Himashield 2024

Team name - Glofsense

Problem Statement Title - Early warning detection system for Glacial Lake Outburst Floods (GLOFs) using sensor data

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Team members :

Venkatesh R, Nithish T, Naveen krishnaa S, Mukeshraj

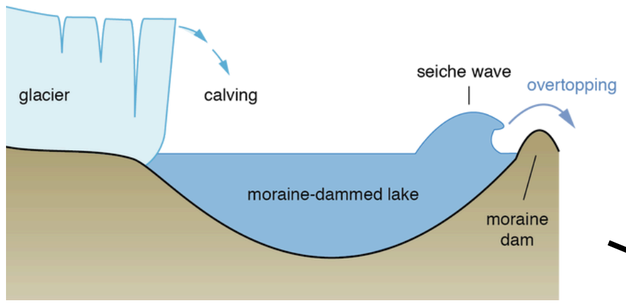
College name :

Bannari Amman Institute of Technology

Idea

- Our Idea is make a web interface (glofsense.com) for early prediction of GLOFs in **Hindukush and Sikkim region. (189 lakes)**
- We use a integrated approach of **Sensor attachment to end moraines** and **ML Prediction of outburst based on Landsat Images**.
- For sensor detection, we developed a **PCB** with **water level, temperature, flow, tilt and pressure sensors** coupled with hybrid battery and LORA that last for **14 years**.
- The ML model trains by time-series data of lake images from 1980 - 2022 by **LSTM model** to predict the increase in size.
- Upon increase in threshold, the data will be transmitted to nearest control center and buzzer to alert residents.

Real time workflow (overview):



lake with high risk of GLOF

Attach PCB to end moraine

Data transmission on Increase of threshold values

send alert to nearest control centre

Alerts residents to migrate

Landsat images of the same lake

ensembled CNN model to predict increase in size

Alert messages to our website and NDAP

Technical Approach

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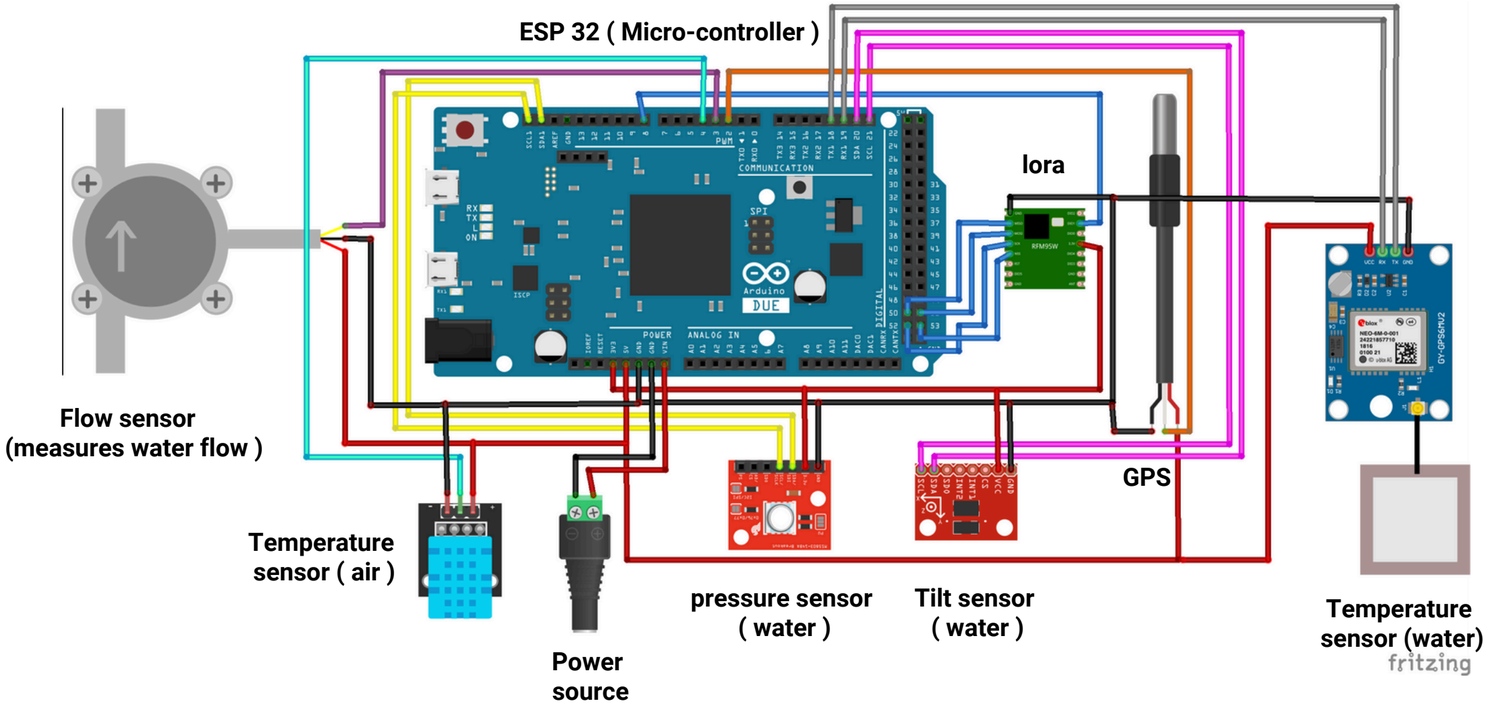
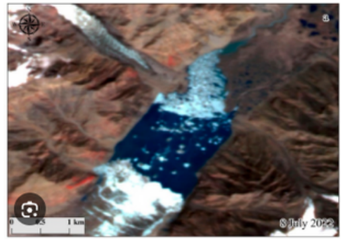
Circuit Architecture :

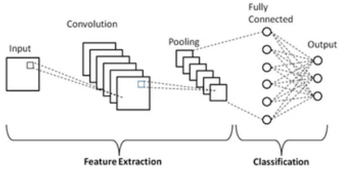


- The circuit will be printed as an **waterproof PCB** and attached to end moraines of GLOF lakes.
- The PCB will transmit **real time data to the nearest control centre** which is of **5 - 12 km range**.
- Installation of these PCBs can be done through **drones** to remote lakes and the whole setup weighs around **550g.**

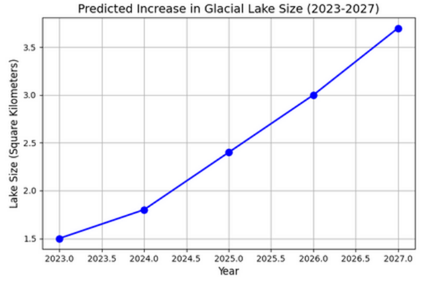
Software (ML) :



6000 landsat images from IEEE (128*128, 15 epochs)



Parsing into pre-trained ResNET based CNN



using LSTM layer to do Time series analysis and predict the increase in size as a graph (year vs sq.km)

Feasibility (cost analysis)

Hardware components :

Component	Explanation
MS5803-14BA	Water level sensor
DHT11	Temperature sensor
YFS201	Water flow sensor
ADXL345	Tilt/Inclinometer sensor
BME280	Pressure/Humidity sensor
NEO-6M GPS	Location tracking
LoRa SX1276	Long-range communication
ESP32	Main microcontroller
Solar Panel	Power supply
Li-ion Battery	Power storage

Software components :

Component	Explanation
Python	Programming language
Ensembled CNN	Machine learning model
Flask	Web server for UI
IEEE Dataport	Image dataset (6000 images)

Cost :

The cost of a one particular PCB comes out be **8000** and one time installation cost will be **4000**.

For a lake, we need 2 PCBs to monitor, we get **20000 INR**

To monitor all **critical lakes in India (189)** - we need **38 lakhs.**

Implementation (South Lhonak Glacial Lake)

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Landsat picture of South Lhonak Glacial lake, Sikkim

As calving increases, the water level of lake increases waiting to reach above end moraine.

We will attach PCBs at the **lower end of end moraine,** once the sensors finds values higher than threshold, data transmission will occur through **LORA**.

Sensor	Threshold Value
MS5803-14BA	10-20 cm/hour water rise
DS18B20	>3°C temperature rise
YFS201	50-100% increase in flow rate
ADXL345	>1-2° tilt change
BME280	Pressure drop > 20-30 hPa

Disaster alert centre, Pakyong

Lora will transmit alert message with sensor values to nearest control centre.

The data will provide enough time of **4 - 6 days** for mitigation efforts.

References & demo

Github - https://github.com/Ni8crawler18/glofsense

Website - https://glofsense.com (our website)

Youtube - https://youtu.be/aGuI9aw29T4

Papers

1. https://www.unisdr.org/files/14048_ICIMODGLOF.pdf
   Formation of Glacial Lakes in the Hindu Kush-Himalayas and GLOF Risk Assessment.

2. https://link.springer.com/article/10.1007/s12665-021-09740-1
   Prevalent risk of glacial lake outburst flood hazard in the Hindu Kush–Karakoram–Himalaya region of Pakistan.

3. https://www.tandfonline.com/doi/full/10.1080/19475705.2011.615344
   Glacial lake outburst flood hazards in Hindukush, Karakoram and Himalayan Ranges.

4. https://www.researchgate.net/publication/358958944
   Glacial Lake Outburst Flood (GLOF) Triggering Factors at Hindu Kush-Himalaya, Mt. Everest Region, Nepal.