Bernoulli Robot for Air and Spaces Sanitation

Autonomous Bernoulli robot integrates UV-C, electrostatic spraying, and AI mapping for smart air and surface sanitization.

The Bernoulli robot is an advanced, autonomous sanitization system designed to disinfect air and surfaces in public and medical spaces. It integrates multiple proven and innovative technologies to enhance disinfection efficiency, particularly in combating airborne and surface pathogens like SARS-CoV-2. The robot increases the volume of filtered air by leveraging airfoils to enhance air suction while in motion, along with a UV-C germicidal light to deactivate any remaining pathogens that pass through its filters. To ensure thorough surface sanitization, it utilizes an electrostatic nebulizer to spray a nanoparticle-based disinfecting solution. The charged nanoparticles improve adherence to surfaces, including hard-to-reach areas, providing a uniform coating and extended antimicrobial effect, while real-time nanoparticle detection capabilities help monitor and optimize disinfection cycles. The Internet of Medical Things (IoMT) integration allows real-time detection of surface and air contamination, while AI-driven mapping determines high-risk infection areas, optimizing sanitization routes. Additionally, temperature and thermodynamic property sensors help identify potentially infected regions. The robot's surface-adaptive spraying system employs artificial vision systems to analyze surface roughness and fractal dimension, adjusting spray parameters accordingly to maximize efficiency on surfaces of varying porosity, texture, and contamination levels. Bernoulli uniquely integrates multiple sanitization technologies, including UV-C light for air and surface disinfection, electrostatic spraying for surface sanitization, advanced air filtration, and real-time data collection with AI-driven insights, making it a highly effective and versatile solution for sanitizing high-risk environments.

Technology Validation:

A functional prototype was built, integrating components such as advanced air filtration, UV-C disinfection, and electrostatic spraying. Computational fluid dynamics (CFD) simulations were conducted to optimize airflow and

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particle distribution, checking for proper air filtration and pathogen removal. The spraying mechanism was analyzed through artificial vision systems that assess surface adaptability, while nanoparticle adhesion and spread were evaluated through electrostatic deposition experiments. Additionally, biological tests with Serratia marcescens bacteria were conducted on highly touched surfaces to measure disinfection effectiveness. The integration of IoMT and AI-driven mapping was validated through real-time data acquisition and predictive analysis, confirming the robot's ability to adapt to infection-prone areas.

Advantages:

-Comprehensive Air and Surface Disinfection

-AI and IoMT-Driven Smart Sanitization

-Electrostatic Spraying for Maximum Coverage

-Minimizes Human Exposure to Pathogens

Applications:

-Hospitals and Medical Facilities

-Airports and Transportation Hubs

-Universities and Public Spaces

-Commercial and Industrial Buildings

Related Publications:

Occupant-Centric Robotic Air Filtration and Planning for Classrooms for Safer School Reopening Amid Respiratory Pandemics. Yang, H., Balakuntala, M. V., Kaur, U., Quiǹƒones, J. J., Moser, A. E., Doosttalab, A., Esquivel-Puentes, A., Purwar, T., Castillo, L., Mahmoudian, N., Ma, X., Voyles, R. M., Journal of Robotics and Autonomous Systems Elsevier, 147, 103919, (2021).

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