Landslide Victories

Dr Bheemaiah, Anil Kumar, B.C Seattle W.A 98125
miyawaki@yopmail.com

Abstract:
Tensor decompositions are defined for deep learning networks and active filter designs for the class of problems of event detection and wake word detection filters, for wildlife and demographic vocalization and footstep census and for landslide detection. The problems are proven Z complete from previous work, in published literature. An estimate on the minimal number of samples required to predict demographic and wildlife census and reasonably predict landslides within given confidence intervals is presented using clustered, stratified sampling.
The Shaktiman(™) is introduced as a USB form factor IP 68 system for integration into computing for IoT applications using SoC RF solutions similar to BOMU and TOMU using the Shakti Risc V processor developed at IIT Madras. The Thunderboard Sense 2 module is directly integrated to 3D printed mathematical art to create solar lanterns for hymnology and early bird warning systems, for data logging, bioluminosity, early bird warning systems for natural disasters like landslides and other weather disturbances, using integrated temperature, humidity and hall sensors.
Cloud integration with Google Firebase is used for a FaaS framework to the use of tensor decomposition in defining the architecture of deep learning and procedural A.I for event detection from multi sensor fusion.
A commercial product already available through Shapeways.com, designed by the author is to be enhanced to add event detection and wake word detection functions for PID systems and natural disaster monitoring and prediction infrastructure to add to the existing pioneering efforts by IIT Mandi.

Keywords: Disaster Prediction, Landslide, Footstep detection, Air Pollution Monitoring, Solar Garden Lamps, Hymnology, Early Bird Warning Systems, Indigenous Whistle Languages

What:
Versatility of the Silicon Labs ThunderBoard Sense 2 as an IOT platform with integrations to a 3 DOF accelerometer and 3 DOF gyroscope, and Bluetooth transreceivers in the 2.4 GHz band has proven universal applicability in integrations, with easy deployment in hilly areas with little or no development. The additional use of mini bluetooth speaker units powered by solar electronics, allows for the use of low power early bird warning transmissions as a proto-musical whistle language to alert citizens of impending natural disasters including landslides and landslide related phenomenon, including earthquakes. In this paper a simple language with a small vocabulary, alerting the public to the location and the occurrence or risk of occurrence of a landslide is described.

How:
Silicon Labs ThunderBoard BG22 is integrated with a 3DOF accelerometer and a 3 DOF gyroscope on the SPI bus and a Bluetooth ceramic antenna integrated to the M33 ARM processor, with bluetooth integrations. This is housed with a solar cell and a DC2DC unit for power management , integrating Silicon Labs ThunderBoard BG22's power bus with a USB socket.

Why:
Arboreal worship, lends itself to a new product at the KalkiChapel, a solar garden light with integrated sensor fusion, landscape detection and bluetooth transreceivers and ready off the shelf mini bluetooth speakers, to be used as repeaters of early bird warning system calls, and towards worship in hymnology from mobile devices.

Summary:

Main Points:
1. Use of the temperature, humidity, 6 DOF accelerometer and light sensor for data collection and implementation of an early bird warning system.
2. Description of a proto-musical language for location specific early bird warning signals, based on semiotic theories of proto musical languages.
3. Use of a solar powered bluetooth speaker as a repeater unit and in hymnology.

Applications:
1. Natural disaster detection, Early bird warning systems.
2. Solar Lamps, for arboreal worship to local deities.
3. Bluetooth speakers for hymnology in worship.

Introduction.

Landslide detection and early bird warning systems by IoT technologies and remote sensing are proven technologies, successfully detecting and warning residents of both an imminent landslide event as well as events that have occurred.
The successful use of IoT devices in the Indian Himalayas, by scientists of IIT Mandi has created a market for disaster detection and response hardware. While several avalanche and landslide detectors are available for off the shelf use, recent progress in 5G networks, satellite communication in IoT and lower power requirements, has led to cost effective solutions for IoT based solutions.

Tensor based representations lead to optimization of network architectures. While tensors can represent a range of computing solutions, from deep learning supervised learning to unsupervised learning, tensor formulations have been developed for active filters, deep learning networks and wave data mining solutions, applicable to IoT solutions.
In previous work, the author proves the event calculus used in these research problems to be z-complete and hence tensor decompositions are proven to exist for the classifiers and active filters needed.(dr B. A. Kumar, 2020)

Problem Definition.

Need for an integrated cost effective solution to PID systems and disaster prediction systems, integrated into commercial consumer products. Multi sensor fusion of hall sensors, temperature, humidity, far field microphones, ambient light sensors, VOC sensors, and pressure sensors, are integrated with cloud functions for data logging and data mining to detect events in event programming and early bird warning systems.
In this publication, Google Tensor Flow is used for a FaaS based approach to R-CNN based event detection and the use of DSP based algorithms inspired by Amazon Alexa Echo technology for wake word detection, as described in a companion publication.(Bheemaiah, 2020)
The paper presents two research problems in event calculus, and reactive programming in the context of IoT, calling for urgent funding in the fields of CAS systems with a backend for Tensor Decomposition Representations, and in the exploration of the fields of R-CNN and active filters for IoT based event detection in the context of Lie Computability.

Problem 1:
If [T] is defined as a tensor decomposition , serving in a Event Calculus definition of an Event Wd, as a wake word detection trigger, in events [footstep, vocalizations]
We describe tensor architectures for footstep identification, census of human and faunal traffic and for vocalization detection.
Problem 2.
A similar tensor decomposition [T] is defined for Landslide event risk assessment and detection. A classifier with risk levels [low, medium, high] is developed and a similar network for landslide detection from camera based streams and accelerometer data.
Problem 3:
Creation of a database of human whistle language based warning calls and bird, primate and critter warning calls.

Background.

Tensor representations of neural networks, (*Website*, n.d.-a) are described in published literature, as a means to represent with tensor decompositions , the architecture of neural networks, with simplification of the tensor decomposition to create computationally less intensive , equivalent networks.

Included below is a summary of the algorithms and machine learning in research in published literature, on landslide detection and earlybird warning systems, by the indian institute of technology mandi.

Landslide Detection algorithms:

I = 1.82* D^ (-0.23)----------- (1)
P3 = -0.73*P15+29.3----------------(2)
Here I is the hourly rainfall measured in mm/hr on each node, and D the duration of rainfall. P3 and P15 are rainfall in mm, 3 days and 15 days prior to a landslide event.(Chaturvedi, Dutt, et al., 2014)

Statistical Z Score and Multi Valued Regression for sensor data:
Altitude of about 1450 m near Tangni village with specific geographic location as Latitude 30° 27' 54.3" N and Longitude 79° 27' 26.3" E.
Multi valued regression, using the Java Weka tool, was used , using
Yi = Ci + Ci − 1 ∗ Xp1 + Ci − 2 ∗ Xp2 + Ci − 3 ∗ Xp3 + ⋯.... + C1 ∗ Xpi − 1 (3) Where, Yi represents the sensor displacement, Xpi represents the cumulative rainfalls of pi previous days and Ci represents the multi linear equation coefficients, i = 1, 2, 3, … n.
Z scores were evaluated,
Zi = (xi − μ)⁄s (4) Where s - standard deviation, μ - mean of the data, xi - actual data point (displacement in consecutive days) (Chaturvedi et al., 2017)
IPI sensor network.
Deformation (mm/m) = b0+b1*V+b2*V*V+b3*V*V*V-- (1) Where b0 to b3 are unitless calibration factors.
Vibrating wire Piezometer data , the frequency is converted to pascals using a calibration sheet.(Chaturvedi, Jaiswal, et al., 2014)

Auto Regression through ANN and SVM ML for sensor 1D data.
Time data about ground movements from five sensors placed on Tang's Landslide Hill was collected daily during the 78-week period from July 2012 to July 2014. Various model parameters were calibrated in the training data (first 62-weeks). Made to predict test data (last 16 weeks). The results showed that the moving-average models (Sarima and AR) performed better than the support-vector models (SMOs) during both training and testing.(P. Kumar et al., 2020)

ML algorithms and oversampling:
Assessment has been made using various algorithms
Technologies such as field under ROC curve (AUC) and
Sensitivity index (D'). The results indicate a random one
The appearance of the algorithm is better than other classifications
Technologies like neural network, logistic regression, support vector
Machines, and decision trees. Moreover, between class-imbalances
Methods, with synthetic minority oversampling technique
Repeated partitioning filters (SMOTE-IPF) performed better than
Other techniques. We publish the effects of our results
Methods of predicting landslides in the real world.(Agrawal et al., 2017)

Pi camera based IoT monitoring system:
The centroid with foreground and background imaging is monitored for movement with a Pi based camera IoT hardware, demonstrated with examples like sluice gate video feeds.(Aggarwal et al., 2018)

International Published Literature.

([No Title], n.d.) describe the use of redundant submerged 6 DOF accelerometer and gyroscope usints, integrated to arduino based hardware for landslide event detection.(Duc-Tan et al., 2015)(Real Time Monitoring & Alert System for Landslide, n.d.)(Website, n.d.-b) describe the use of submerged accelerometers, with the use of single MCU based computers for landslide vent detection, by a search for a procedural criterion for landslide events.

<original-contribution>

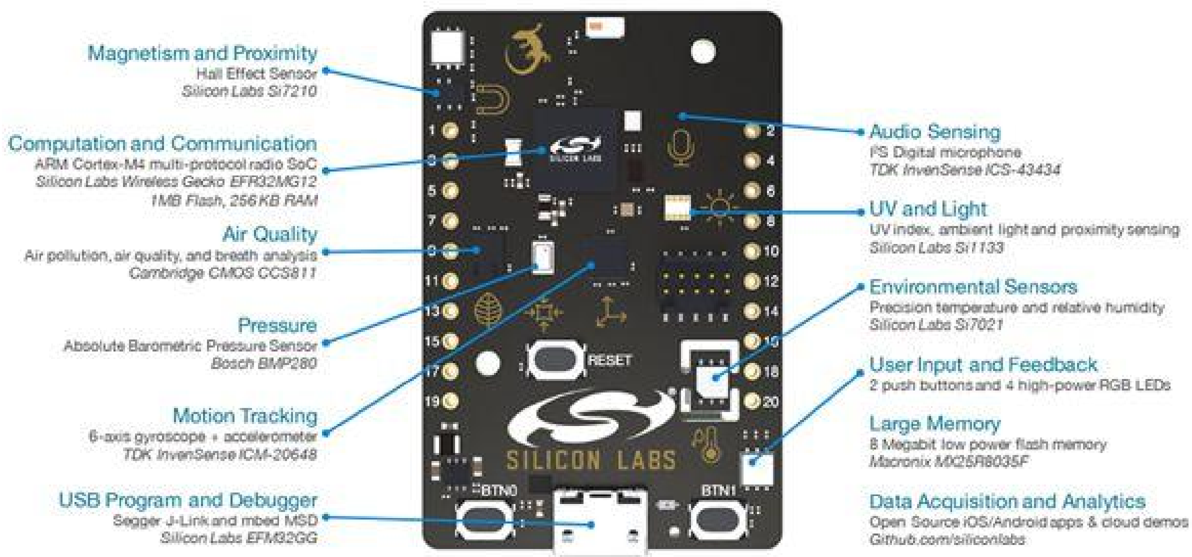
Previous work on algorithms for landslide detection include multivalued regression models, applicable to displacement data from 6 DOF accelerometers, as described above.
Displacement data from accelerometers, @edge or on the cloud-RAN network, include active filters or deep learning for landslide event detection, and filtering of noise. Long term integration filters on the data help identify movement by signal source triangulation and location specific movement patterns, learnable by deep learning networks such as R-CNN architectures.
We define a few such networks below with a high potential for high efficiency landslide event prediction and risk assessments.

1. Active filters for landslide event prediction and risk evaluation.
2. Deep learning classifiers for categorial prediction of landslide events

Both approaches 1 and 2, show promise, in effective prediction and classification of landslide events and risk factors. While previous work at IIT Mandi has led to the successful development and deployment of accelerometer and arduino based detection grid, in this publication, we

present a novel approach of a white product, to be commercially available to indigenous populations, subsidized by the local administration for arboreal worship and hymnology.
The publication, centered in the Uttaranchal region of the Indian Himalayas, also proposes the restoration and preservation of local proto musical whistle languages for the creation of early bird warning systems.

Use of mobile instruments.



The Sense 2 Thunder Board, allows for the flashing of @edge hardware and the integration of a IP68 bluetooth speaker unit, for mobile based hymnology, and the monitoring or data collection of temperature, humidity and other data.
@edge software for the event detection using tensor flow lite architecture or with the use of Google Firebase is easily developed with both procedural A.I and Deep Learning networks, primarily CNN networks , improved with recursion with R-CNN architectures.
The functions integrated include firebase tensorflow lite functions, bioluminosity with the light sensor and four high power LEDs, and the use of the unit as a repeater with wake words and repeated alarm calls. The Sense 2 , also has an Android Application, allowing for the monitoring of sensor data logs and the use of firebase functions.
Proposed FaaS functions:

1. Tensorlite based R-CNN landslide event detection.
2. Tensorlite based active filters for landslide detection.
3. Wake word detection, for gunshots.
4. Wake word detection for early bird whistle sequences
5. Footstep detection and signatures.
6. Photo switch for LED controls and energy management.
7. Bioluminosity with pulse based modulation.

A simple python based program, with firebase functions is described in (*Website*, n.d.-c), a straightforward extension with the use of pi4 or arduino hardware is in seven firebase functions mentioned above, to be described in an accompanying paper.

Development of ShaktiMan(™), a USB computer similar to TOMU/BOMU

A USB form factor MCU based computer, for indigenized arboreal worship is proposed with the RF Soc based on the Risc V Shakti processor from IIT Madras. A SoC with bluetooth is integrated to multiple sensors on the SPI bus with micro SDRAM storage, powered by a Dc2Dc converted, a single AAA NiMH battery and a solar cell.

Arboreal Worship.

Fig 1: Arboreal worship with a Solar Lamp with Bluetooth for Landslide detection and data logging.

Fig 2: Integrated Bluetooth speakers, in totem based worship for hymnology, early bird warning systems and foot step/gunshot detection and early bird warning systems.

</original-contribution>

Discussion.

A USB form factor for a SoC based computer for data logging and early bird warning systems for landslides and arboreal worship with light and hymnology is presented, with two promising architectures, defined in tensor decompositions. One a procedural AI based active filter system and another, a deep learning architecture based on R-CNN for risk assessment and event classification.

Estimates for the sampling frequency needed for effective prediction of landslides are to be determined using data and stratified cluster sampling techniques, with estimated confidence intervals.

Given the optimal distribution of the units, the units are to be marketed online for purchase by the indigenpous and the conservation communities. The system uses a simple sound based early bird warning language , a revival of indigenous proto musical languages of the Indian Himalayas.

References.

Aggarwal, S., Mishra, P. K., Sumakar, K. V. S., & Chaturvedi, P. (2018). Landslide Monitoring System Implementing IOT Using Video Camera. *2018 3rd International Conference for Convergence in Technology (I2CT)*, 1–4.

Agrawal, K., Baweja, Y., Dwivedi, D., Saha, R., Prasad, P., Agrawal, S., Kapoor, S., Chaturvedi, P., Mali, N., Kala, V. U., & Dutt, V. (2017). A Comparison of Class Imbalance Techniques for Real-World Landslide Predictions. *2017 International Conference on Machine Learning and Data Science (MLDS)*, 1–8.

Bheemaiah, A. K. D. (2020). *Scalable IOT solutions with the Amazon Echo Flex Model for 3P integrations. IoT for AI for Earth series, starring Early Bird Warning for Flood Prediction Analytics, an AIaaS data mining Lambda of S3 data from a* *network of IoT nodes with river level sensors*. https://doi.org/10.13140/RG.2.2.10141.67042

Chaturvedi, P., Dutt, V., Jaiswal, B., Tyagi, N., Sharma, S., Mishra, S., Dhar, S., & Joglekar, P. (2014). Remote sensing based regional landslide risk assessment. *Int. J. Emerg. Trends Electr. Electron. (IJETEE)*, *10*(10), 135–140.

Chaturvedi, P., Jaiswal, B., Sharma, S., & Tyagi, N. (2014). Instrumentation Based Dynamics Study of Tangni Landslide near Chamoli, Uttrakhand. *International Journal of Research in Advent Technology*, *2*(10). https://www.researchgate.net/profile/Pratik_Chaturvedi/publication/274255315_Instrumentation_Based_Dynamics_Study_of_Tangni_Landslide_near_Chamoli_Uttrakhand/links/552278150cf2f9c13052c547.pdf

Chaturvedi, P., Srivastava, S., & Kaur, P. B. (2017). Landslide Early Warning System Development Using Statistical Analysis of Sensors' Data at Tangni Landslide, Uttarakhand, India. In *Advances in Intelligent Systems and Computing* (pp. 259–270). https://doi.org/10.1007/978-981-10-3325-4_26

Duc-Tan, T., Dinh-Chinh, N., Duc-Nghia, T., & Duc-Tuyen, T. (2015). Development of a Rainfall-Triggered Landslide System using Wireless Accelerometer Network. *International Journal of Advancements in Computing Technology*, *7*, 14.

Kumar, dr B. A. (2020). *Computable Continuous Functions, in the design of BEAMOS based auto navigation*. https://doi.org/10.5281/zenodo.4044702

Kumar, P., Sihag, P., Pathania, A., Agarwal, S., Mali, N., Singh, R., Chaturvedi, P., Uday, K. V., & Dutt, V. (2020). Predictions of weekly soil movements using moving-average and support-vector methods: A case-study in chamoli, India. In *Information Technology in Geo-Engineering* (pp. 393–405). Springer International Publishing.

[No title]. (n.d.). Retrieved March 15, 2021, from https://jpaut.com.br/wp-content/uploads/2018/12/PEROTONIv.1-n.2-p.35-40-2018.pdf

Real time monitoring & alert system for landslide. (n.d.). Retrieved March 15, 2021, from https://ieeexplore.ieee.org/document/7918030

Website. (n.d.-a). Retrieved March 22, 2021, from Bheemaiah, A., Dr. (2020, July 12). Open Technology : The Free EEG 32 project. https://doi.org/10.31234/osf.io/pqfbv

Website. (n.d.-b). Retrieved March 15, 2021, from https://arxiv.org/pdf/1103.1678

Website. (n.d.-c). Retrieved April 25, 2021, from https://www.silabs.com/community/projects.entry.html/2017/03/08/thunderboard_sensew-Scqr

Aggarwal, S., Mishra, P. K., Sumakar, K. V. S., & Chaturvedi, P. (2018). Landslide Monitoring System Implementing IOT Using Video Camera. 2018 3rd International Conference for Convergence in Technology (I2CT), 1–4.

Agrawal, K., Baweja, Y., Dwivedi, D., Saha, R., Prasad, P., Agrawal, S., Kapoor, S., Chaturvedi, P., Mali, N., Kala, V. U., & Dutt, V. (2017). A Comparison of Class Imbalance Techniques for Real-World Landslide Predictions. 2017 International Conference on Machine Learning and Data Science (MLDS), 1–8.

Bheemaiah, A. K. D. (2020). Scalable IOT solutions with the Amazon Echo Flex Model for 3P integrations. IoT for AI for Earth series, starring Early Bird Warning for Flood Prediction Analytics, an AIaaS data mining Lambda of S3 data from a network of IoT nodes with river level sensors. https://doi.org/10.13140/RG.2.2.10141.67042

Chaturvedi, P., Dutt, V., Jaiswal, B., Tyagi, N., Sharma, S., Mishra, S., Dhar, S., & Joglekar, P. (2014). Remote sensing based regional landslide risk assessment. Int. J. Emerg. Trends Electr. Electron. (IJETEE), 10(10), 135–140.

Chaturvedi, P., Jaiswal, B., Sharma, S., & Tyagi, N. (2014). Instrumentation Based Dynamics Study of Tangni Landslide near Chamoli, Uttrakhand. International Journal of Research in Advent Technology, 2(10). https://www.researchgate.net/profile/Pratik_Chaturvedi/publication/274255315_Instrumentation_Based_Dynamics_Study_of_Tangni_Landslide_near_Chamoli_Uttrakhand/links/552278150cf2f9c13052c547.pdf

Chaturvedi, P., Srivastava, S., & Kaur, P. B. (2017). Landslide Early Warning System Development Using Statistical Analysis of Sensors' Data at Tangni Landslide, Uttarakhand, India. In Advances in Intelligent Systems and Computing (pp. 259–270). https://doi.org/10.1007/978-981-10-3325-4_26

Duc-Tan, T., Dinh-Chinh, N., Duc-Nghia, T., & Duc-Tuyen, T. (2015). Development of a Rainfall-Triggered Landslide System using Wireless Accelerometer Network. International Journal of Advancements in Computing Technology, 7, 14.

Kumar, dr B. A. (2020). Computable Continuous Functions, in the design of BEAMOS based auto navigation. https://doi.org/10.5281/zenodo.4044702

Kumar, P., Sihag, P., Pathania, A., Agarwal, S., Mali, N., Singh, R., Chaturvedi, P., Uday, K. V., & Dutt, V. (2020). Predictions of weekly soil movements using moving-average and support-vector methods: A case-study in chamoli, India. In Information Technology in Geo-Engineering (pp. 393–405). Springer International Publishing.

[No title]. (n.d.). Retrieved March 15, 2021, from https://jpaut.com.br/wp-content/uploads/2018/12/PEROTONIv.1-n.2-p.35-40-2018.pdf

Real time monitoring & alert system for landslide. (n.d.). Retrieved March 15, 2021, from https://ieeexplore.ieee.org/document/7918030

Website. (n.d.). Retrieved March 15, 2021, from https://arxiv.org/pdf/1103.1678