. This algorithms are collectively called as RASPRO (Rapid Active Summarization for effective PROgnosis). These summaries and alerts are further sent to the doctors either directly over cellular/NB-IoT networks or via the cloud using data networks. RASPRO has been proven to drastically reduce bandwidth and energy usage at the IoT gateways.



## ■ AMRITA SPANDANAM - REAL TIME ECG MONITORING

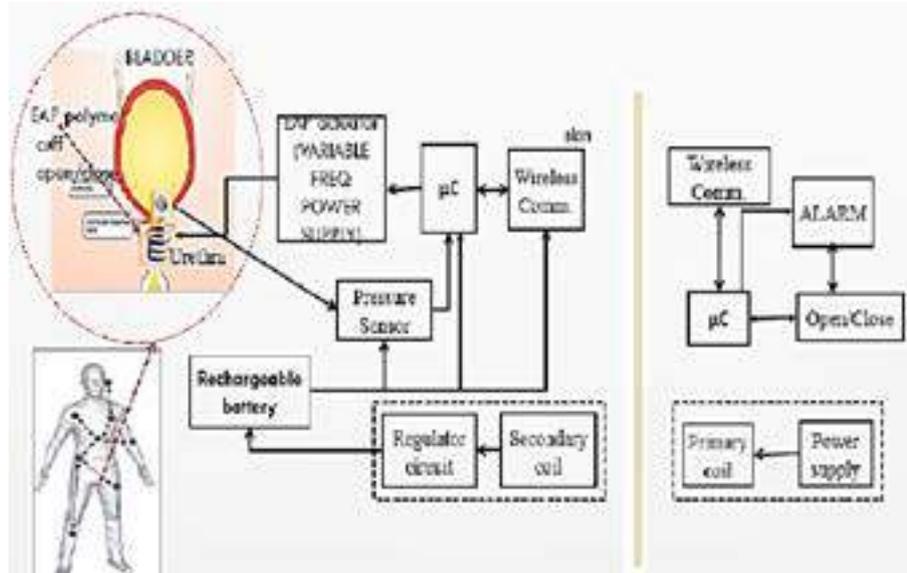
In order to help people with cardiac diseases avail real-time ECG-monitoring without hospitalization, AmritaWNA has designed a prototype low-cost, low-power, wearable ECG-monitoring device called Amrita Spandanam. This device allows postoperative cardiac patients as well as people with other cardiac conditions to

avoid life-disruption and often exorbitant medical costs of hospitalization for the sake of continuous vital-parameter monitoring. This device can be worn either as a necklace or a belt, and the ECG data is sent to the patient's cardiologist/doctor in real-time, with alerts if a patient seems to require examination.

# URINARY INCONTINENCE

Urinary Incontinence (UI) is a very common health issue in old people, multiparous women, neurologic patients, and patients after pelvic surgeries, and autistic kids that results in a heavy impact on both the quality of life as well as causing economic burden. The researchers at AmritaWNA has conceptualized a project to design and develop an assistive device for urinary incontinence. This system consists of biocompatible artificial sphincters based on Electroactive Polymer that are wirelessly triggerable by the patients. It includes context aware algorithms for remotely controlling the artificial sphincter functionalities, in-body wireless communication in the implant, the design of the miniature device with power optimization and design of transcutaneous

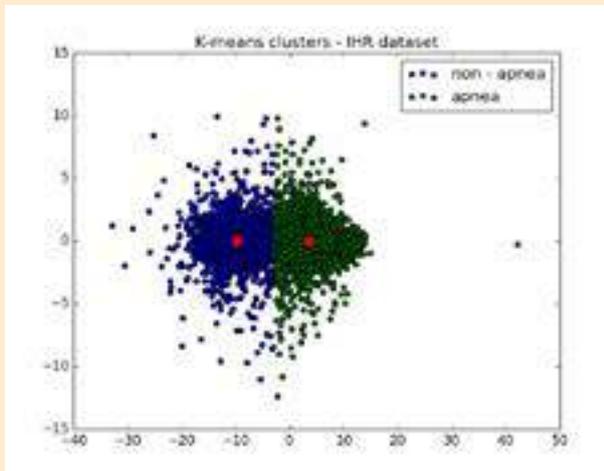
power transfer circuit. In effect, the patients will have control over when to open and close these sphincters that in turn will allow them to lead a better quality of life. This device with ease of use helps UI patients



to receive better care from caregivers and provides an opportunity to have a better social life. We have successfully prototyped this device concept in collaboration with the Urologists at our University hospital.

## SLEEP APNEA DETECTION @ HOME

Our researchers have developed Single Sensor techniques for detection of Obstructive Sleep Apnea (OSA) with the help of Deep Learning. In a joint collaborative work with doctors at our University hospital, the data scientists at CEN Lab, Coimbatore campus, and researchers at AmritaWNA, we have developed a method by which patients need to wear only a single sensor device that measures the heart rate variability and blood oxygen levels, which are then used to identify the severity of OSA with the help of a deep learning technique called long short-term memory. With this innovation, patients suspected of having OSA can conveniently be assessed at home, without undergoing the



cumbersome polysomnograph, which is currently the gold standard in sleep apnea detection.

## BREAST CANCER DETECTION USING INFRARED IMAGING

To provide an affordable system for the early detection of breast cancer, AmritaWNA is involved with the development of computer-aided diagnosis system using Infrared Imaging Techniques which is capable of detecting the abnormality even ten years before the onset of the disease. Thermal Camera-based wireless system is being developed for hospitals in rural areas in India. The acquired thermograms will be analyzed and processed using a smartphone for the first level analysis and screening. The thermograms will also be sent to the server, which can be accessed by doctors in specialty hospitals for the further analysis and diagnosis. AmritaWNA is also developing a system for diagnosis of breast cancer through automated analysis of histopathology slide images using artificial intelligence and computer vision.



# INTELLIGENT INFRASTRUCTURE

## SMART GRID

A prototype architecture of a wireless smart grid has been developed for India. Key features of this design include optimization of electrical transmission, and creation of smart solutions for major problems such as wastage of electrical energy, power theft,

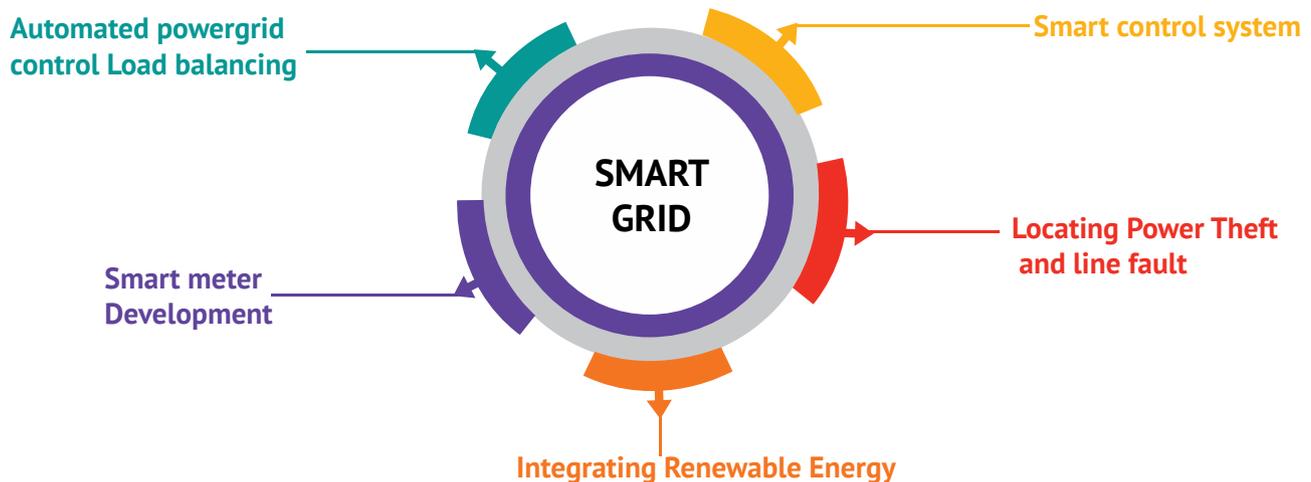
electrical line fault detection method, and to provide smart solutions for automatic billing and controlling system. Smart Energy Meters and other intelligent devices are being developed to monitor and control electric energy usage in real-time.



Stabiliz-E, an Indo-European Research and Innovation Initiative sanctioned under the INDIGO Partnership Program (an FP7 program funded by the European Commission) is the result of immense need to move from the

traditional, centralized, static energy grid towards a decentralized and dynamic grid, which provides more freedom to producers, distributors and consumers in energy sector. The Stabilize-E project aims to

- Design and implement low cost real-time monitoring and control devices to be deployed in remote and cost dependent regions
- Innovative use of Control and Automation solutions, ICT to detect and identify faults in the system, and prescribe optimal reconfiguration methodologies to restore the system.
- Design and Develop a prototype Smart Grid Lab capable of
  - a. Continuous monitoring of distribution grid parameters
  - b. Integration of Renewable Energy Generators to achieve Micro-Grid
  - c. Islanding in the event of Power Outages
  - d. Fault Detection, Isolation & Restoration
  - e. Implementation of real-time reconfiguration algorithms



## SMART HOME

This project provides IoT based solutions for buildings that will cater to optimized usage of energy resources without affecting the physical working comfort of the occupants. Spatiotemporal algorithms were developed for personalized and group-based device automation. A wearable device and wireless switchboard will collect the energy data that is capable to locate the occupants of the building. Machine learning and Artificial Intelligent methods are adapted to learn and model the personalized energy usage which used to give energy awareness to the occupants through the mobile application.



## SMART ENERGY - MONITORING & CONTROL SYSTEMS



Amrita WNA has initiated the Amrita Wireless Smart energy research project envisioning a country with reliable and efficient energy system with electricity access for everyone. The project is initiated to address the shortcomings of current energy system and to design a Wireless network based architecture consisting of multiple smart wireless transformer sensor node, smart controlling station, smart transmission line sensor node, and smart wireless consumer sensor node. Through this design we are attempting to develop cost-effective solutions to address the mentioned issues. It consists of the Smart Meter, R-Pi, Communication Gateway, relays. Installed meter is powered by the latest ARM processors and gigabit Ethernet interface, enables low latency data collection in real time.

## AMRITASPHURANAM - RURAL ELECTRIFICATION

As part of Mata Amritanandamayi Math's 101 Sustainable Village initiative, in September 2014, AmritaWNA completed solar electrification of Mothakara, a tribal village in Wayanad district in Kerala. The project, entitled 'AmritaSphuranam' is funded by Amrita vishwa vidyapeetham. The AmritaWNA Center is currently working on integration of six different clusters in the village to develop a micro-grid capable of energy exchange. The Center will be able to monitor and control the system remotely, from the Amritapuri campus. AmritaWNA plans to replicate its success in several other villages across India through the Amrita Self Reliant Village project (Amrita SeRve) initiated by the Mata Amritanandamayi Math



## AMRITA MICRO HYDRO- ELECTRIC SYSTEM

Komalikudi, is a tribal settlement in Kerala well-known for its abundant natural resources. Under Amma's guidance, members of ASeRve and Live-in-Labs worked with the residents of Komalikudi, to identify key challenges that needed to be addressed. On assessing their requirements, faculty, staff, and students at AmritaWNA along with the Departments of Electrical Engineering, Civil Engineering, Amrita Center for Nanosciences, the Amrita Institute of Medical Sciences (AIMS) and Amrita Center for International Programs (ACIP) as a team, implemented a plan to provide electricity to the village from locally available water resources. This team designed, developed, and installed an electricity distribution and transmission network. The project was an initiative of the University's Live-in-Labs® program. Furthermore, another set of team members from AmritaWNA, ACIP, and Department of Civil Engineering designed and installed a water distribution system in the village. The entire water distribution framework is currently powered by the Micro Hydro Generator.



# **GLOBAL KNOWLEDGE NETWORK**

## AMRITA GLOBAL CLASSROOM: GATEWAY TO GLOBAL LEARNING



In the Amrita National Knowledge Network (Amrita NKN )Global Classroom project, AmritaWNA provides a multi-site, multi-modal, multi-channel, high definition, interactive, immersive classroom experience - a university without walls and borders, that effectively uses the high bandwidth, low latency global network provided by NKN to inter-connect various institutions and expert resources worldwide. The project brings teachers and students across the world under one roof. This project enables

a direct channel of communication among the participants, and essentially aims to transform the NKN institutions into one worldwide cooperative entity for higher education and research. Video and Audio streams with multiple perspectives are linked together in real-time, to create a seamless media and knowledge environment. Amrita University is collaborating with SUNY at Buffalo, MIT, IIT Bombay in this project. This research work has been awarded multiple US patents.

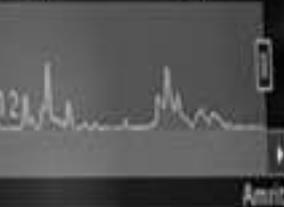
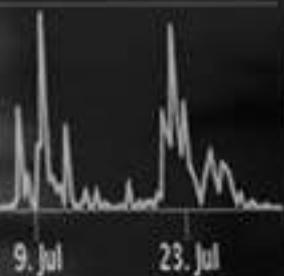
## VIRTUAL REMOTE TRIGGERED LABORATORY

Amrita Wireless Remote Sensing, Experimentation, Monitoring and Administration Lab is a project funded by the Ministry of Human Resources Development (MHRD). It is India's first remote triggered laboratory in the computer science and engineering area. The Remote Triggered Wireless Sensor Network Lab provides an easy, efficient, interactive and user friendly environment to the students, researchers.

The resources are shared to them in a virtual manner wherein they can conduct the experiments online and observe the outputs as in a real lab through an effective visualisation tool. This is an experimental wireless sensor network that is envisioned to provide a practical experience of designing, deploying and implementing wireless sensor networks in both indoor and outdoor conditions.



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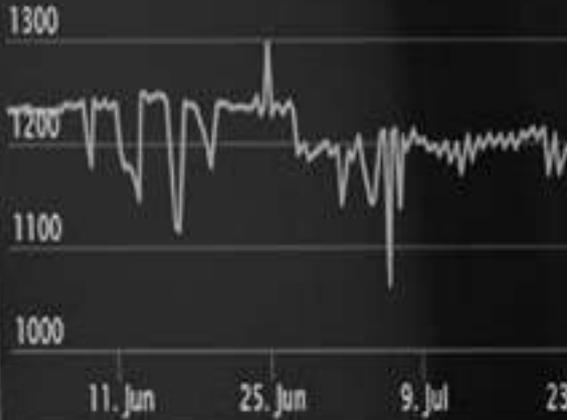
Amrita

From 2012-06-01 To 2012-07-31  
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Amrita

From 2012-06-01 To 2012-07-31  
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StrainGauge (kPa)

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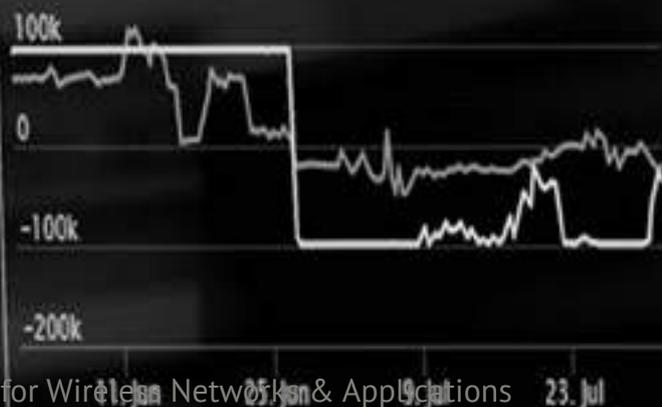


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StrainGauge1000 (microStrain)

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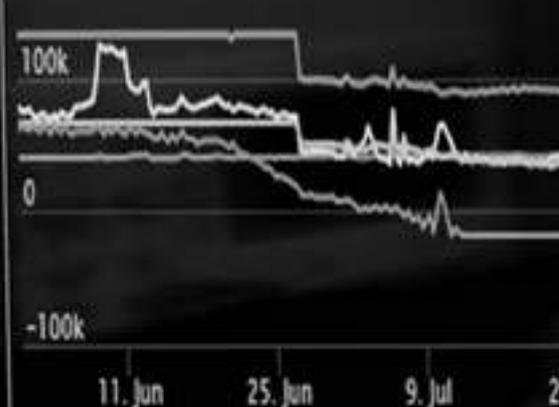


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StrainGauge350 (microStrain)

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# IOT & BIG DATA

## IOT SYSTEM FOR LANDSLIDES

AmritaWNA projects in the domains of IoT and Big Data address real time, remote control of various parameters for environmental monitoring. The projects also focus on developing generic IoT frameworks to help rural India to derive better farming practices that enables micro irrigation and perform smart agriculture.

As a part of a real-time landslide monitoring project, AmritaWNA has deployed more than 150 geophysical sensors connected to 20 wireless sensor nodes at various deployment sites. The sensors collect an assortment of underground parameters and transmit these data using wireless technologies to the Amrita University campus. Using

various complex algorithms developed by researchers at AmritaWNA, and the derived thresholds for key site-specific parameters, alerts or cautionary warnings are issued. The current research focuses on developing generic IoT framework for data analysis and efficient monitoring of multiple landslide prone sites.



## I IOT SYSTEM FOR SMART IRRIGATION



In our Smart Irrigation project, we have designed a generic IoT framework for improving agriculture yield by effectively scheduling irrigation and fertilization based on the crops' current requirements, environmental conditions and weather forecasts. The research focuses to develop low-cost irrigation and fertilization system to be used by farmers in rural India. The

proposed fertilization system spreads fertilizers to the root directly. This reduces the amount of fertilizers required and thus reduces the cost and improves the soil health. The project also focuses on developing user friendly mobile application to deliver the instructions to the farmers based on the current environmental conditions in their regional language.

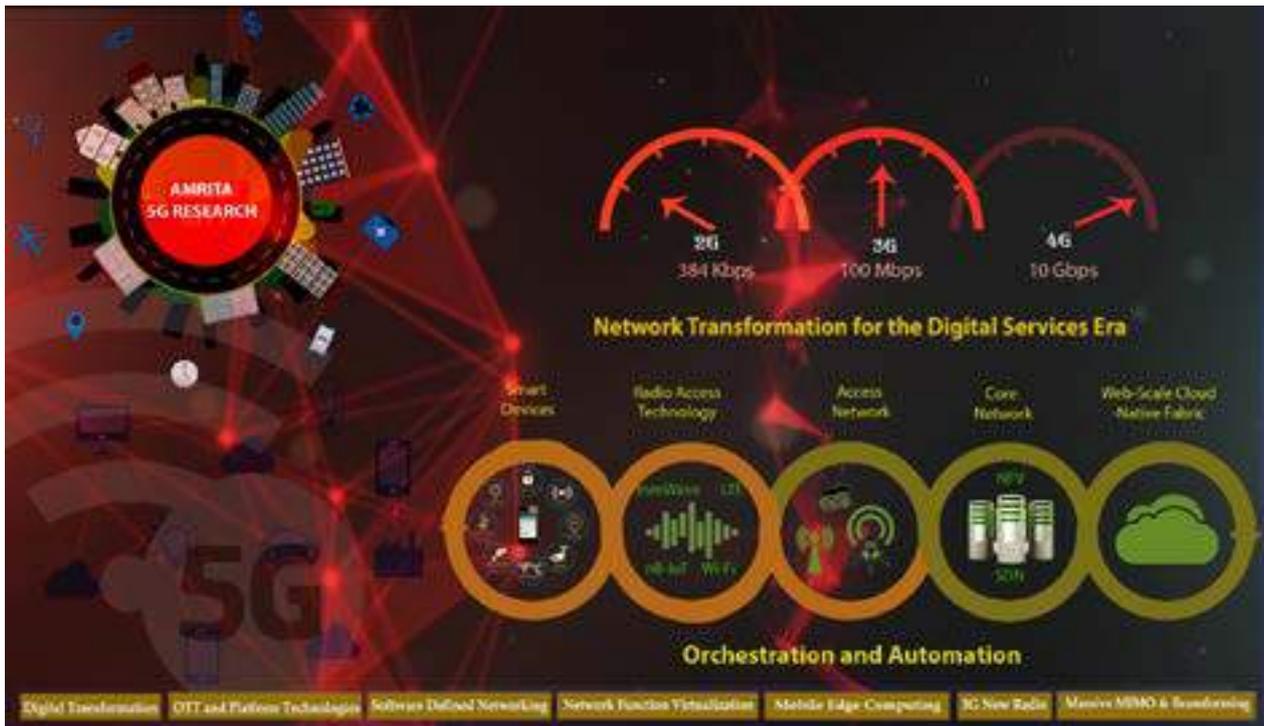


**EXPLORATORY  
RESEARCH AREAS**

## AMRITA 5G FRAMEWORK

Our work involves bringing expertise in state-of-the-art enablers in the digital transformation era where cellular communication providers (TELCOs) are moving towards brand new role of Digital Service Providers (DSPs). The research that underpins this journey is the focal point of the Amrita 5G research. The research themes spans across all areas of infrastructure

including protocols, algorithms, multi-antenna technologies and network resource management. The overall umbrella concept of 5G network from the DSP point of view becomes backdrop the Amrita 5G framework. Within this 5G landscape, topics related to the design of E2E network architectures including Software Defined Networking (SDN), Internet of Things (IoT), Industrial



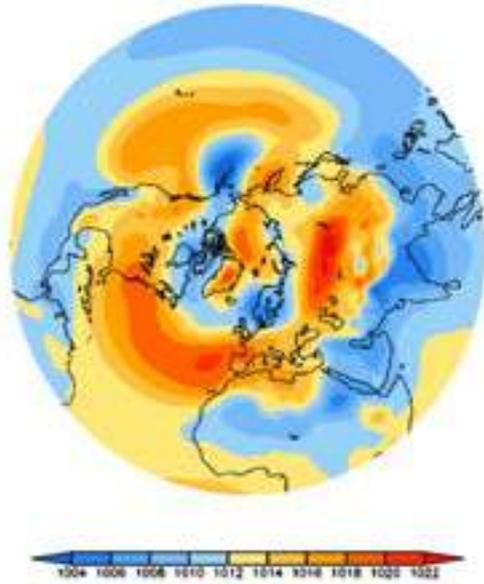
IoT (IIoT), Cloud-RAN (CRAN), Network Function Virtualization (NFV), Mobile Edge Computing (MEC) and Fog controllers within one umbrella. More importantly, it is envisaged that the research that emerges from appropriate combination of Artificial Intelligence (AI), deep learning and predictive data analytics will play valuable role in 5G networks.

Together with the above knowledge-base culminating into much needed 5G industry needs, students are given opportunity to inculcate best practices related to use case development, mathematical modelling and numerical analysis. Amrita 5G research aims to prove the feasibility of promising aforementioned concepts including, SDN/NFV based end-to-end mobile network architecture implementation, exposure to simulation techniques through MATLAB, OMNET++, NS3 and SDN labs. Amrita-Keysight Advanced Wireless Communication laboratory is already in place and, it gives hands on prototype experience



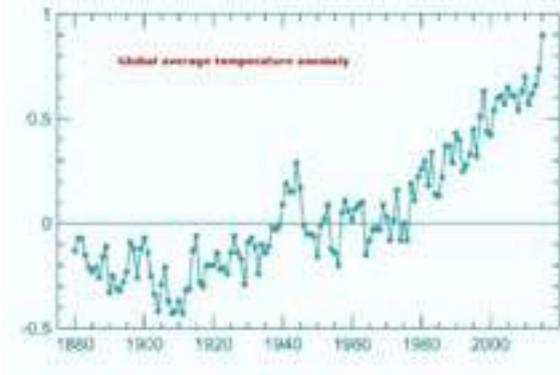
in Multi antenna Design, Radio system and simulations for the next generation solutions. The research has been formulated to bring synergy between 5G and other ongoing Amrita research projects in the IoT based wireless sensor networks for disaster relief applications, mobile offshore communication (OceanNet), security and digital health verticals. Amrita 5G research involves a holistic approach that works on applying diverse use cases of different 5G enablers to enrich the student curriculum and enable what we deem next generation 5G certified engineers.

## CLIMATE RESEARCH



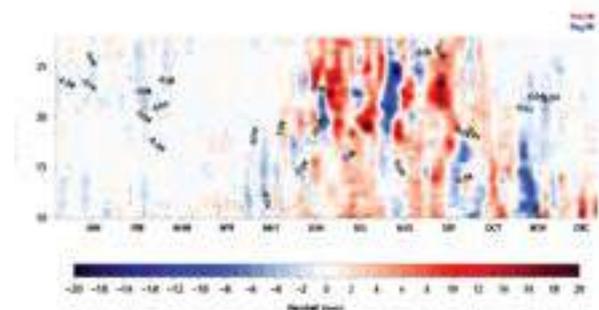
The Climate Research Group (CRG) is engaged in comprehensive research fundamental to AmritaWNA's mission. Researchers at CRG use numerical models and computer simulations to improve our understanding of the earth's climate variability and provide insights in promulgating adaptation/mitigation strategies in different sectors. Research at CRG encompasses climate downscaling, Asian summer monsoon, data assimilation

& weather forecasts, extreme event forecasts, land-surface processes, ocean-atmosphere interactions and climate change impact on agriculture and food security of India. Soil moisture is a project funded by Science & Engineering Research Board (SERB), Department of Science and Technology, India which focuses on characterizing and modelling the impact of soil moisture heterogeneity on convective processes over the Indian landmass. Soil moisture is a crucial variable in the monitoring of droughts, land slide early warning and crop yield. Soil moisture variability will significantly affect the food security of India by influencing the rainfall distribution over the subcontinent. Satellite observations and high-resolution regional climate modelling help to analyse both natural and anthropogenic changes in soil moisture. The modelling efforts in this project aims to improve, the representation of land surface data, spatial resolution of simulations and the quality of simulations over regions with complex terrain. Dynamical downscaling of regional climate: Simulation of extreme



rainfall events and their impact over the state of Kerala (funded by: Kerala State Disaster Management Authority) General Circulation Model (GCM) simulations have coarse horizontal resolutions (approximately 100-200km), good enough to reproduce many aspects of large scale climate, but unable to represent many processes and systems that drive regional and local climate variability, where the consequences of climate change will be mostly felt. To analyse and forecast the impact of changes in extreme weather events on disasters like flood, crop damage and landslides, we need high resolution regional climate predictions. We use dynamical downscaling method to generate local climate projections that consider changes in extremes.

Soil moisture is a crucial parameter that is closely related to precipitation. The feedback between soil moisture and precipitation is predominantly positive. A better understanding of the implications of soil moisture variations on precipitation will enable us in the formation of a decision support system for the rain-fed agricultural practices in India. The Hovmöller diagram explains the simultaneous variations of soil moisture and precipitation over the Indian sub-continent. The soil moisture – precipitation feedback mechanism is important in identifying the diurnal cycle of precipitation which plays a major role in extended to seasonal range forecast of monsoon rainfall over the Indian subcontinent.

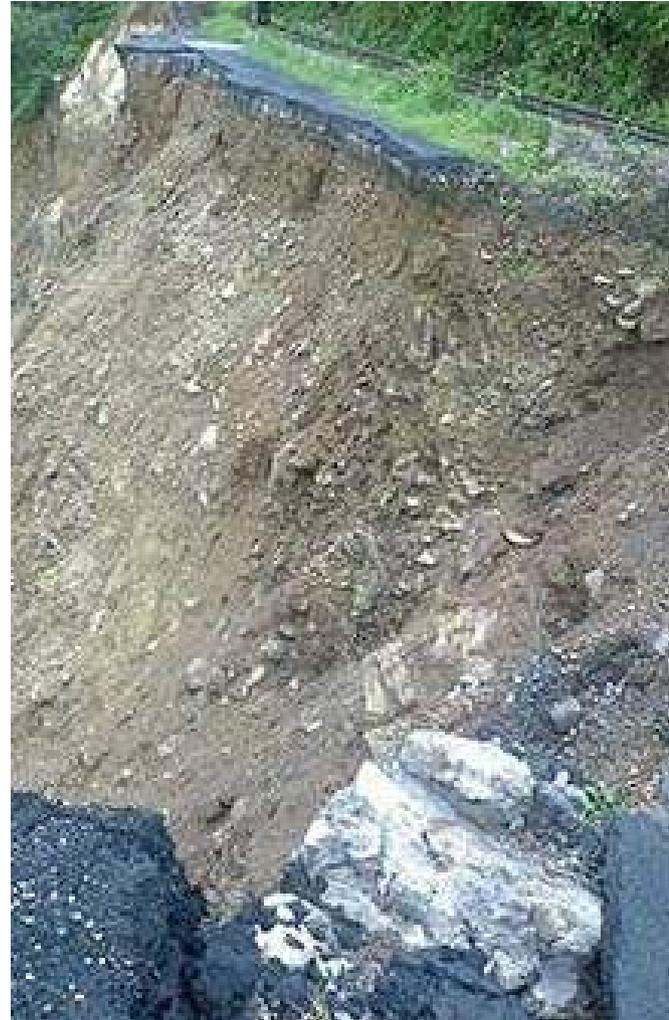


# **LANDSLIP-** LINKING NATURAL AND SOCIAL SCIENCES FOR **LANDSLIDE & MULTI-HAZARD EARLY WARNINGS**

Landslide multi-hazard risk assessment, preparedness and early warning in South Asia integrating meteorology, landscape and society (LANDSLIP). This project aims:

To enhance landslide related multi-hazard risk assessment and monitoring in India in two main study regions ([i] Nilgiris; [ii] Darjeeling/East Sikkim), with a focus on weather regimes, landslide domains and thresholds, societal factors and the interaction of 'cascading' hazards. To explore replicability of methodologies developed for other landslide prone regions such as Uttarakhand.

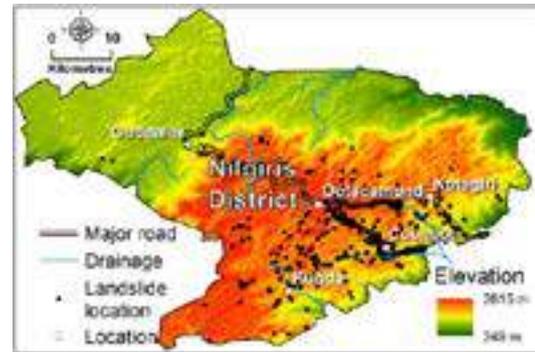
To strengthen understanding of the underlying drivers of risk toward more integrated, multi-hazard landslide risk monitoring and warning systems. To get the right landslide information to the right people in the right ways by using early warning systems, mobile networks, web-based gathering and dissemination of information to national/regional/local stakeholders including the public, including research to enhance the uptake and use of risk information in practice. To disseminate LANDSLIP project knowledge to the wider region of Southeast Asia (in particular, Afghanistan).



Two pilot areas in India build on existing, community-level landslide projects, enabling to derive participatory, community-led assessments of landslide risks and early warning needs.



Pilot A: Darjeeling–East Sikkim, Himalaya, India (north-east India)



Pilot B: Nilgiris District, Western Ghats (southern India)

risks and early warning needs. Both pilot areas are landslide prone, with population densities from very few to over 600 per km<sup>2</sup>. Both have experienced past events with fatalities and socio-economic impacts. Both experience intense rainfall during the north-east monsoon (October to December), which trigger landslides. Earthquakes are also a significant trigger of landslides in the north of India. Both pilot-study areas were chosen in direct collaboration with our GSI and Amrita teams, due to existing knowledge and data.



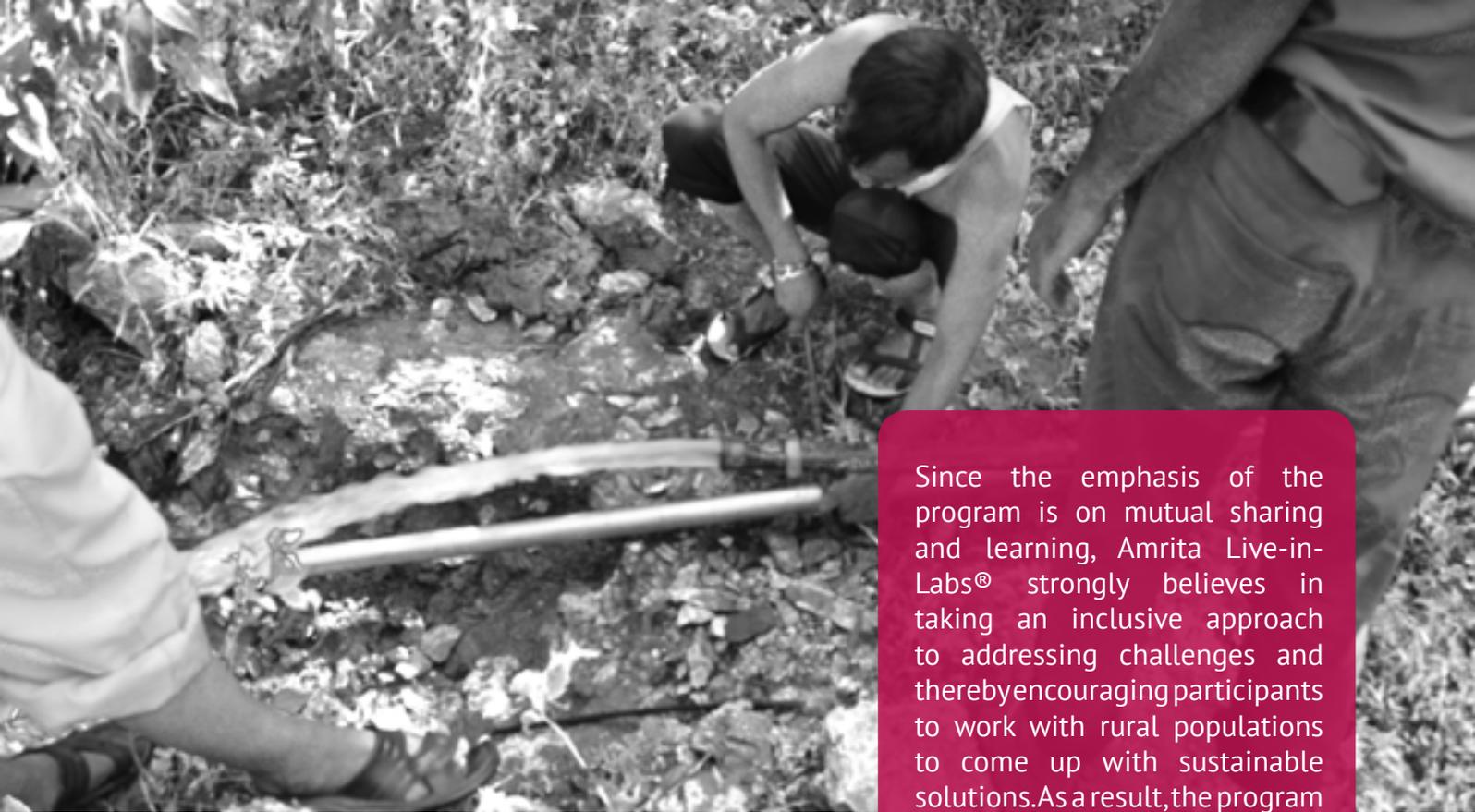
**Live-In-Labs<sup>®</sup>**

## Live-in-Labs<sup>®</sup>

Established in 2013, Amrita Live-in-Labs<sup>®</sup> is a multidisciplinary experiential learning program that exposes youth to problems faced by rural communities in India. Participants spend two weeks to six months in Indian villages to understand current challenges and subsequently, develop sustainable solutions.

The program brings together Amrita students and faculty - in conjunction with students and faculty from international universities - to put theory into practice, thereby generating innovative solutions and developing collaborative problem-solving skills.





Since the emphasis of the program is on mutual sharing and learning, Amrita Live-in-Labs® strongly believes in taking an inclusive approach to addressing challenges and thereby encouraging participants to work with rural populations to come up with sustainable solutions. As a result, the program is designed as a two-way model of sharing and learning and encourages participants to be open to “other ways of thinking”.

## OUR JOURNEY SO FAR

**58,953**  
Beneficiaries

**21**  
States

**63**  
Projects

**200,000+**  
Field Hours

**30+**  
Partner  
Universities



**AMRITA**  
JIVAMRITAM  
PE KUTIB D DEHAALAC. N. KEE. PUNJI  
INAUGURATED BY  
HONOURABLE PRESIDENT OF INDIA  
SRI RAM NATH KOVIND  
8<sup>TH</sup> OCTOBER 2017  
IN THE DIVINE PRESENCE OF  
SRI MATA AMRITANANDAMURTI

## **JIVAMRITAM**- RURAL DRINKING WATER FILTRATION SYSTEM



The Jivamritam project, Mata Amritanandamayi Math's ₹100 crore initiative to provide clean drinking water for rural India, was launched by Honourable President of India, Shri Ram Nath Kovind. The initial phase of the project aims to install Jivamritam filtration systems for clean drinking water in 5,000 villages throughout the nation. Each Jivamritam System can filter the daily drinking-water needs of up to 400 five-member families, potentially providing safe and clean drinking water to one crore villagers. The aim of the project is not only to provide a centralized and easily accessible source for clean drinking water, but also to

unify and galvanize members of a given community. Thus the core principle of the project is to initiate a movement by changing existing mindsets about water quality, usage, and storage; generating a sense of awareness about proper water treatment methods and waterborne illnesses; and empowering the rural poor towards better management and maintenance of water resources. In the process, the project has brought together government representatives, school teachers, women, children, the elderly, social activists, local community agents and leaders, NGO workers, and faculty, staff, and students from Amrita Vishwa Vidyapeetham.

## AMRITA WATER DISTRIBUTION SYSTEM

Water scarcity has been a major issue in rural India, warranting a high demand to design and implement different water distribution networks. Polluted wells, dried out hand pumps, lack of water source nearby cause the villagers to walk miles to fetch water for their daily needs. To this effect, Live-in-Labs® in collaboration with Amrita Wireless Networks and Application relentlessly worked on developing a micro water distribution system for almost 18 months. This system was designed, developed, tested and has been deployed in 7 different villages across India so far. The challenges faced during the deployment of this system differed diversely among the 7 villages. In addition, it was a participatory intervention which has proven to be both unique and effective for successful micro schemes with a minimum per capita cost of installation and maintenance.



## ■ E-CYCLE: AN OFF-GRID SOLUTION FOR RURAL ELECTRIFICATION

Amrita E-Cycle, provides rural electrification by utilizing available resources present in rural communities as an affordable alternative to current electrification schemes. The project transforms a common mode of transportation – a bicycle – into an innovative mechanism to provide free electricity to villagers who have intermittent or zero access to electricity. In 2017, we launched our first prototype, “E-Cycle: An Off-Grid Solution for Rural Electrification” for rural villagers to generate clean energy in a sustainable and low-cost approach. This idea was proposed by an 11th-grade student of Amrita Vidyalayam, who worked with our research team to build the system. This

innovative alternative energy source was designed and developed by integrating and harnessing the mechanical energy generated by the cycling and the available solar power captured during the cycling process and while at rest via fixed solar panels. This innovative solution has transformed the utility of a normal bicycle into a smart power generation unit for addressing the challenges of sustainable rural electrification. The captured and stored energy can now be used to power three bulbs and a mobile charger for up to 24 hours in each home. Over 60 people in the tribal village of Dheruba, located in the Koregaon district of Chhattisgarh, will benefit from utilizing the Amrita E-Cycles.





# LABORATORY FACILITIES

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## **LANDSLIDE**

AmritaWNA is equipped with India's first ever life size landslide laboratory setup, designed and developed at our University to provide better understanding of landslide phenomena. Laboratory is equipped with an indigenously designed and developed seepage simulator and a rainfall simulator to generate the required water infiltration, capable of conducting two modes of testing, one for static slopes in which seepage and rainfall flow is added, and the second for relatively static hydrology conditions. The system also has a variable tilt that can be used to simulate slopes.

## **SMART GRID**

In the Amrita Smart Grid lab, research is focused on developing and optimising a smart grid system specifically designed for the Indian power grid. Research areas include application of wireless technologies towards electrical system optimisation and congestion control, available transfer capability (ATC), power theft identification and electrical line fault detection and isolation.

## **WIRELESS HEALTHCARE**

Amrita Wireless Healthcare Lab focuses on enabling affordable and convenient healthcare with the help of wireless technologies, specifically for the rural population.

## **WIRELESS NETWORKS**

Focuses on research in heterogeneous wireless networks and technologies comprising Wi-Fi, Bluetooth, zigbee, 3G, 4G and LTE. Protocol optimisation and application development

## **EMBEDDED SYSTEMS**

To solve real world engineering problems, this lab facilitates creating prototypes of embedded system devices in order to create prototypes of devices including IoT and MEMS

## **ADVANCED COMPUTER NETWORKS**

Lab focuses on research in security and performance aspects of computer networking algorithms.

## AMRITA-KEYSIGHT ADVANCED WIRELESS COMMUNICATIONS

Provides frame work needed to conduct research in emerging areas such as Mu MIMO, Antenna System Design and Development, 5G, Testbeds, RF Microwave and Millimeter technologies. .

## REMOTE TRIGGERED

This is one of a kind Lab that provides a virtual environment for designing, and testing wireless sensor networks & protocols in both indoor and outdoor conditions and allows users to remotely trigger and study wireless sensor networks





# EVENTS AND AWARDS

## WORLD CENTRE OF EXCELLENCE ON LANDSLIDE DISASTER REDUCTION



AmritaWNA was conferred the title ‘World Centre of Excellence on Landslide Disaster Reduction’, by the International Program on Landslides (IPL) at the fourth World Landslide Forum in Ljubljna, Slovenia. The title will be held by the University till 2020. The institution successfully deployed the world’s first wireless sensor network system for detection and early warning of landslides in Munnar, Kerala. Though there are 20 centers around the world, there is no such center in India. At the request of the Indian Government, a similar technology was deployed at Sikkim, Northeast Himalayas. The center has also initiated a landslide research project with the British Geological Society and UK Met office called the ‘Landslip’. This project was initiated to develop regional thresholds for landslide warning from the real-time data of Amrita’s field deployment in the Himalayas and the Western Ghats.

## AMRITA JOINS UNESCO LANDSLIDES CONSORTIUM

Amrita Vishwa Vidyapeetham has become a partner of the International Consortium on Landslides (ICL). The International Consortium on Landslides (ICL), created at the Kyoto Symposium in January 2002, is an International non-governmental and non-profit scientific organization. The ICL established the International Programme on Landslides (IPL) as a programme of ICL by the 2006 Tokyo Action Plan. Dr. Maneesha V. Ramesh, Director of Amrita Center for Wireless Networks and Applications (AmritaWNA), presented an ICL proposal, “Enhancement of the Existing Real-time Landslide Monitoring and Early Warning Systems in Western Ghats & Himalayas, India.” at the ICL-UNESCO Symposium from November 15-18, 2016, at UNESCO Bonvin Building, Paris, France.



## UNITED NATIONS TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

The conference “Technology for Sustainable Development” held on July 8th, 2015 at United Nations, New York was jointly hosted by United Nations Academic Impact and Amrita University. The keynote address in the conference was delivered by Satguru Sri Mata Amritanandamayi Devi, the Chancellor of Amrita University. Amma urged the scientific community to approach their research with a balance of awareness and compassion, stressing the importance of keeping the upliftment of the poor and suffering in mind when they undertake technological research.



## THE UNITED NATIONS/INDIA WORKSHOP ON THE USE OF EARTH OBSERVATION DATA IN DISASTER MANAGEMENT AND RISK REDUCTION



Dr. Maneesha V. Ramesh attended the United Nations India Workshop on the ‘Use of Earth Observation Data in Disaster Management and Risk Reduction: Sharing the Asian Experience’, held in Hyderabad during 8th -10th March 2016. The United Nations Office jointly organized this workshop for Outer Space Affairs (UNOOSA) through its Programme on Space Applications and the UN-SPIDER platform and the Indian Space Research Organisation (ISRO), on behalf of the Government of India. This workshop was organized in order to share experience from Asia and other parts of the World in using Earth observation for disaster management. Eminent scientists in disaster management, policy makers,

and providers of space technology solutions/ tools/applications from governments, academia, research, NGO and corporate sector from across the globe attended this workshop

## **UNISDR SCIENCE AND TECHNOLOGY CONFERENCE**

The abstract titled as “Wireless Sensor Networks for Real Time Monitoring & Early Warning of Landslides: A Real World Deployment in Western Ghats & Himalayas in India” got accepted for the United Nations Office for Disaster Risk Reduction (UNISDR) conference titled as UNISDR Science and Technology Conference on Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030. The authors of the abstract are Dr. Maneesha V Ramesh, Dr. Nirmala Vasudevan, Mr. Sangeeth Kumar, Mr. Joshua Freeman and Dr. Venkat Rangan.



## **NABARD AWARD FOR RURAL INNOVATIONS**

Dr. Maneesha V Ramesh, Director of Amrita Center for Wireless Networks and Applications, Amrita Vishwa Vidyapeetham, received the NABARD Award from the then Finance Minister, Dr. P Chidambaram, for her outstanding commitment towards the development of Landslide detection device at the rural villages of Munnar, Idukki. The Union Government has also selected it as a model project and has asked the Center to deploy it in several landslide prone areas in the Himalayas and the North-East regions to save human lives.



## **CREATE UNAOC AWARD FOR AMRITA SANSKAR APP**

Sanskar, an interactive Android app, developed by Mr. Rahul Krishnan from the Amrita Center for Wireless Networks and Applications under the guidance of Dr. Maneesha V Ramesh was shortlisted among the top five finalist applications in the 2012 Create UNAOC Challenge, an international competition for app developers that sought to introduce new avenues for intercultural dialogue.

## **PARLIAMENT PRAISES AMRITAWNA'S REAL TIME LANSLIDE MONITORING AND DETECTION SYSTEM**

Honourable mention was made in the Indian parliament about Amrita WNA's system for Detection and Early warning of rainfall Induced Landslides deployed in Munnar, Kerala



## **AMRITA SPANDANAM LAUNCH BY HONOURABLE PRIME MINISTER OF INDIA, SRI NARENDRA MODI**



Amrita Spandanam prototype being unveiled on September 26, 2013, at Amritavarsham 60, The 60th Birthday Celebrations of Sri Mata Amritanandamayi Devi (Amma) by the present Honourable Prime Minister of India , Sri Narendra Modi

# FUNDING AGENCIES




**DeitY** – Department of Information Technology  
**DST** – Department of Science & Technology  
**NRDMS** – Natural Resource Data Management Systems  
**MHRD** – Ministry of Human Resource Development  
**MoES** – Ministry of Earth Science



# COLLABORATIONS

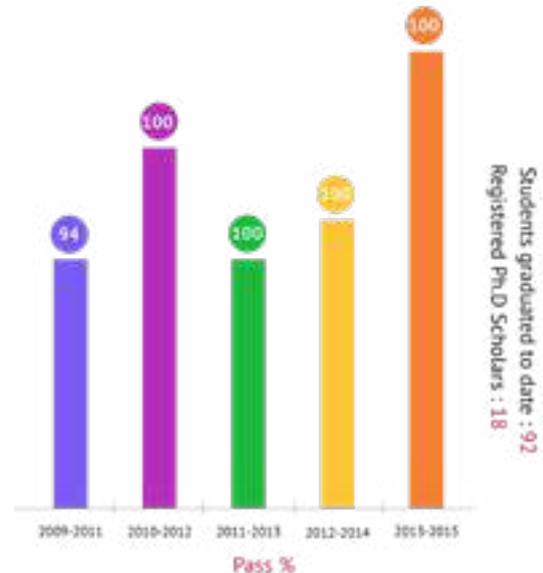


# NEWS AND EVENTS



# ACADEMICS @WNA

Launched from the success of the WINSOC project, AmritaWNA established Masters program to enable the academic study of Wireless Sensor Networks and their applications in a variety of fields. The program allows in-depth inquiry of topics such as Wireless Communications, Mobile Computing, Sensor Networks, Embedded Systems, Signal Processing, and Wireless Networks and Applications in areas such as Disaster Management, Energy Conservation, Healthcare Solutions, Distance Education, and Environmental Monitoring. In addition to



theory classes, students receive practical experience by working on current and on-going projects with senior faculty members. Students also have the opportunity to work on their own projects and are required to publish and present papers in various academic journals and conferences. The duration of the program is two years. Currently, the department is only accepting full-time students.



Post numerous discussions, rethinking, and sieving, Amrita outlasted to be the ultimate choice for pursuing my master degree in Technology. The expert guidance of professors located around the globe, kindled my curiosity to “learn and ask”. Industry-based teaching techniques and course works conspicuously helped me in cracking every interview I attended. I got many opportunities to awaken the inner empathetic person inside me through the “live-in-labs” program. Amrita outperforms the rest of the universities, in developing young minds and bring out individual talents through its efficient teaching methodology and outstanding infrastructures. - **Urmila M S** (Dell EMC)

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Amrita has world-class infrastructure and educational facilities. It's staff members are professional with amazing teaching skills. Students are trained comprehensively in the state of the art systems in wireless networks and applications. Exposure to the latest developments and participation in active research instil in us a high degree of confidence and a competitive edge in the highly dynamic field of communication technologies. Thanks to Amma's divine blessings and placement team's hard work I have been able to achieve success in my chosen course of study clearing all obstacles with relative ease. - **Aishwarya** (Oracle)

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I am glad to pursue my Masters in Wireless Networks and Application to enrich my skills and abilities. I am enjoying the journey of this learning process in our department. This has helped me in projecting myself better in the placement process. Being part of Amrita family in order to pursue my education is always a special, memorable experience. Thankful to my parents, teachers, and Lord almighty for supporting me in this endeavour. I always feel that our beloved Amma is holding my hand and guiding me in all phases of my life.



- **Guru Prasad** (Oracle)

I am very proud to be a part of Amrita WNA Family. Faculties not only taught us but also provided us with moral values. The world class facilities , efficient resources and ever supporting faculties have created a friendly environment in the campus. I am very well satisfied with my decision to choose Amrita Center for Wireless Networks and Applications for my postgraduate degree. We studied and worked as a family, handled case studies, and various projects. Exposure to solving real time problems related to society enhanced our thinking, logical and creative abilities. Amma's blessings gave us strength to face every situations and come out successfully **-Athira Vinod** (Nokia)



I made the right choice by joining Amrita WNA. Dept with world class infrastructure, internationally trained faculty, taught us based on existing industry standards and provided us an opportunity to work on real time projects along with PhD students. This experience has enhanced my technical skills, improved my thinking capabilities and enhanced my problem solving skills.

**-Harish Ravichandran** (Nokia)

I am very much thankful to the WNA department for the support they gave us. The project oriented and case study based teaching made me think deeper and taught me to face challenges. We got opportunities to work in real time projects run by WNA department. Internationally experienced faculties helped me to achieve required growth in my career. The team work enhanced my ability to share ideas and think differently which were a vital factor for my selection to an industry.

**-Anju Murali** (WABCO)



## ■ DUAL DEGREE & PhD PROGRAMS

AmritaWNA offers a Masters program (MTech) in Wireless Network & Applications with an option of dual master's degree from one of

- Vrije University, Netherlands,
- Universitat Politècnica de Catalunya, BarcelonaTechSpain,
- University of New Mexico, USA.

Doctoral programs are also offered in the areas of wireless communications, mobile computing, wireless sensor networks, embedded systems, signal processing, and applications research in disaster management, wireless healthcare, smart energy, environmental monitoring etc. Applications Research @AmritaWNA is

primarily focused on solving major societal and humanitarian issues and challenges, especially in developing countries such as India. Our close association with our parent organization, MA Math – a world renowned NGO and our sister medical organization (AIMS), helps us tremendously in achieving this goal.

## ■ ADJUNCT FACULTY



**Dr. Leland Hartwell**  
Nobel Laureate, Fred  
Hutchinson Cancer  
Research Centre, ASU



**Dr. Maarten Van Steen**  
Professor, University of  
Twente



**Dr. Prasant Mohapatra.**  
Professor of Computer  
Science, Dean & Vice-Provost  
of Graduation Studies  
University of California, Davis



**Dr. Sajal K. Das**  
Professor & Daniel St.  
Clair Endowed Chair,  
Computer Science,  
Missouri Univ of Science  
and Tech.

## PATENTS



- Network based System for Predicting Landslides and Providing early warnings US8692668
- System and method for Synthesizing and preserving consistent relative neighborhood position in multi-point Tele-Immersive environments.

Patent #1 US9826196

Patent #2 US9386271

Patent #3 US9852647

- Wearable Wireless Tongue Controlled Devices
- Mobile Infrastructure for Coastal Region Offshore Communication



**Dr. Dilip Krishnaswamy**  
Vice President, Reliance Jio  
Infocomm Ltd, India



**Dr. Eric Blanco**  
Deputy Director  
School of Industrial  
Engineering and  
Management  
Grenoble INP, France

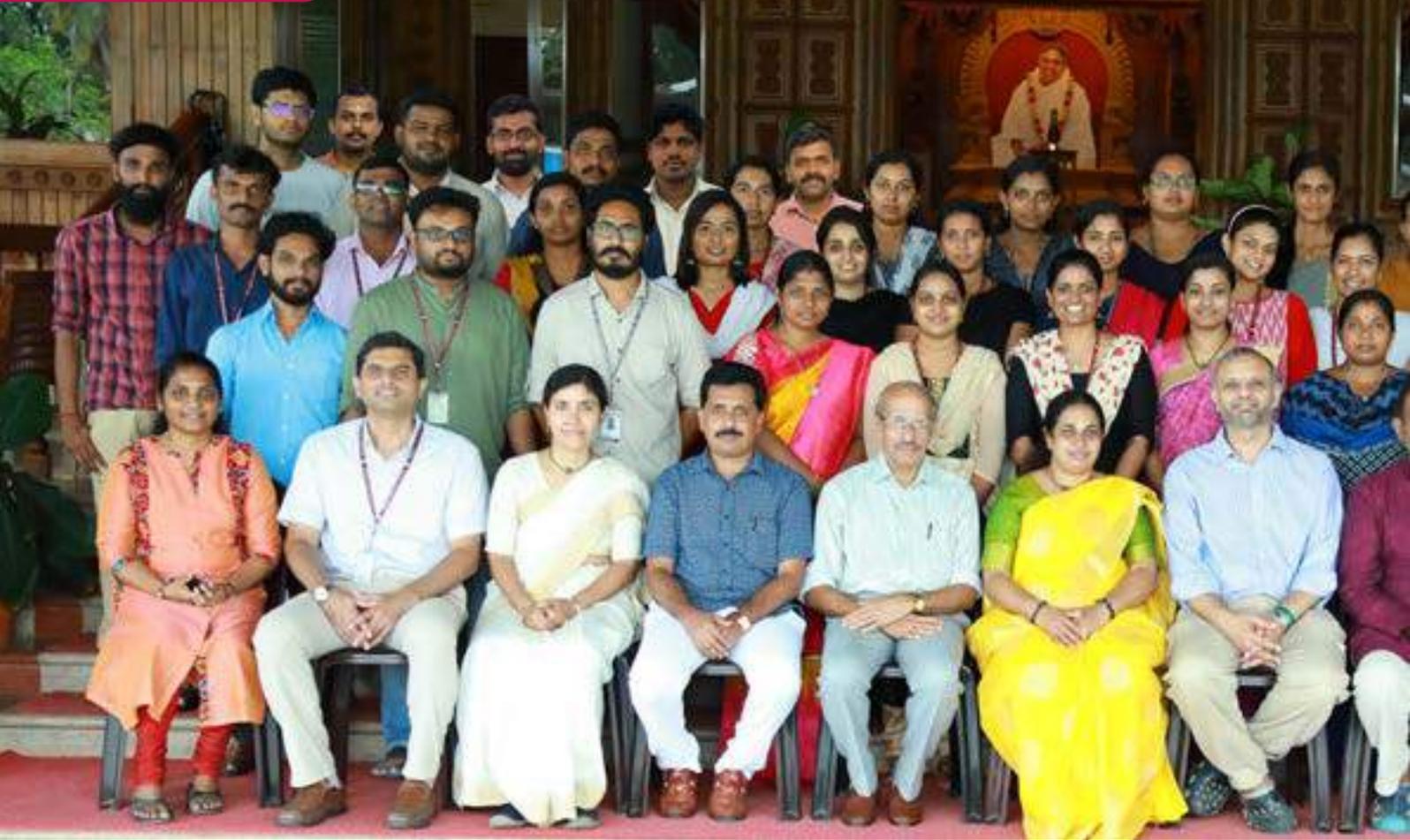


**Dr. Sesaiah  
Ponnekanthi**  
NEC-UK and consultant  
to DUNE-Italy



**Karthik Kannan**  
Engineer, Sr Staff/Mgr  
atQualcomm  
Texas A&M University

## OUR TEAM



AMRITA CENTER FOR WIRELESS NETWORKS & A

Amrita Center for Wireless Networks & Applications



**Dr. VENKAT RANGAN**  
Vice Chancellor  
Amrita University



**Dr. MANEESHA V. RAMESH**  
Director & Professor  
Amrita WNA



**MR. K. A. UNNIKRISHNA MENON**  
Professor  
Amrita WNA



**MR. BALAJI HARIHARAN**  
Associate Professor  
Amrita WNA



**Prof. SETHU RAMAN RAO**  
Associate Professor  
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**Dr. NIRMALA VASUDEVAN**  
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APPLICATIONS



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