ELYSIUMPRO
INSPIRING THE LEADING EDGE TECHNOLOGIES

MACHINE LEARNING

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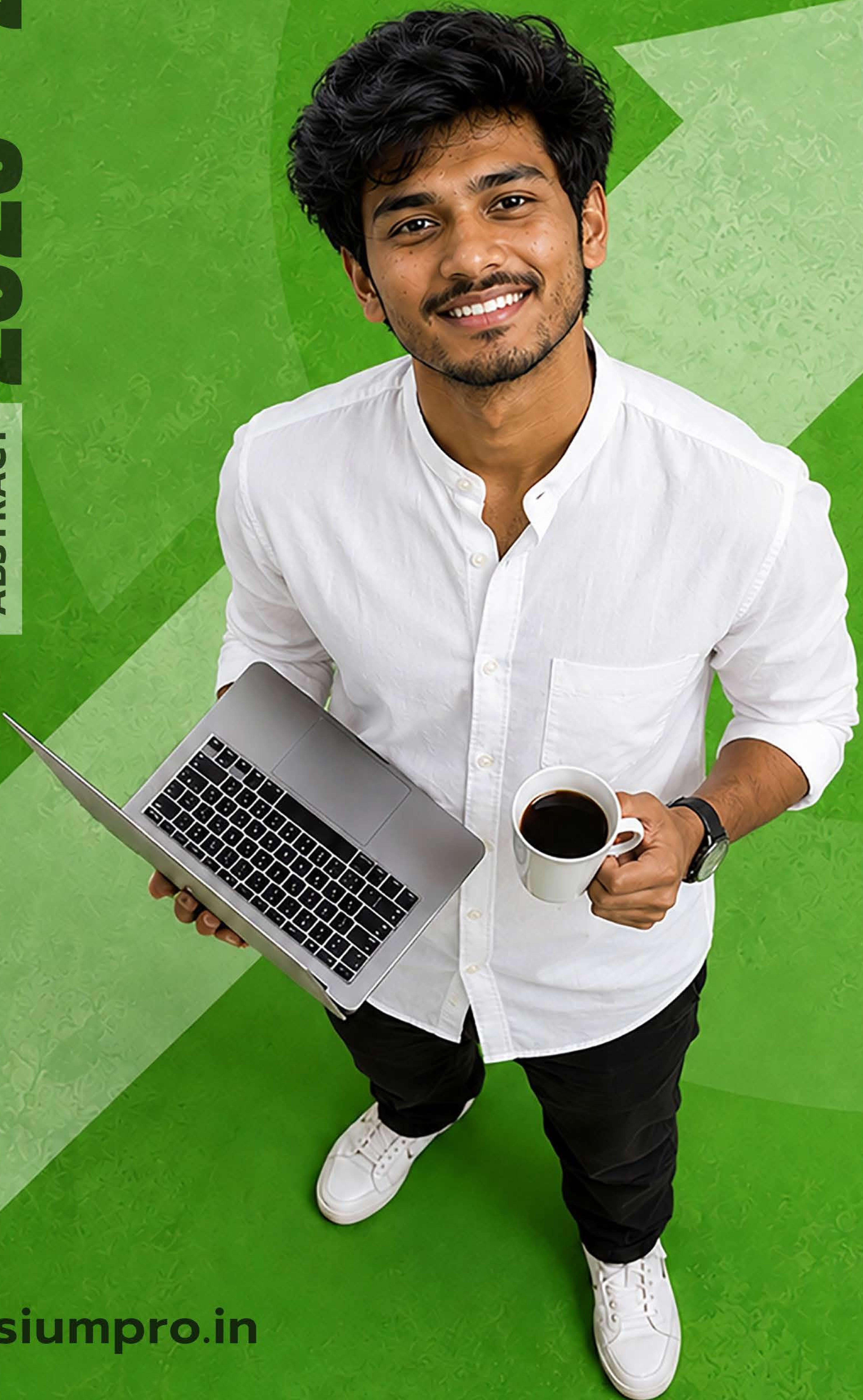
TITLE & ABSTRACT

Advanced Academic Final Year Projects



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Forecasting Dropout in Home-Based Movement Rehabilitation After Stroke With Sensors and Machine Learning

This system uses sensor data and machine learning to predict whether stroke patients may discontinue home-based rehabilitation programs. Movement patterns, exercise frequency, and rehabilitation activity data are collected through wearable or motion sensors. Machine learning models analyze these behavioral and physical indicators to identify potential dropout risks. Healthcare professionals can use the predictions to provide timely intervention and personalized rehabilitation support. The system helps improve patient engagement, rehabilitation continuity, and long-term recovery outcomes.

Machine Learning and AI Applied to fNIRS Data Reveals Novel Brain Activity Biomarkers in Stable Subclinical Multiple Sclerosis

This system applies artificial intelligence and machine learning techniques to functional near-infrared spectroscopy data for analyzing brain activity. The system extracts meaningful neural patterns from fNIRS signals collected from individuals with subclinical multiple sclerosis. Machine learning algorithms identify potential brain activity biomarkers that may not be easily detected through conventional analysis. Visualization and classification techniques help researchers understand neurological changes and disease-related patterns. The system supports advanced neurological research and early identification of meaningful brain activity indicators.

Sub-Connection Learning for fMRI-Based Brain Functional Network

This system uses machine learning to analyze functional magnetic resonance imaging data and identify relationships between different brain regions. Sub-connection learning focuses on discovering meaningful connections within complex brain functional networks. The extracted connectivity patterns can be used to understand brain organization and neurological variations. Machine learning techniques help classify and analyze functional network structures efficiently. The system provides valuable insights for neuroscience research and brain-related disorder analysis.

NEuRT: A Transformer-Based Model for Explainable Neuronal Activity Analysis

NEuRT is a Transformer-based machine learning system designed to analyze neuronal activity and identify important neural patterns. The model processes sequential neuronal signals and learns relationships between different activity patterns. Explainable AI techniques are incorporated to show which features contribute to the model's predictions. Researchers can use the generated insights to better understand complex neuronal behavior. The system supports transparent and interpretable analysis of neural activity data.

Large Language Models Improve Scene-Invariant Detection of Behavior of Risk in Dementia Residential Care Across Multiple Surveillance Camera Views

This system uses large language models and computer vision techniques to detect potentially risky behaviors in dementia residential care environments. Video information from multiple surveillance cameras is analyzed to identify activities such as falls, wandering, or other unsafe behaviors. Scene-invariant learning enables the system to recognize relevant behaviors across different camera locations and environments. AI models convert visual observations into meaningful behavioral information for caregivers. The system supports continuous monitoring, early risk detection, and improved patient safety.

Dictionary Learning for Phase-Less Beam Alignment Codebook Design in Multipath Channels

This system applies dictionary learning techniques to improve beam alignment in wireless communication environments with multipath channels. Wireless signal characteristics are analyzed to develop efficient beamforming codebooks without requiring complete phase information. Machine learning identifies representative signal patterns and optimizes the available beam directions. The approach can reduce alignment complexity while improving communication performance. The system is useful for advanced wireless networks and high-speed communication applications.

Impact of Sensory Haptic Vibrotactile Feedback on Manual Dexterity in Augmented Reality

This system investigates how vibrotactile feedback influences human manual dexterity during augmented reality interactions. Users perform interactive tasks while receiving different forms of haptic sensory feedback through wearable or interactive devices. Performance indicators such as accuracy, completion time, and movement efficiency are analyzed. Data analytics and machine learning can be used to identify the relationship between feedback and user performance. The system supports the development of more effective and immersive augmented reality interfaces.

Deep Feature Learning From Electromyographic Signals for Gesture Recognition Systems

This system uses deep learning to recognize human gestures from electromyographic signals collected through wearable sensors. EMG signals generated by muscle activity are preprocessed to remove noise and extract meaningful patterns. Deep neural networks automatically learn important signal features without requiring extensive manual feature engineering. The trained model classifies different gestures and provides real-time recognition capabilities. The system can be applied to human-computer interaction, assistive technologies, and wearable control systems.

OPTIMUS: Predicting Multivariate Outcomes in Alzheimer's Disease Using Multi-Modal Data Amidst Missing Values

OPTIMUS is a machine learning framework designed to predict multiple Alzheimer's disease outcomes using different types of patient data. The system integrates clinical, imaging, demographic, and other healthcare information from multiple modalities. Special data-processing techniques are used to handle missing values and incomplete patient records. Machine learning models analyze combined information to generate reliable predictions for disease-related outcomes. The system supports personalized assessment, clinical research, and improved Alzheimer's disease management.

The Value of Corrective Feedback in the Online Active Learning Paradigm

This system studies the effectiveness of corrective feedback within an online active learning environment. Machine learning models continuously learn from incoming data while requesting feedback for uncertain or incorrectly classified instances. Corrective responses are incorporated into the learning process to improve model accuracy over time. Performance metrics are used to compare learning behavior with and without user feedback. The system demonstrates how interactive feedback can improve adaptive machine learning system

Intelligent System for Upper Limb Motor Assessment Using Inertial Sensors and Machine Learning for Telerehabilitation Therapies

This system uses inertial sensors and machine learning to evaluate upper limb movements during remote rehabilitation sessions. Sensors capture motion parameters such as acceleration, orientation, movement speed, and range of motion. Machine learning models analyze these signals to assess exercise performance and identify abnormal movement patterns. The results can be displayed through a dashboard for therapists and patients to monitor rehabilitation progress. The system enables objective, remote, and personalized upper limb rehabilitation assessment.

Fairness via Fuzzy Systems: Analysis of Accuracy–Fairness Tradeoff by Multiobjective Fuzzy Genetics-Based Machine Learning

This system investigates the balance between prediction accuracy and fairness in machine learning models. Fuzzy logic is used to represent uncertain relationships between input features and prediction outcomes. Genetic algorithms optimize multiple objectives simultaneously to improve both model accuracy and fairness. The system evaluates how different model configurations affect biased or unequal predictions. It supports the development of more responsible, transparent, and fair artificial intelligence systems.

Detecting the Presence of COVID-19 Vaccination Hesitancy From South African Twitter Data Using Machine Learning

This system applies machine learning and natural language processing to identify COVID-19 vaccination hesitancy from social media posts. Publicly available Twitter data is processed to extract opinions, sentiments, keywords, and behavioral patterns related to vaccination. NLP models classify posts according to different levels or indicators of vaccine hesitancy. Data visualization helps researchers understand major trends and public attitudes. The system can support public health research and targeted communication strategies.

A Scoping Review of Machine Learning Approaches for Predicting Lower Extremity Joint Contact Loads: Current Trends, Common Pitfalls and Future Directions

This project reviews machine learning approaches used for predicting contact loads in lower extremity joints. Different datasets, algorithms, input features, and evaluation methods are analyzed and compared. The system identifies common challenges such as insufficient datasets, inconsistent validation, and inappropriate model selection. Findings are organized to highlight current research trends and limitations. The study provides useful guidance for developing reliable machine learning models for biomechanical analysis.

Virtual Speech Therapy Room: A Machine Learning-Based Neuro-Behavior Sensing Virtual Reality System for Aphasia Assessment and Treatment Through Multimodal Fusion

This system combines virtual reality, machine learning, and multimodal sensing for aphasia assessment and speech therapy. Patient speech, facial expressions, gestures, and behavioral signals can be collected during virtual therapy sessions. Machine learning models fuse these different data sources to assess communication performance and therapy progress. The virtual environment provides interactive exercises designed to improve patient engagement. The system supports personalized, immersive, and data-driven speech rehabilitation.

ACHILLES: A Machine Learning Framework for Explainable and Generalized Automotive Intrusion Detection System

ACHILLES is a machine learning framework designed to detect cybersecurity attacks in automotive systems. Vehicle network data is continuously analyzed to identify abnormal communication patterns and potential intrusion attempts. Machine learning models classify normal and malicious activities while explainable AI techniques help identify the reasons behind predictions. The framework is designed to generalize across different automotive environments and attack patterns. It improves vehicle cybersecurity monitoring and supports transparent intrusion detection.

Employing Eye Tracking to Assess Proficiency Level in Manufacturing Tasks via Machine Learning

This system uses eye-tracking technology and machine learning to evaluate worker proficiency during manufacturing tasks. Eye movement features such as fixation duration, gaze direction, and visual attention patterns are collected during task execution. Machine learning models analyze these features to estimate the user's experience and skill level. Managers can use the results to identify training requirements and improve workforce development. The system provides an objective approach for assessing manufacturing task proficiency.

A Vision-Based System for Automated Sign Language Teaching

This system uses computer vision and machine learning to automatically recognize sign language gestures for educational purposes. Camera input captures hand movements and visual features, which are processed and classified by a trained recognition model. The system provides feedback to learners based on whether the performed signs are correct. Interactive visual outputs can help users understand and practice different signs. The solution supports accessible and technology-assisted sign language learning.

Toward a Machine Learning-Driven Digital Twin for Real-Time Hormone Biosensing in Personalized Infertility Care

This system proposes a machine learning-driven digital twin for monitoring hormone-related information in personalized infertility care. Real-time biosensor data is collected and transferred to an intelligent digital representation of the individual's physiological condition. Machine learning models analyze hormone patterns and identify changes that may be relevant to fertility monitoring. Predictive analytics can provide personalized insights based on historical and real-time data. The system supports continuous monitoring and personalized decision-making in reproductive healthcare.

Deep Reinforcement Learning-Based Scheduling for Wi-Fi Multi-Access Point Coordination

This system uses deep reinforcement learning to optimize scheduling among multiple Wi-Fi access points. Network conditions such as traffic load, channel usage, interference, and user demand are continuously observed. The reinforcement learning agent learns suitable scheduling decisions through interaction with the network environment. The objective is to improve throughput, reduce interference, and provide efficient resource utilization. The system supports intelligent management of dense and dynamic wireless networks.

MACHINE LEARNING

Fast Real-World Classification of ECH-Enabled Applications

This system proposes a machine learning-driven digital twin for monitoring hormone-related information in personalized infertility care. Real-time biosensor data is collected and transferred to an intelligent digital representation of the individual's physiological condition. Machine learning models analyze hormone patterns and identify changes that may be relevant to fertility monitoring. Predictive analytics can provide personalized insights based on historical and real-time data. The system supports continuous monitoring and personalized decision-making in reproductive healthcare.

Machine Learning and Cultural Heritage: An Italian Perspective

This project explores the application of machine learning techniques in the preservation and analysis of cultural heritage. Historical documents, artworks, images, monuments, and other cultural resources can be processed using intelligent algorithms. Machine learning supports tasks such as classification, restoration analysis, image recognition, and heritage documentation. Data visualization can help researchers identify patterns across cultural collections. The system demonstrates how AI can contribute to digital preservation and cultural heritage management.

Distributed Agentic AI Framework for Autonomous Edge-Cloud Service Orchestration

This system introduces a distributed agentic AI framework for automatically managing services across edge and cloud environments. Multiple intelligent agents monitor computing resources, network conditions, workloads, and application requirements. AI-based decision-making determines where and how services should be deployed or migrated. Distributed orchestration helps reduce latency and improve resource utilization. The system supports autonomous and adaptive management of modern edge-cloud infrastructure.

Minimum Foot Clearance Prediction in Stroke Survivors: A Transformer-Based Approach

This system uses Transformer-based machine learning to predict minimum foot clearance during walking in stroke survivors. Motion sensors or gait data are analyzed to capture important movement characteristics. The Transformer model learns temporal relationships between gait sequences and predicts potential foot clearance values. The predictions can help identify abnormal gait patterns and potential fall risks. The system supports objective gait assessment and personalized rehabilitation planning.

Dictionary Learning for Phase-Less Beam Alignment Codebook Design in Multipath Channels

This system applies dictionary learning to create efficient beam alignment codebooks for multipath wireless communication channels. Signal characteristics are analyzed to learn representative beam patterns from available communication data. The method reduces dependence on phase information while maintaining effective beam selection. Machine learning techniques optimize the codebook for improved signal alignment and communication quality. The approach can be useful for next-generation wireless communication systems.

Forecasting Dropout in Home-Based Movement Rehabilitation After Stroke With Sensors and Machine Learning

This system predicts the likelihood of stroke patients discontinuing home-based movement rehabilitation using sensor and machine learning data. Wearable sensors collect information about exercise activity, movement consistency, and rehabilitation participation. Machine learning models analyze these patterns to identify patients who may be at higher risk of dropout. Healthcare professionals can use these predictions to provide personalized support and timely intervention. The system aims to improve rehabilitation adherence and patient recovery.

Machine Learning and AI Applied to fNIRS Data Reveals Novel Brain Activity Biomarkers in Stable Subclinical Multiple Sclerosis

This system analyzes fNIRS brain activity data using artificial intelligence and machine learning methods. Neural signals are processed to extract meaningful features associated with brain function in subclinical multiple sclerosis. Machine learning models identify patterns that may serve as potential neurological biomarkers. The results can be visualized to support interpretation of complex brain activity information. The system contributes to data-driven neurological research and biomarker discovery.

Development and Validation of a Wearable Intelligent Telerehabilitation Device for Postoperative Rehabilitation of Chronic Ankle Instability Using a Portable Integrated Sensors System and Few-Shot Learning Algorithm

This system develops a wearable device for monitoring postoperative ankle rehabilitation using integrated motion and physiological sensors. The collected data is analyzed using few-shot learning, allowing the system to work effectively even with limited training samples. Machine learning evaluates rehabilitation movements and identifies progress or abnormal exercise patterns. A remote dashboard can provide therapists with continuous patient performance information. The system enables intelligent, portable, and personalized telerehabilitation for ankle recovery.

Peering Partner Recommendation for ISPs Using Machine Learning

This system uses machine learning to recommend suitable peering partners for Internet Service Providers. Network traffic, latency, geographical information, bandwidth requirements, and connectivity characteristics are analyzed. Machine learning models identify relationships between ISPs and predict potentially beneficial peering opportunities. Recommendations can help improve routing efficiency and reduce network communication costs. The system supports intelligent decision-making for Internet infrastructure management.

Development of an Experimental Test Stand and Machine Learning Surrogate Models for Capturing Complex Responses in Pulsed Septa

This system combines experimental testing with machine learning to model complex responses in pulsed septa. An experimental test stand collects measurements under different operating conditions and input parameters. The collected data is used to train surrogate machine learning models that approximate complex physical behavior. These models can provide faster predictions compared with repeated physical experiments. The system supports efficient analysis, simulation, and optimization of complex engineering systems.

A Scoping Review of Machine Learning Approaches for Predicting Lower Extremity Joint Contact Loads: Current Trends, Common Pitfalls and Future Directions

This project investigates existing machine learning methods for predicting contact loads in lower extremity joints. Different algorithms, datasets, input features, and evaluation strategies are systematically reviewed. The study identifies common methodological problems that may affect model reliability and generalization. Research trends and future opportunities are organized to provide a comprehensive technical overview. The work supports researchers in developing more accurate and clinically useful biomechanical prediction systems.

Virtual Speech Therapy Room: A Machine Learning-Based Neuro-Behavior Sensing Virtual Reality System for Aphasia Assessment and Treatment Through Multimodal Fusion

This system provides a virtual reality environment for speech therapy and aphasia assessment using machine learning. Speech, facial behavior, gestures, and other patient responses are captured through multiple sensing modalities. Multimodal fusion combines these signals to evaluate communication and behavioral performance. Machine learning models provide intelligent assessment and progress monitoring during therapy sessions. The system creates an interactive and personalized environment for technology-assisted speech rehabilitation.

ACHILLES: A Machine Learning Framework for Explainable and Generalized Automotive Intrusion Detection System

ACHILLES is an intelligent automotive cybersecurity system that detects malicious activities in vehicle communication networks. Vehicle network traffic is analyzed to identify deviations from normal communication behavior. Machine learning models classify potential attacks and explainable AI methods provide interpretable reasons for detection decisions. The generalized framework is designed to handle different automotive environments and attack scenarios. It provides a reliable approach for intelligent and transparent automotive intrusion detection.

Addressing Nonnegligible Model Uncertainty in Machine Learning-Assisted Measurements

This system focuses on identifying and managing uncertainty in measurements assisted by machine learning models. Measurement data is analyzed to determine how prediction errors and model uncertainty influence the final results. Statistical and machine learning techniques can be used to quantify uncertainty and improve prediction reliability. The system provides confidence information along with predicted measurements for better interpretation. It supports safer and more reliable deployment of machine learning in measurement applications.

Variational GAN-Enhanced Causal Effect Inference for Interpretable Learning in Heterogeneous IoT Systems

This system combines Variational Generative Adversarial Networks with causal inference for analyzing heterogeneous IoT data. IoT devices generate diverse data streams that may contain missing, noisy, or complex relationships. The proposed approach learns realistic data representations and estimates causal effects between important variables. Explainable techniques help users understand how different IoT factors influence system outcomes. The system supports interpretable and intelligent decision-making in complex IoT environments.

A Vision-Based System for Automated Sign Language Teaching

This system uses computer vision and machine learning to provide automated sign language teaching through camera-based interaction. Hand gestures are captured and processed to identify the performed sign using visual recognition techniques. The system compares recognized gestures with expected signs and provides immediate learning feedback. Interactive visual guidance helps users practice and improve their signing skills. The solution promotes accessible, interactive, and technology-based sign language education.

Task-Specific Sharpness-Aware O-RAN Resource Management Using Multi-Agent Reinforcement Learning

This system applies multi-agent reinforcement learning to optimize resource management in Open Radio Access Network environments. Multiple intelligent agents observe network traffic, resource availability, user requirements, and task-specific conditions. Sharpness-aware optimization improves model generalization while agents learn effective resource allocation strategies. The system aims to improve network efficiency, reduce resource wastage, and maintain service quality. It supports intelligent and adaptive resource management for next-generation O-RAN systems.

Enhancing Dynamic Security Assessment in Smart Grids Through Quantum Federated Learning

This system combines quantum computing concepts and federated learning to improve security assessment in smart grid environments. Distributed energy systems generate sensitive operational data that cannot always be centrally collected. Federated learning allows participating devices or organizations to train models while keeping local data private. Quantum-inspired or quantum machine learning techniques can enhance complex security analysis. The system supports privacy-preserving, intelligent, and adaptive detection of security threats in smart grids.

Toward a Machine Learning-Driven Digital Twin for Real-Time Hormone Biosensing in Personalized Infertility Care

This system develops a digital twin concept for continuously monitoring hormone-related information using biosensors and machine learning. Real-time sensor measurements are processed to create a personalized digital representation of physiological changes. Machine learning models identify patterns and predict relevant changes based on historical and current hormone information. The system can provide personalized insights for monitoring fertility-related conditions. It supports continuous, intelligent, and data-driven healthcare management.

Rethinking the Flow: A Canal-Based Machine Learning Approach to Urban Flood Detection

This system uses machine learning to detect and monitor urban flooding with a focus on canal and water-flow conditions. Sensor and environmental data such as water levels, rainfall, flow rate, and drainage conditions are collected. Machine learning models identify patterns associated with increasing flood risk and abnormal water flow. The results can be presented through a real-time monitoring dashboard with alerts. The system supports early flood detection and improved urban disaster management.

Wearable-Based Emotion Recognition Using Electrocardiogram and Galvanic Skin Response and Instrumentation Audit: A Systematic Review

This project analyzes wearable-based emotion recognition approaches using ECG and galvanic skin response signals. Physiological signals collected through wearable devices are examined for their ability to represent different emotional states. Machine learning techniques are reviewed for signal processing, feature extraction, and emotion classification. The study also evaluates instrumentation methods, datasets, and common limitations across existing systems. It provides insights into reliable and practical wearable emotion recognition technologies.

A New kk-Anonymity Method Based on Generalization First kk-Member Clustering for Healthcare Data

This system uses machine learning to detect and monitor urban flooding with a focus on canal and water-flow conditions. Sensor and environmental data such as water levels, rainfall, flow rate, and drainage conditions are collected. Machine learning models identify patterns associated with increasing flood risk and abnormal water flow. The results can be presented through a real-time monitoring dashboard with alerts. The system supports early flood detection and improved urban disaster management.

Manifold Learning Approaches for Characterizing Photoplethysmographic Signals

This system applies manifold learning techniques to analyze and characterize photoplethysmographic signals. PPG data collected from wearable or medical sensors is processed to remove noise and extract relevant signal patterns. Manifold learning reduces complex high-dimensional signal information into meaningful representations. These representations can be used for visualization, classification, and physiological analysis. The system supports intelligent analysis of PPG signals for health monitoring applications.

Equivariant Multi-Agent Reinforcement Learning for Multimodal Vehicle-to-Infrastructure Systems

This system applies multi-agent reinforcement learning to intelligent vehicle-to-infrastructure communication environments. Multiple vehicles and infrastructure units act as autonomous agents that share information and make coordinated decisions. Equivariant learning helps the system maintain consistent behavior under different spatial configurations and transformations. The agents learn optimal communication and coordination strategies based on changing traffic conditions. The system supports efficient, adaptive, and intelligent transportation infrastructure.

Building-to-Building Grid Energy Exchange Optimization: A Rolling Horizon Game Theory Approach With Machine Learning Forecasting

This system optimizes energy exchange between buildings using machine learning forecasting and game theory. Historical energy consumption and generation data are analyzed to predict future electricity requirements. A rolling horizon approach continuously updates energy decisions as new information becomes available. Game-theoretic optimization helps buildings coordinate energy buying, selling, and sharing decisions. The system supports efficient energy utilization, cost reduction, and intelligent building-level energy management.

An Intrinsically Knowledge-Transferring Developmental Spiking Neural Network for Tactile Classification

This system uses a developmental spiking neural network to classify tactile information from sensory inputs. Tactile signals are processed as time-dependent neural patterns that resemble biological information processing. The network transfers learned knowledge between related tasks to improve classification with limited training data. Spiking neural mechanisms enable efficient processing of temporal sensory information. The system can be applied to robotics, prosthetics, and intelligent tactile sensing applications.

Heel-Tapping-Based Parkinson’s Disease Progression Monitoring Using Smart Insoles

This system uses smart insoles to monitor heel-tapping movements for assessing Parkinson's disease progression. Embedded sensors capture movement characteristics such as tapping frequency, force, timing, and consistency. Machine learning techniques analyze these measurements to identify patterns associated with motor impairment. Historical results can be compared to track changes in patient performance over time. The system provides a portable and non-invasive approach for continuous Parkinson's disease monitoring.

Accurate and Efficient Prediction of Wi-Fi Link Quality Based on Machine Learning

This system uses machine learning to predict Wi-Fi link quality under different network conditions. Parameters such as signal strength, packet loss, latency, interference, and throughput are collected from wireless connections. Machine learning models learn relationships between these network features and link-quality measurements. The predicted quality can help optimize connection selection and network resource management. The system improves wireless reliability and supports efficient Wi-Fi performance monitoring.

Multi-Temporal Device Clustering for Federated Learning-Internet of Things Intrusion Detection Systems

This system combines device clustering, federated learning, and IoT intrusion detection to improve cybersecurity. IoT devices are grouped according to their behavior and network characteristics over multiple time periods. Federated learning enables distributed devices to collaboratively train intrusion detection models without directly sharing sensitive local data. Temporal clustering helps identify changing device behaviors and emerging attack patterns. The system provides a scalable and privacy-preserving approach to IoT security monitoring.

Machine Learning Validation of a Physical Prime Random Number Generator

This system uses machine learning to validate the randomness and statistical behavior of a physical prime random number generator. Random sequences generated by the physical system are collected and analyzed using different statistical and machine learning techniques. The models identify potential patterns, correlations, or irregularities that could indicate weaknesses in the generated sequence. Performance results are compared against established randomness requirements and evaluation criteria. The system provides an intelligent approach for testing and validating the reliability of physical random number generators.

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