LiDRNet: Lightweight Inertial Dead Reckoning Network

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Accurate indoor positioning remains a significant challenge due to poor permeability of Global Navigation Satellite System (GNSS) signals within buildings, rendering traditional GNSS-based methods ineffective. Alternatives often suffer from limitations, hindering their practicality in constrained platforms. We propose a lightweight and robust deep learning method for pedestrian dead reckoning (PDR), termed LiDRNet. Our method leverages the Neutral Ordinary Differential Equation (Neural ODE) technique and applies them to existing architectures ResNet and LSTM. We then operate on a Heading Agnostic Coordinate Frame and apply back-propagation on velocity loss to improve the effectiveness of our model. Finally, we use the Neural-ODE backbone to predict motion trajectories from raw Inertial Measurement Unit (IMU) data, significantly reducing the number of parameters. Benchmarking LiDRNet against SOTA deep learning approaches shows a significant improvement in performance aspects, reducing parameter count by 7 times while achieving comparable accuracy. Our results also indicate that LiDRNet achieves an average trajectory error (ATE) that remains within an acceptable range for practical applications, achieving an average error of less than 4 meters for every 250 meters travelled. LiDRNet is well-suited for deployment on resource-constrained edge devices such as smartphones or IoT platforms for accurate, robust and real-time dead reckoning. Enabling accurate indoor positioning without the need for external infrastructure or high computational resources allows our approach to significantly enhance navigation, which has the potential to improve navigation assistance, asset tracking, and emergency response in indoor settings (such as cave systems or dense forests).

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