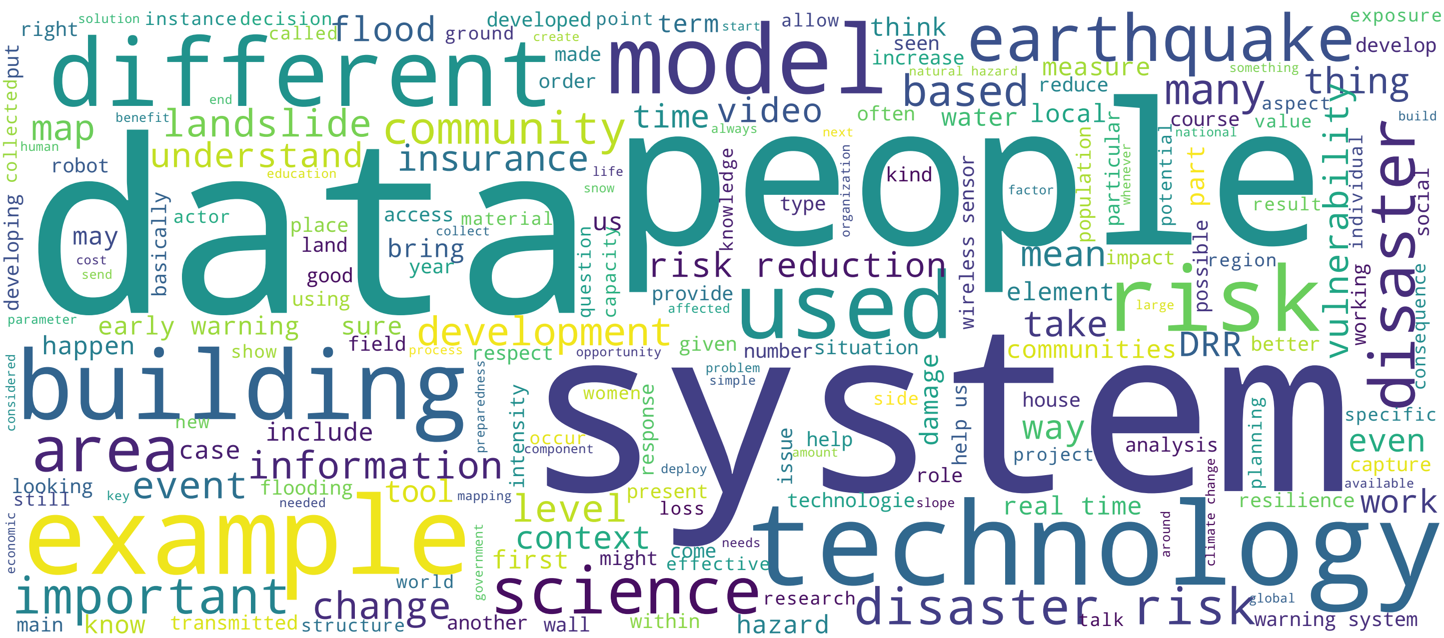
Landslide Monitoring Sensors

A Resilient Future: Science and Technology for Disaster Risk Reduction

Interview with Professor Maneesha Ramesh, Amrita University (India)



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Video

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Hi, Professor Maneesha Ramesh, currently the director for the Amrita Center for Wireless Networks and Applications (AmritaWNA), also holds a position of Dean in the National Program of Amrita University. In this video, she will present an affordable system for landslide monitoring and early warning, using wireless sensor network in India. The system was developed in the context of the European research project [Winsock] initiated in 2006. The pilots were conducted in 2008 and 2009. This whole work was given to us to look into how wireless sensor network can be used for disaster monitoring. And the deliverables were mainly focused on looking into the lab setups and developments. So, our Chancellor has given us an opportunity where she has, she's a world renowned humanitarian Amma. She has asked us that this is the opportunity for us to save lives and serve humanity and asked us to go and deploy a system in the field. That's how we were able to deploy the system in the landslide prone areas and then work in the real time, real world system. Currently, the system is working from 2009 onwards. It was able to issue two times the warnings, 2009, 2011 and even the latest is 2013.

Notes

Summary

0m 04s

And the system has a multi-level warning system where it is able to look into how it is progressing the slope instability and based on that it is able to give the warning to either the researchers or the government organizations or the community based on the intensity of the risk. And the whole system consists of 150 geophysical sensors which includes seven types of sensors like raingauge, moisture sensor, low pressure sensor, tilt sensors, it has inclinometers, it has rain gauges, geophones, etc. And these sensors have been identified in such a manner that we're able to capture the real time change in the slope stability. These sensors help us to capture those changes and with this data are continuously collecting and using wireless sensor network, sensor node which is above ground, whereas other sensors are deployed beneath the earth. There are sensors which have been deployed almost 30 meters down, and you have multiple sensors at multiple layers with different parameters has been considered in designing the whole deep earth probe which consists of the sensors. These data are collected and transmitted to our field management center in Munnar and from there it is transmitted to the control center at Amrita University.

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There, the data is continuously checked and evaluated using complex algorithms which will help us to understand the risk levels of the imminent landslide and based on that, automatic warnings are issued with the respect to the risk levels which have been seen. Now the major challenge in developing such a system was that it needs interdisciplinary knowledge. Without interdisciplinary knowledge, we cannot bring an affordable solution which is capable of working in real time. So we need to work together with geologists, computer science, mechanical engineers to bring out the solution. And while we were working, we had to integrate the different theories together, knit them together, to bring out a result. And based on that, one of the major things which we were facing was how do we make sure the system is functional for a long time because this is going to be a real time monitoring in a hostile region. You cannot go there and continuously monitor and power the system. So we were in a big challenge of making sure in sustaining the energy for the system.

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This prompted us to develop very unique algorithms, which were able to capture the context and based on that it was able to schedule the different sensors to act and collect the data at different rates based on the changing context, and make sure that even though they change the amount of data they have collected, it will make sure the reliability of that data has not compromised and we're able to give reliable warnings. And once the warning is there, the major thing there is, it was able to communicate to the society directly without any external, manual process. It directly, automatically initiate the different levels of warning. And while building the system, one of the major things which we have taken up was providing awareness to the community about the system. So before even we started the projects, first we had large scale of workshops which is conducted for the police and armed forces, for the administration the district administration and for the community, the Panchayat levels. Where we have told them what is the system, why are we doing, how is it going to benefit them, and we made them to participate and involve in the development of the system.

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So there were a lot of villages who have taken part in developing while we were developing the system so they will help us in maybe cutting the wood or cutting the different materials we just needed but by being part of it, they felt it as their own system. One of the major change which we have seen in the community was that the moment the rain comes, they start waiting for our decision because before the system was there, what used to happen was the whole set of population used to actually evacuate themselves during the monsoon season. That is almost three months they don't have job, their kids do not have any education and psychologically and emotionally is it affecting their life. And they used to go to different places, stay there, and when the monsoon finishes they come back because they were afraid of the landslides which can happen in the night, which can take their life. Because that's what happened in the previous years in 2005 and earlier, a lot of people have died because of that. And after we had put in the system, they believe in the system and even today they stay in same place without doing the evacuation. They wait for our warning to come in to take any decision.

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5m 26s

So they believe in the system and they have told us that it is such a big relief for them. Psychologically, emotionally and economically it has helped them to actually prosper in that place. So, whenever we develop a system, design, develop and deploy a system which has to be used in real time, one of the major considerations we have to look into is the robustness of the system, the reliability of the system, the scalability of the system and how do you ensure that these things are achievable. So while developing this system we have always looked into it having redundant answers, redundant notes which can cater to the continuous data collection. But we have brought in the redundancy not only in sensor type, we have even brought in redundancy with respect to the number of data you are going to sample and receive it with respect to when you have the different failures, the expected failures, like node failure, link failure and propagational effects can cause loss of connectivity. So we have come up with protocols which will adaptively understand how the climate is changing and based on that which is going to be my best neighbor which will be able to capture my data and send it with the minimum latency.

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6m 39s

So always latency was another major concern which we had to look into it because you want issue a real time warning. So even though you may have thirty nodes, you have to found out the best route which will take through all the data with minimum end to end and link delay, with maximum reliability in the data. And as you know that, these data had to be sent during the worst climate scenarios because the landslides happen when there is heavy rainfall. That's when you have the maximum problem, and you will experience the maximum propogational effects for a wireless communication. So we had used unique algorithms or novel algorithms which were capable to understand the scenario ahead of time so that they were able to constrain and or they were able to reduce the package loss which may affect during such harsh environment and send the data through that. And also, since these are like low powered wireless sensor nodes has been used for collecting data, their transmission range is very less and they get very easily affected by the propagation effects. So if you put it for a large scale area this is going to create problems.

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8m 01s

So what we had come up with we came up with a heterogeneous network architecture where we have used zigbee Wi-Fi, satellite network and the cellular network to make sure the data is transmitted at different levels. So, we had a probe network which consists of all this intelligent wireless probe integrated with deeper probes consisting of all the sensors which collects the data and the probe gateway will transmit all the data through the Wi-Fi network to the field management center, and from the field management center, the data is transmitted to our university, the control center through satellite network and if there is a fault coming up, automatically from the satellite, it will actually change to cellular network so that will be very able to make sure that transmission is taken care of. The other thing which we were also looking into was when you have these multiple networks, you have to make sure how the traffic is managed. So now each of the networks, the capabilities are different. So based on that, automatically this traffic is catered to and we were giving priority of the data which is necessary with the respect to the change in the context.

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9m 22s

That was another thing which we were building into the whole system. The third thing was, whenever you have a data, you have a problem of losing the data. So, there was multi-level of storage system which was making sure that even if we lose a link a one point, whenever the link comes back we're able to retrieve the data which has been collected and whenever a link fails, it will automatically give the information to the researcher, there is a problem happening. So the maintenance can be very quick. And since it now has been running for nearly now a decade, we have learned, there was a lot of things which we have learned in the whole process and this helped us also looking into how can we remotely configure the network, how can we remotely trigger the network. So we are able to actually control each and every sensor in the field when it has to sample, how much it has to sample, what it is. And also, the complete software system has been developed at Amrita and we made in such a manner that we're able to remotely trigger the software that means, the very time that you see that there is a change which is needed in a piece of software, we're able to send the code from our University, which is 300 kilometers away, and then install it in each and every wireless sensor node which is there.

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10m 33s

Rather than waiting for a risk to happen and then do the management aspect this is one of the system which has shown it's capability to look into the changes in the earth's system, understand the changes and based on that changes they're able to warn the people, leading to reduction of risk in disasters. And this technology has the capability to be used in other disaster areas, like flood monitoring, avalanche, drought etc. So we are extending this work into other areas of deployment so that multi-disaster probabilities can be looked into it and warning can be issued to reduce the disaster risk.

Notes

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11m 51s

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