Abstract

Autonomous Aquatic Sentinels: Advancing Water Quality Assessment with Non-Intrusive Biomimetics approach

Aditi Kishore [1]*, Bodhisattya Pal [1]

[1] Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 221005, Uttar Pradesh, India.

* author for correspondence: aditikishore.8@gmail.com

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INTRODUCTION

The ongoing urbanisation and industrialization in developing nations produce hazardous wastes, including heavy metals such as iron, nickel, cobalt, cadmium, etc., and bring naturally occurring radioactive materials to the surface through anthropogenic activities. Apart from radionuclides in the uranium and thorium series, surface water may contain natural radionuclides like ^{40}K, ^{3}H, and ^{14}C, with anthropogenic sources contributing to ^{90}Sr, ^{131}I, transuranium products, and other emitters [1]. Their gradual buildup in the aquatic environment poses a persistent threat of metal-related diseases and endangers both aquatic biota and other organisms [2]. The integration of biomimicry principles can be a transformative avenue for environmental monitoring and aquatic research. This study aims to design a biomimetic swimming fish bot with advanced detectors to revolutionise water sample collection, reduce human interaction, and address environmental health by swiftly managing potential threats from heavy metals and radioactive materials.

MATERIALS AND METHOD

Drawing inspiration from the swift swimming motion of Sailfish (*Istiophorus platypterus*), the bot employs a specialised fin-like structure that mimics the hydrodynamic efficiency of marine organisms, allowing it to cover large areas efficiently. The bot's capability to assess heavy metal contaminants is influenced by the bioaccumulating prowess of Zebra mussels (*Dreissena polymorpha*). The device utilises a radiation detection module inspired by the colour-changing behaviour of Spiderwort (*Tradescantia virginiana*) flowers. Responding dynamically to radiation fluctuations, the sensors change colour for rapid and easily visible radioactivity analysis. Additionally, the entire device is powered by an energy-efficient system inspired by the metabolic efficiency observed in marine organisms. Testing is performed to evaluate its efficiency in a simulated environment.

RESULT

The simulation demonstrates the bot's efficiency in assessing water quality, showcasing excellence in propulsion, precise metal detection, and prompt responsiveness in radiation analysis.

CONCLUSION

The result validates this design as a state-of-the-art biomimetic robotic device for water quality assessment.

References:

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