Title :

A Robust Cloud-based Machine Learning and AI Platform for Low-cost and Intelligent Decentralised Wastewater Monitoring System for Remote Communities in Low Income Countries

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Background :

- SDG 6 Objective: Ensure water and sanitation access for all

- Challenges in Remote Areas:
  - ✓ Remote communities are often far from centralised treatment systems
  - ✓ Geographical conditions can be challenging in these areas
  - ✓ High costs in terms of capital and operation to connect sewage to centralised systems

- Mobilising Experts:
  - ✓ Bringing experts to remote areas is difficult, especially in emergencies
  - ✓ Lack of rapid support can inconvenience and harm isolated communities

- Low-Income Countries:
  - ✓ Challenges are more pronounced in low-income countries
  - ✓ Remote communities have limited awareness of sanitation practices
  - ✓ Lack of knowledge and expertise to manage local facilities

Targets:

- Decentralisation of sewage treatment systems offers a potential solution for remote areas in low-income countries struggling with the lack of sanitised water.

- To promote the adoption of decentralised sewage treatment systems in remote low-income areas, technologies should be made:
  - ✓ Automated
  - ✓ Digitalised for predictive modeling
  - ✓ Equipped with robust water quality monitoring systems
  - ✓ Optimised for resource recovery
  - ✓ Designed for long-term sustainability

- This approach aims to minimise disruptions to local communities while ensuring effective and lasting water sanitation solutions.

Proposed Method:

- A 5-year project with an end goal of delivering a low-cost and intelligent decentralised sewage wastewater treatment system deployable to remote communities in low-income countries has been proposed at Monash University Malaysia.

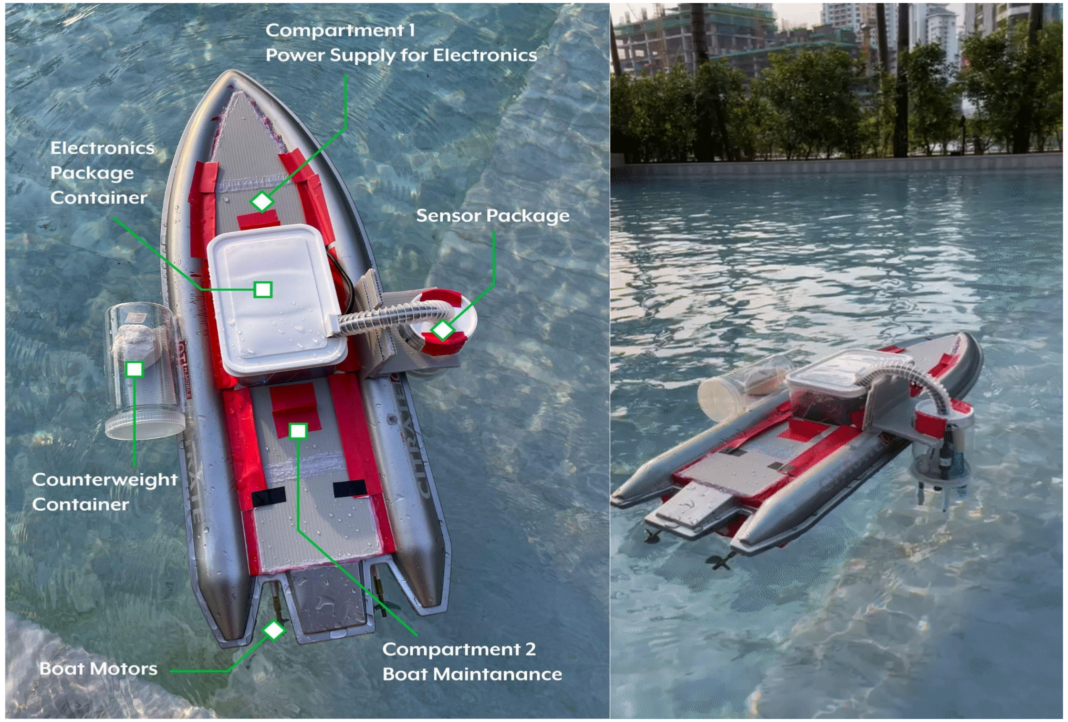
- In my capacity as one of the work package leaders, along with the collective expertise of our team members, we aim to establish an effective Cloud-based machine learning and AI platform to achieve the following objectives:
  1. To monitor wastewater transport
  2. To reduce chemicals used in the decentralised sewage treatment process
  3. To predict anomalies in process or water quality and propose appropriate control measures to mitigate risk of water pollution

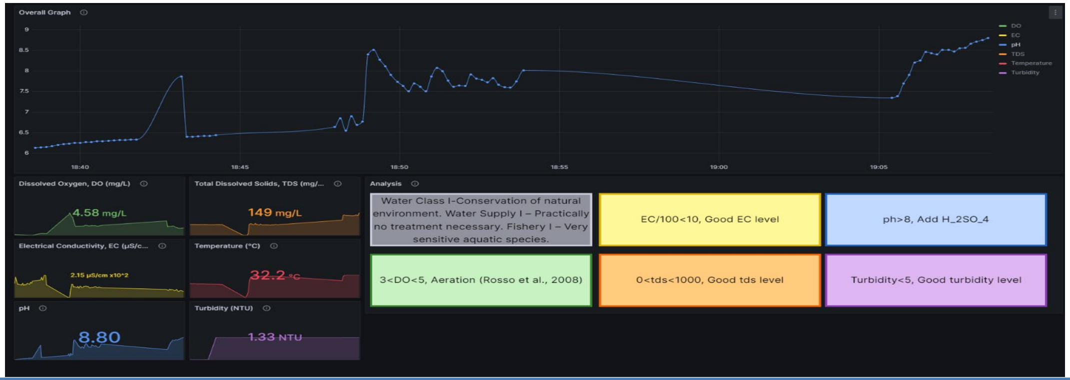
Proposed Method:

- Mini projects: Installation of IoT on wastewater monitoring prototypes for data collection, monitor and process control

- Wastewater Monitoring Prototypes:
  - ✓ Built with IoT devices such as Raspberry Pi, Arduino, and a diverse array of sensors, facilitating the comprehensive collection of wastewater attributes
  - ✓ Wastewater attributes include pH levels, temperature, turbidity, dissolved oxygen (DO), total dissolved solids (TDS), and electrical conductivity (EC)
  - ✓ Cloud storage has been established to securely store the collected wastewater attribute data
  - ✓ Analytical dashboard that plays an essential role in meaningfully visualising and analysing the gathered data

- Most recent miniature project: A mini waterborne vehicle prototype is built with the capability of navigation along water courses for water sample collection and water quality monitoring



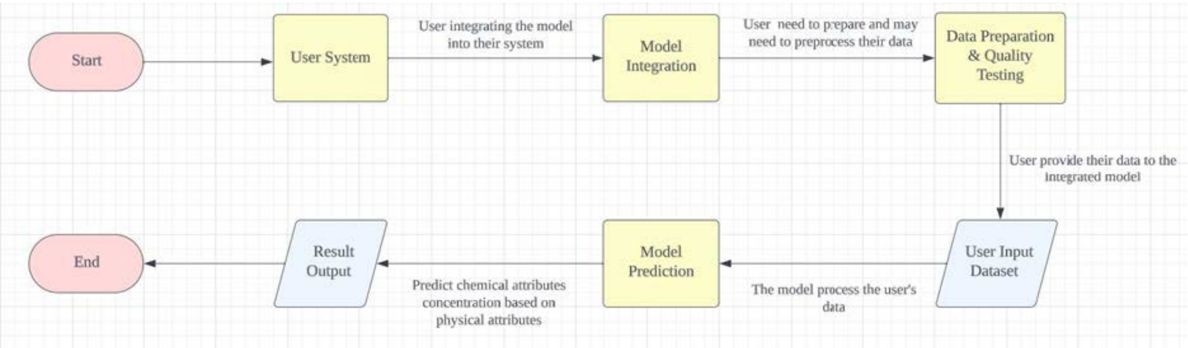


Proposed Method:

- Next step: Integration of big data analytics into a comprehensive decision-making framework

- Main goal: To establish a robust Cloud-based machine learning and AI platform, leveraging the power of advanced technology to revolutionise wastewater monitoring and treatment
  - ✓ To reduce the use of chemicals in decentralised sewage treatment processes
  - ✓ To predict anomalies in both process dynamics and water quality
  - ✓ To propose personalised control measures to mitigate the risk of water pollution

- Four main phases for machine learning:
  - ✓ Integration
  - ✓ Machine Learning Analysis
  - ✓ Prediction Generation
  - ✓ User Access and Further Analysis



- Observable performance expectations for machine learning model:
  - ✓ Accuracy – performance benchmark, minimum threshold
  - ✓ Response time – efficiency assurance, efficient real-time monitoring
  - ✓ Scalability – adaptability and versatility, accommodating diverse datasets, performance consistency

Impacts of the Proposed Methods:

- ❑ Scientific and Technological Impact:
  - ✓ Transformation of analytical methods for wastewater monitoring
  - ✓ Enhanced accuracy and validity via meticulously proposed data wrangling and feature selection strategies
  - ✓ Establishment of strong technological infrastructure to empower advanced analytical models
  - ✓ Efficiency through the automation of data analysis processes
  - ✓ Data-driven decision making in the field of wastewater management

- ❑ Societal Impact:
  - ✓ Improved environmental protection
  - ✓ Public health and safety

- ❑ Collaborative Impact:
  - ✓ Interdisciplinary Collaboration
  - ✓ Enhanced Industry and Environmental Collaboration
  - ✓ Data Sharing and Collaboration
  - ✓ Shared Responsibility for Sustainability

Output/Outcome:

- The expected outcomes of this project include:

1. **Talent Development**: The project fosters talent development in several critical areas, including decentralised wastewater treatment systems, digitalisation of processes, IoT technology, machine learning, process optimisation, circular economy principles, and water education.
2. **Improved Amenities**: Remote communities stand to benefit significantly from the implementation of improved wastewater treatment systems, leading to enhanced amenities and an overall improvement in their quality of life.
3. **Educational Enhancement**: The working prototype offers valuable educational opportunities. It can be utilised for educational purposes, allowing students to gain knowledge and raise awareness about the importance of water sanitation.
4. **Industrial Exposure**: The project addresses the issue of limited industrial exposure in engineering education by providing a virtual live view of the wastewater treatment unit through its IoT setup. This exposure enhances students' understanding of real-world applications.
5. **Collaborative Potential**: The project has the potential to strengthen collaboration, particularly with the School of Engineering and School of IT from different universities in ASEAN countries. This collaboration can lead to the development of a digital twin and an optimised wastewater treatment system, advancing research and educational opportunities in these fields.

Conclusion:

- ❑ Decentralisation of sewage treatment systems offers a potential solution for remote areas in low-income countries struggling with the lack of sanitised water.

- ❑ To move forward, we are working towards creating an effective Cloud-based machine learning and AI platform which enable us to:
  - ✓ Monitor wastewater transport efficiently
  - ✓ Minimise chemical usage in decentralised sewage treatment
  - ✓ Predict and manage process and water quality anomalies, reducing the risk of water pollution

- ❑ Tentative methods and focuses:
  - ✓ A strong emphasis on accurate data collection, data wrangling, and feature selection
  - ✓ Ensuring the accuracy and validity of our models
  - ✓ Recognising the potential to expand our dataset with data from different sources
  - ✓ Enabling validation of our proposed models in diverse contexts
  - ✓ Leveraging crucial Python libraries (Scikit-Learn, Pandas, Matplotlib, etc.) as the technical backbone of our machine learning implementation
  - ✓ Ensuring smooth and low-error model development
  - ✓ Proactive risk management to mitigate potential challenges
  - ✓ Capitalising on favorable opportunities

Conclusion:

- Project's Impact:
  - ✓ Contributing to the evolving field of wastewater attribute analysis
  - ✓ Promoting efficient wastewater management, environmental preservation, and sustainable water resource utilisation

- We are actively pursuing a grant to back our research, and we are also seeking collaborators who share an interest in joining our research project. If you're interested, please feel free to reach out to me, and I'd be delighted to explore this further with you.

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