| Date of Submission | 15- September-2020 |
|---|---|

# IPL Project Proposal Form 2020

(MAXIMUM: 3 PAGES IN LENGTH)

1. **Project Title:** Advancing Landslide Early Warning Systems using Machine Learning & Artificial Intelligence Techniques

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,

3. **Name of Project leader**

Dr. Maneesha Vinodini Ramesh

**Affiliation:** Professor & 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) Ms. Hemalatha T, Research Associate, Amrita Center for Wireless Networks and Applications, Amrita Vishwa Vidyapeetham, Kerala.

(2) Ms. Divya. P, Research Associate, Amrita Center for Wireless Networks and Applications, Amrita Vishwa Vidyapeetham, Kerala.

(3) Ms. Indukala P K, Research Associate, Amrita Center for Wireless Networks and Applications, Amrita Vishwa Vidyapeetham, Kerala.

(4) Mr. Nitin Kumar M, Research Associate, Amrita Center for Wireless Networks and Applications, Amrita Vishwa Vidyapeetham, Kerala.

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

This project aims to advance existing landslide early warning systems in India. Existing IoT based systems and wireless sensor network systems will be enhanced with multilevel data analysis and machine learning approaches. This will provide the opportunity to develop near real-time site specific and regional thresholds for early warning of the imminent landslides. Artificial intelligence based multi scale decision models will be developed to enhance the multi level, multi scale early warning models for landslide detection. Landslide disaster risk reduction will be incorporated through participatory engagement with the community leading to community level enhanced landslide resilience.

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. In order to save loss of numerous life and property damage happening in these regions, Amrita has deployed its Internet of Things (IoT) system for landslide monitoring and early warning. The IoT system comprises meteorological, geophysical and geotechnical sensors such as weather station, geophones, moisture sensor, piezometer, tiltmeter, strain gauge etc., The system has so far given early warnings in 2009, 2011, 2013, 2018, 2019 and 2020 to the Munnar community through the Government. Recently, a regional level landslide warning was issued on August-6-2020 in Munnar, Western Ghats and on August-7-2020, a devastating landslide happened in Pettimudi, Rajamalai which is 20 km away from our deployment site in Munnar. Landslides that had occurred after the warnings in Munnar surroundings, validates the reliability of early warnings from our IoT system. Apart from this, our center is a leading partner in international collaborative projects such as WINSOC(2016), LANDSLIP. IoT system is also recognized as on the best‘Make in India’ innovations by the Indian government.

6. **Study Area:** Western Ghtas and North-Eastern Himalayas, India

7. **Project Duration:** 3 Years

8. Resources necessary for the Project and their mobilization
   Personnel, Facilities, and Budgets

9. **Project Description:** (30 lines maximum)

This project aims to advance the existing IoT system for landslide early warning systems deployed in India. Current research focuses mainly on rainfall threshold models and statistical analysis approaches to extract actionable information from heterogeneous data in real-time. These information are utilized for providing early warnings to the community.

In this project, we further aim to develop (i) Intelligent algorithms that can be implemented in EDGE, FOG and CLOUD layers of the IoT system. This will help in the efficient usage of the available resources such as power, memory, and bandwidth to extend the lifetime of the system and improve network performance. (ii) Machine learning-based nowcasting and forecasting methodologies that can forecast the slope stability conditions ahead of time. These algorithms will help in understanding the real-time conditions of the slope ahead of time, which can be utilized by the decision-makers to be prepared for disasters. (iii) Multi-level warning system based on the multiple monitoring parameters, these multi-level warnings will improve the efficacy and reduce false positives since the decision made is based on multiple parameters such as rainfall, moisture, pore pressure, and movement of soil layers.

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

| Stages | WORK PLAN | Work Phases and Milestones |
|---|---|---|
| 1 | Developing intelligent algorithms in EDGE, FOG, and CLOUD | ● Algorithms for context analysis and context actuation in EDGE and FOG nodes<br>● Power-aware algorithms in EDGE and FOG<br>● Context-based adaptive sampling algorithm in FOG and CLOUD<br>● Fault diagnostic system in CLOUD |
| 2 | Nowcasting and Forecasting algorithms | ● Implementing various machine learning algorithms for forecasting the slope stability conditions<br>● Comparing the performance of the algorithm using historic data and landslide incidences.<br>● Choosing the best methodology for nowcasting and forecasting |
| 3 | Multi-level warning system | ● Developing thresholds for heterogeneous sensors<br>● Designing a multi-level warning system from the multiple thresholds<br>● Validating the multi-level warning system using the historic data and landslide incidences |

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

| Stages | Deliverables | Time frame |
|---|---|---|
| 1 | Intelligent algorithms in EDGE, FOG, and CLOUD | 12 months (1st year) |
| 2 | Nowcasting and Forecasting algorithms | 12 months (2nd year) |

| | | |
|---|---|---|
| 3 | Multi-level warning system | 12 months (3rd year) |

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. National Disaster Management Authority (NDMA), India, 3. State Disaster management Authority, 4. Indian Meteorological Division, 5. Geological Survey of India, 6. District Administration

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


Wadhawan, Sudesh Kumar, Balmukund Singh, and Maneesha Vinodini Ramesh. "Causative factors of landslides 2019: case study in Malappuram and Wayanad districts of Kerala, India." *Landslides* (2020): 1-9.
Thirugnanam, Hemalatha, Maneesha Vinodini Ramesh, and Venkat P. Rangan. "Enhancing the reliability of landslide early warning systems by machine learning." *Landslides* (2020): 1-16.

Hemalatha, T., Ramesh, M. V., & Rangan, V. P. (2019). Effective and accelerated forewarning of landslides using wireless sensor networks and machine learning. *IEEE Sensors Journal*, *19*(21), 9964-9975.

Harilal, Geethu Thottungal, et al. "Towards establishing rainfall thresholds for a real-time landslide early warning system in Sikkim, India." *Landslides* 16.12 (2019): 2395-2408.


Note: Please fill and submit this form by 15 September 2020 to ICL Network <icl-network@iclhq.org> and ICL secretariat <secretariat@iclhq.org>