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ALGAE CULTIVATION FOR SUSTAINABLE LIFE SUPPORT IN SPACE AND CLIMATE CHANGE: DEVELOPMENT OF A COMMERCIAL BIOREACTOR FOR OPTIMAL ALGAE GROWTH USING ARTIFICIAL INTELLIGENCE

Abstract

Processing carbon dioxide to generate sufficient oxygen is one of the challenges in developing life support systems for human presence in space. Algae is known to grow its biomass through photosynthesis and thus produces oxygen. Algae cultivation in an artificial environment requires maintaining proper environmental conditions to extend healthy colony growth and life cycles. Previous attempts to cultivate algae, are mostly carried out in relatively large facilities. Accordingly, they have not been adequate for the installment in spacecraft or buildings, and have not fully utilized artificial intelligence (AI) based on specific data analytics to achieve optimal growth.

Hypergiant's innovative development for a small-scale bioreactor using AI on a commercial and open-source platform is focused on the growing concern of climate change. The details outlining this autonomous system are illustrated through several design aspects such as mechanical, electronics, automation, and data analysis. The bioreactor is designed to be modular, from small indoor installations to large outdoor industrial form factors. The pumping system circulates water and air into cylinder manifolds. Electronics provide control and sensor data while adjusting the optimal wavelength and intensity of LED lighting, as one of several control variables. Sensor clusters collect various measurements about biological and environmental status. AI algorithms utilize various sensor data such as the ppm concentration of oxygen and carbon dioxide, pH, turbidity, temperature and optical density; automatically adjusting the cultivation environment by cascade control.

As a result, the data indicates that a bioreactor has been successful in cultivating algae while significantly reducing carbon dioxide in the controlled environment. The estimation of carbon dioxide absorption is also calculated to demonstrate the performance of consuming carbon dioxide. Additionally, a cost model addresses its potential applications in various places such as office buildings, high density living structures and commercial manufacturing facilities.

For ongoing development, data analysis based on AI will be implemented for automatic machine control and a robotic algae harvester is under development to collect and recycle algae into useful material by 3D printing. To maximize the efficiency of harvesting and sequestering carbon dioxide while lowering power consumption, AI will help find optimal operational conditions to grow algae in multiple machines within a distributed network. Developing this innovative bioreactor is expected to realize a viable solution for life support systems in human space habitat and help fight climate change by compensating carbon footprint.