Final Year Design Project Showcase
Batch-2022
Year 2026

Department: Department of Computer & Information Systems Engineering **Programme**: Bachelor of Engineering (BE)	
1	**Project Title:** RUN-GAIT PRO: Intelligent Shoes for Gait Monitoring in Athletes and Rehabilitation Using Machine Learning
2	**Project Idea:** RUN-GAIT PRO is an intelligent wearable footwear system designed to monitor running gait in real time. The system integrates pressure sensors, an inertial measurement unit (IMU), and an ESP32 microcontroller within a custom PCB embedded inside a shoe. Sensor data is transmitted wirelessly to a mobile application where machine learning analyzes gait patterns, identifies injury risks, and provides immediate feedback for athletes and rehabilitation patients.
3	**Process:** The project began with a comprehensive literature review on gait analysis and wearable healthcare systems. Suitable hardware components, including the ESP32 microcontroller, BNO055 inertial measurement unit, and force-sensitive resistors, were selected and integrated into a custom-designed printed circuit board embedded inside a sports shoe. Embedded firmware was developed for real-time sensor data acquisition, while a Flutter-based mobile application integrated with Firebase enabled wireless communication and visualization. A Random Forest machine learning model was implemented to analyze gait patterns, and the complete system was validated through experimental testing and performance evaluation.
4	**Outcome :** The project successfully developed a fully functional smart shoe capable of continuously monitoring running gait outside laboratory environments. The system accurately measures six clinically relevant gait parameters, including cadence, foot strike pattern, ground contact time, stride length, step time, and stride time, while providing real-time visualization through a Flutter-based mobile application. Experimental validation demonstrated a foot strike classification accuracy of 93.8%**,** stride length error below 2% (±1.9%)**,** ground contact time error of ±5.2 ms**,** and cadence error of ±1.4 steps per minute compared with laboratory reference systems. The cloud-based Random Forest classifier achieved 91% classification accuracy with a macro F1-score of 0.885, while maintaining an average inference latency of approximately 118 ms per stride, making the system suitable for real-time gait analysis and injury risk assessment.
5	**Evidence (Theoretical Basis):** The theoretical foundation of RUN-GAIT PRO is based on biomechanics, embedded systems, wearable sensing technology, Internet of Things (IoT), and machine learning. The

	project combines data acquired from a BNO055 inertial measurement unit and force-sensitive resistors to capture spatiotemporal gait characteristics while employing machine learning techniques to classify gait patterns and identify potential abnormalities. The proposed system addresses the limitations of conventional laboratory-based gait analysis by providing continuous, real-time monitoring through an integrated wearable hardware and software platform.
6	**Competitive Advantage or Unique Selling Proposition** (Cost Reduction, Process improvement, Attainment of any SDG (Sustainable Development Goal), increase of market share or capturing new market or having superior performance over a competitor. In summary, any striking aspect of the project that compels the industry to invest in FYP or purchase it. Some detailed description is required in terms of how, why when what. You can select one or more from the following dropdown and delete the rest of them). Please keep relevant options, delete the rest of them, and correct the sequence
a	**Attainment of any SDG** : RUN-GAIT PRO directly contributes to United Nations Sustainable Development Goal 3 (Good Health and Well-being) by promoting preventive healthcare through continuous gait monitoring and early identification of movement abnormalities. The system enables timely intervention, supports rehabilitation, reduces the likelihood of sports-related injuries, and encourages healthier physical activity among athletes and the general population.
b	**Cost Reduction of Existing Product:** Traditional gait analysis requires specialized laboratories equipped with motion capture systems, force plates, and trained personnel, making the diagnostic process expensive and inaccessible to many users. RUN-GAIT PRO significantly reduces these costs by integrating commercially available sensors, embedded electronics, and cloud-based processing into a compact wearable device that delivers comparable gait analysis capabilities at a fraction of the cost.
c	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** : Current gait assessment methods are typically performed only during scheduled laboratory sessions, limiting continuous monitoring and delaying diagnosis. RUN-GAIT PRO improves this process by enabling real-time gait analysis during normal outdoor activities through wireless data transmission and automated machine learning analysis. This continuous monitoring approach provides immediate feedback, reduces manual analysis, improves diagnostic efficiency, and supports remote monitoring by healthcare professionals and sports coaches.
d	**Capture New Market** : The project targets emerging markets that currently lack affordable gait monitoring solutions, including home-based rehabilitation, elderly mobility assessment, sports injury prevention, and remote physiotherapy services. Its portability, affordability, and real-time monitoring capabilities make it suitable for users who cannot regularly access specialized gait laboratories.
e	**Any Other Aspect:**

	RUN-GAIT PRO uniquely combines embedded hardware, custom PCB design, Internet of Things connectivity, cloud computing, mobile application development, and machine learning into a single integrated wearable healthcare platform. Its modular architecture allows future integration of additional sensors, edge artificial intelligence, personalized gait coaching, and predictive healthcare analytics, making it highly scalable for future commercial and research applications.	
7	**Target Market**: RUN-GAIT PRO is primarily intended for professional athletes, amateur runners, physiotherapists, orthopedic specialists, rehabilitation centers, sports medicine clinics, fitness enthusiasts, elderly individuals requiring mobility monitoring, healthcare organizations, and academic research institutions. The system provides continuous and affordable gait assessment for both performance optimization and clinical rehabilitation, making it suitable for a wide range of healthcare and sports-related applications.	
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11	**Video (If any)**	N/A