# Real-Time Insole-Integrated Pressure Mapping and Patient-Specific 3D-Printed Orthotics for Accessible, Low-Cost AI-Driven Detection and Prevention of Diabetic Peripheral Neuropathy

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Every 30 seconds, a person loses a lower limb due to a diabetic complication. Diabetic peripheral neuropathy (DPN) causes degenerative nerve damage in approximately 50% of the world's 537 million diabetics, with 75% in low-income regions where advanced healthcare is limited. This nerve damage results in pressure ulcers, infections, and fractures that fail to heal or require amputation. Current diagnostic options are either highly inaccurate, such as monofilament testing with only 50-75% accuracy, or prohibitively expensive, like nerve conduction studies costing $500-$2,000, while prevention relies on ineffective mass-manufactured orthotics or cost-prohibitive custom orthotics. This research focuses on engineering low-cost pressure-sensing insoles to detect DPN early and using the pressure data to create affordable, personalized 3D-printed orthotics to prevent further complications. Pressure data was collected from 34 neuropathic patients and 21 controls to train a gradient-boosted random forest model that achieved an accuracy of 83.33% and an AUC of 0.875. This <$100 system significantly outperforms monofilament testing and rivals nerve conduction studies. Beyond detection, the system models pressure patterns to design variable-density 3D-printed orthotics at approximately $5 per pair. These orthotics provide personalized pressure redistribution that generic options cannot deliver, potentially preventing ulceration and subsequent complications. This research democratizes healthcare globally by providing accessible technology to detect DPN and prevent millions of unnecessary amputations in resource-limited regions, potentially transforming diabetic care worldwide and significantly reducing DPN's $4.6-13.7 billion annual economic burden in the US alone.

**Awards Won:**