TITLE PAGE

- **Problem Statement ID –** SIH1650
- **Problem Statement Title-** Early Warning System for Glacial Lake Outburst Floods (GLOFs)
- **Theme-** Disaster Management
- **PS Category-** Software
- **Team ID - 48955**
- **Team Name -** Ministry of Glacial Affairs

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GLOF EARLY WARNING SYSTEM
USING IOT SENSORS AND ML

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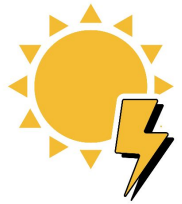
PROBLEM RESOLUTION

The system uses sensors and **edge computing** for real-time data collection and correlation-based analysis, rather than threshold-based results. Data is processed via an **API Gateway**, message queue, and stream processor, with integration of a preprocessing model to analyze correlations between datasets. Processed data is stored in **Prometheus** for time-series management and a custom-developed organic database, with visualizations provided through a tailored dashboard for immediate insights and alerts.

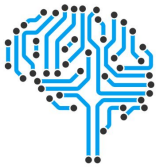
Integration of sensors and edge computing to analyze environmental data with real-time processing and robust data visualization

- **Solar-powered sensors** to detect anomalies in critical parameters
- **Edge computing** for initial data processing and threshold logic
- **API Gateway** to handle user request and authentication
- **Message queue** to buffer incoming data for reliable transfer
- **Stream processing** for real-time data analysis
- **Store processed data** and handle user queries using Prometheus
- Customizable dashboards and real-time **visualization** to give alerts using a custom designed model
- **User Interaction** through API Gateway, routing requests to services and providing them data visualizations



Additional solar-powered supply to reduce need of continuous power supply

Edge Computing to reduce time for data analysis



ML to accurately predict anomalous behaviour

Maintaining Database for future reference

INNOVATION IN SOLUTION

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TECHNICAL APPROACH

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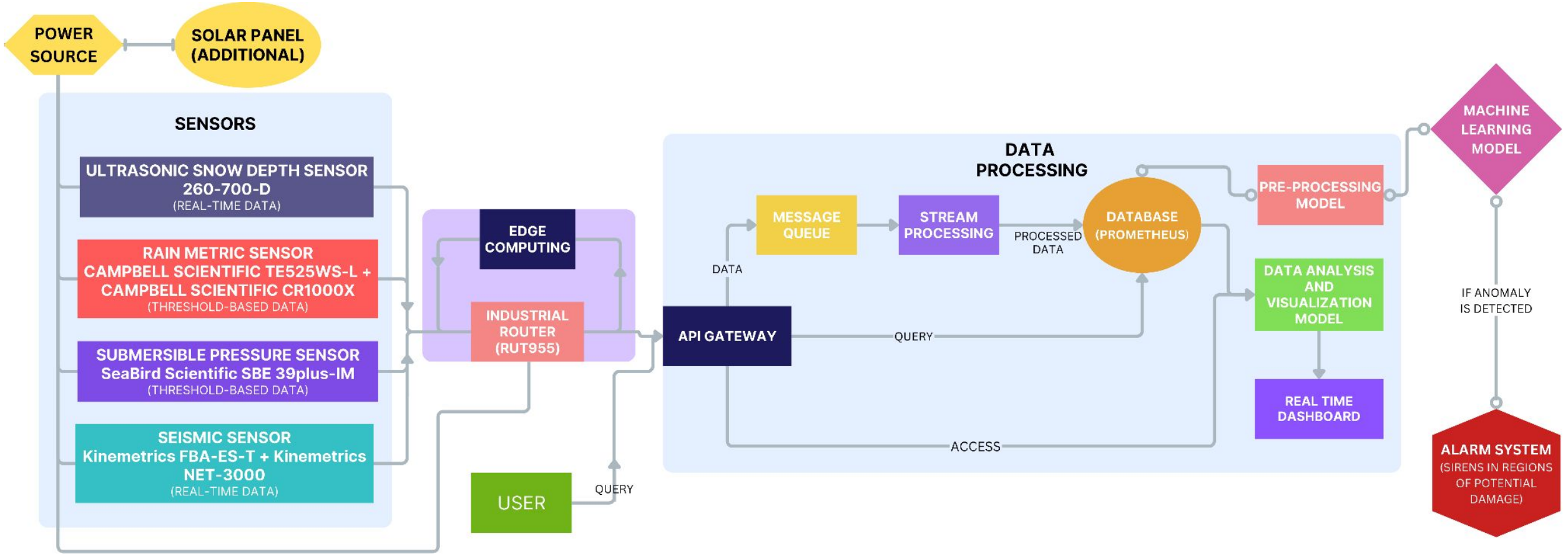

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FEASIBILITY AND VIABILITY

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	CHALLENGES	STRATEGIES
01	Sensor reliability in harsh conditions	Deploy proven sensor technology with redundant backup sensors to ensure continuous operation even in extreme environments
02	Power limitations in remote locations	Utilize solar-powered sensors as a sustainable power source, reducing dependency on traditional power grids
03	Refining detection accuracy using machine learning	Leverage machine learning models trained on large datasets to improve the accuracy of detection and enhance early warning capabilities
04	Effectively alerting populations in danger zones	Implement a color-coded alert system integrated with SMS notifications to provide clear and immediate warnings, relying on available mobile network coverage
05	High upfront costs of sensor installation and infrastructure	Reduce costs by utilizing affordable sensors and open-source software tools, ensuring the system remains financially viable

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IMPACT AND BENEFITS

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- Real-Time Analytics Integration of machine learning improves predictive accuracy over time.
- Solar-powered sensors promote sustainable technology adoption, minimizing carbon footprints in disaster monitoring.
- Access to rich data sets for studying climate change and its impacts on glacial environments.
- Edge computing allows the system to be easily expanded or adapted to other environmental monitoring needs.
- Access to immediate insights allows agencies to make quick decisions regarding evacuations and resource allocation
- Reducing the likelihood of disaster-related injuries or health crises by ensuring timely alerts.
- Real-time anomaly detection enables timely alerts, reducing the risk of loss of life and property .

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RESEARCH AND REFERENCES

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We based our data flow and sensor choices on insights from various case studies and research papers, including those listed below, ensuring a reliable and efficient environmental monitoring system.

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- A. Karanth, Dr. S. Rao, Dr. U. Rajasekar, L. Dashora, “Review of Early Warning Systems in Indian Cities”, 2014 GOI-UNDP Climate Risk Management in Urban Areas through Disaster Preparedness and Mitigation Project :
- National Disaster Management Authority Guidelines, Management of Glacial Lake Outburst Floods (GLOFs), A Publication of the National Disaster Management Authority, Government of India. October 2020, New Delhi
- Rounce, David & Mckinney, Daene & Lala, Jonathan & Byers, Alton & Watson, C. Scott. (2016). A new remote hazard and risk assessment framework for glacial lakes in the Nepal Himalaya. Hydrology and Earth System Sciences. 20. 3455-3475. 10.5194/hess-20-3455-2016.
- M. D. Mehta, “DESIGN AND IMPLEMENTATION OF AN IOT PLATFORM FOR FLOOD PREDICTION”, M.Comp.Sc. thesis, Concordia University, 2023. Available: