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Design & Development of Autonomous Beach Cleaning Vehicle

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Abstract : In the quest to enhance coastal environmental health, this study introduces a fully autonomous beach cleaning machine, a breakthrough in leveraging green energy and advanced artificial intelligence for ecological preservation. Designed to operate independently, the machine is propelled by a solar-powered system, underscoring a commitment to sustainability and the use of renewable energy in autonomous robotics. The vehicle's autonomous navigation is achieved through a sophisticated integration of LIDAR and a camera system, utilizing an SSD MobileNet V2 object detection model for accurate and real-time trash identification. The SSD framework, renowned for its efficiency in detecting objects in various scenarios, is coupled with the lightweight and precise highly MobileNet V2 architecture, making it particularly suited for the computational constraints of on-board processing in mobile robotics. Training of the SSD MobileNet V2 model was conducted on Google Colab, harnessing cloud-based GPU resources to facilitate a rapid and cost-effective learning process. The model was refined with an extensive dataset of annotated beach debris, optimizing the parameters using the Adam optimizer and a cross-entropy loss function to achieve high-precision trash detection. This capability allows the machine to intelligently categorize and target waste, leading to more effective cleaning operations. This paper details the design and functionality of the beach cleaning machine, emphasizing its autonomous operational capabilities and the novel application of AI in environmental robotics. The results showcase the potential of such technology to fill existing gaps in beach maintenance, offering a scalable and eco-friendly solution to the growing problem of coastal pollution. The deployment of this machine represents a significant advancement in the field, setting a new standard for the integration of autonomous systems in the service of environmental stewardship.

Keywords : autonomous beach cleaning machine, renewable energy systems, coastal management, environmental robotics
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