Artificial Intelligence Techniques for Extracting Impervious Surface Areas from Satellite Imagery

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SUMMARY

Urbanization is rapidly occurring on a global scale reflecting human behavior and movement. Urbanization is manifested by anthropogenic activities such as the construction and development of impervious surfaces. Impervious surfaces are artificial hard areas that do not allow water to seep into the ground, such as buildings, roads, sidewalks, and parking lots. They prevent water infiltration into the soil resulting in several environmental issues and are considered a major trigger for natural disasters and climate change. Moreover, impervious surfaces disturb the local ecological and economic systems by removing the natural land cover. Therefore, unplanned construction of impervious surfaces has negative impacts on sustainability.

Small Island Developing States (SIDS), like the rest of the world, share similar distress from the increasing stated urbanization issues alongside their small size and remoteness. Caribbean SIDS have additional challenges being susceptible to natural disasters due to their tropical location and low elevations. All of that exacerbates the environmental and socio-economic vulnerabilities of the Caribbean SIDS. Moreover, they lack current and accurate geospatial datasets that are needed to plan for sustainable development. Being key quantifiable indicators of urbanization, information on impervious surface area is essential to mitigate the above-mentioned challenges and facilitate sustainability. Therefore, an urgent solution is required to acquire information on impervious surface areas.

For several decades, remote sensing technologies were used to capture quantitative data of Earth features. More recently, Artificial Intelligence (AI) techniques are increasingly being applied to effectively extract necessary spatial information from such data with major breakthroughs being made through its subsets Machine Learning (ML) and Deep Learning (DL). Adopting AI techniques for extracting impervious surface areas from freely available satellite imagery becomes a

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necessity when one considers the limited financial, technical, and human resources in the Caribbean SIDS.

Consequently, this paper reviews the technical architectures and compares existing leading AI image processing techniques to extract impervious surface areas from satellite imagery against conventional extraction techniques to determine the accuracies involved with consideration of cost, time, and feasibility. The proposed approach utilizes the available AI geospatial tools and freely available satellite imagery data to provide information critical for making informed decision towards mitigating urbanization issues and battling climate change impacts in the Caribbean SIDS.

The findings of this study demonstrated that DL techniques are generally a promising area for unlocking unlimited capabilities to develop solutions to many problems, and they have great potential specifically for extracting impervious surfaces areas from satellite images.

Keywords: Impervious Surfaces; Remote Sensing; Satellite Imagery; Artificial Intelligence; Deep Learning; Caribbean Small Island Developing States.

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