Date of Submission	July-01-2016

IPL Project Proposal Form 2016

(MAXIMUM: 3 PAGES IN LENGTH)

1. **Project Title:** Enhancement of the existing Real-time Landslide Monitoring and Early warning System in Western Ghats & Himalayas, India.
2. **Main Project Fields**

Select the suitable topics. If no suitable one, you may add new field.

(1) Technology Development

✓ A Monitoring and Early Warning, B. Hazard Mapping, Vulnerability and Risk Assessment

(2) Targeted Landslides: Mechanisms and Impacts

A. Catastrophic Landslides, B. Landslides Threatening Heritage Sites

(3) Capacity Building

A. Enhancing Human and Institutional Capacities

B. Collating and Disseminating Information/ Knowledge

(4) Mitigation, Preparedness and Recovery

A. Preparedness, B. Mitigation, C. Recovery

3. **Name of Project leader:** Dr. Maneesha V Ramesh

Affiliation: Director, Amrita Center for Wireless Networks & Applications,

Contact: Amrita Vishwa Vidyapeetham, Amritapuri, Kollam, Kerala, PIN- 690525

Core members of the Project

Names/Affiliations: (4 individuals maximum)

1. Dr. Venkat Rangan, Vice chancellor, Amrita University, Coimbatore, Tamilnadu,
2. Dr. Nirmala Vasudevan, Associate Professor, Amrita University, Amritapuri, Kerala.
3. Mr. Sangeeth Kumar, Research Associate, AmritaWNA, Amrita University, Kerala
4. Ms. Hemalatha T, Research Associate, AmritaWNA, Amrita University, Kerala.

4. **Objectives: (5 lines maximum; what you expect to accomplish?)**

The objective is to enhance the existing large scale real-time landslide monitoring and early-warning system for landslide prone regions of Himalayas and Western Ghats using wireless sensor networks, Geotechnical devices, and satellite information. The above objective is achieved by increasing in-situ & remote measurements, developing thresholds for real-time data analysis, developing thresholds from landslide simulation setup, developing an enhanced slope stability model for landslide detection; developing automatic context aware data dissemination software for issuing alarms in real-time.

5. **Background Justification: (10 lines maximum)**

The southern Himalayan arc and The Western Ghats in India are the global landslide hotspots, which accounts for large number of landslide deaths every year [4]. The Himalayan Mountains are young fold

mountains and are tectonically active up to date. In order to save loss of numerous life and property damage happening in these region, scientific knowledge has to be applied to early-warn for landslide risks. Amrita University has proved its excellence in the field of Monitoring & Early warning for landslides. Amrita University was one of the partner in European Commission funded WINSOC project. This project consists of a consortium of 11 partners from Europe and India. Other than AMRITA, the only other Indian partner was ANTRIX (a commercial arm of Indian Space Research Organization) and it includes nine other Government, Industry, Research Organizations, and Academic organizations from Europe. Amrita University was given the leadership to carry out the preliminary design and working pilot prototype for a landslide detection system using wireless sensor networks in Western Ghats, India. Amrita University has successfully issued three early warnings for Landslides so far in Munnar region of Western Ghats, and the landslides happened in the near vicinity of the deployment site in 2013 validated our Early Warning System. Recently, Government of India appreciated our work and funded us to extend this research in Sikkim Himalayas, the pilot deployment for the same was completed successfully in January 2016. Currently, research is also being carried out in the grounds of making a low cost early warning solution.

6. **Study Area: (2 lines maximum; where will the project be conducted/applied?)**
   In a selected landslide prone zone of The Himalayan Mountains & The Western Ghats.
7. **Project Duration:** 3 years
8. **Resources necessary for the Project and their mobilization:** Facilities, and Budgets
9. **Project Description: (30 lines maximum)**

In this proposal, we propose to enhance and deploy an integrated real-time landslide monitoring and early warning system using Wireless Sensor Networks, Electrical Resistivity Tomography, & Satellite data. This system will be deployed in the landslide prone areas of The Western Ghats or in The Himalayas. This landslide monitoring and early warning system will consist of designing and developing an Intelligent Wireless Probes (IWP) containing sensors such as moisture sensors, pore pressure sensors, geophones, tilt meters, inclinometers, strain gauges, and a low cost GPS system integrated with intelligent algorithms, which adaptively senses the environment. The data from these systems will be transmitted using heterogeneous wireless networks to the data analysis center. This research will deploy the Intelligent Wireless Probes (IWP) in the selected landslide prone zone and establish a secure heterogeneous wireless network. We propose this research as an enhancement to the existing Landslide monitoring and Early warning system deployed in Munnar, Western Ghats and Sikkim, Himalayas. The key features required for the existing landslide detection system are the development of a low cost and low power consuming IWP's, and the development of a five day future landslide forecasting model taking into account the five days future weather forecast from Indian Meteorological department. Data visualization will be developed as part of this project, in which the real time data from the field and the archived data can be seen. Results from data analysis algorithms such as Rainfall Intensity, Rainfall thresholds, Thresholds of different sensors etc, will also be made available in the visualization software. Dynamic thresholds will be developed from the real-time data and from the landslide laboratory. An enhanced slope stability model will be developed to assess the risks. An Early warning system will also be developed, by understanding the site geological

conditions, field capacity, hydrological conditions, monsoon rains and past landslide history. The Early warning system will be used in giving alerts to the government and public if any potential landslides are foreseen from the data analysis.

10. Work Plan/Expected Results: (20 lines maximum; work phases and milestones)

Stages	WORK PLAN	Work Phases and Milestones
1	Design of Sensors, Intelligent Wireless Probes (IWP), establishing wireless link, developing and deploying the suitable wireless network architecture, and simple visualization software.	• Selection of site and understanding the site geology • Pilot deployment of the IWP and establishing a wireless link and Design of sensors and IWP • transmitting to the data analysis center • Creating a simple visualization software to visualize the data • Using the pilot deployment experience, deciding on appropriate wireless network and enhancing the wireless link • Deciding on the optimum transmission frequency Establishing the wireless network architecture in the field
2	Deploying multiple IWP	• Designing intelligent and adaptive algorithms for 1.Remote triggering, 2.Security 3.Optimizing bandwidth performance, 4. Minimum power consumption and implementing the same in IWP's
3	Developing Complete Decision Support System & Early warning systems	• Dynamic thresholds from Real-time data and from laboratory simulations. Enhancing the existing slope stability models and Factor of safety calculations • Developing Early-warning system. Automated risk assessment and alert messages to concerned authorities

11. Deliverables/Time Frame: (10 lines maximum; what and when will you produce?)

Stages	Deliverables	Time frame
1	Design of Sensors & Intelligent Wireless Probes (IWP) with a wireless link established and a simple visualization software.	12 months
2	Deploying multiple IWP	12 months
3	Developing Complete Decision Support System & Early warning systems	12 months

12. Project Beneficiaries: (5 lines maximum; who directly benefits from the work?)

Direct beneficiaries from this project are 1. Public people and their properties. 2. Disaster management board of that area, 3. Government economy

13. References (Optional): (6 lines maximum; i.e. relevant publications)

[1] Ramesh, Maneesha Vinodini. "Design, development,and deployment of a wireless sensor network for detection of landslides." *Ad Hoc Networks* 13 (2014): 218.

[2] Ramesh, Maneesha V. "Real-time wireless sensor network for landslide detection." *Sensor Technologies and Applications, 2009. SENSORCOMM'09. ThirdInternational Conference on*. IEEE, 2009.

[3] Ramesh, Maneesha V., and Nirmala Vasudevan. "The deployment of deep-earth sensor probes for landslide detection." *Landslides* 9.4 (2012): 457-474.

[4] Petley, David. "Global patterns of loss of life from landslides." Geology 40.10 (2012): 927-930.

Note: Please fill and submit this form by 1 July 2016 to ICL secretariat <secretariat@iclhq.org> and ICL network <ICL-network@iclhq.org>