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Advancing Accessible Tennis Training: An AI-powered Personalized Application for Children With Special Needs

Zhentao Bao¹, Rodrigo Onate², ¹USA, ²California State Polytechnic University, Pomona, CA, 91768

ABSTRACT

This research addresses the barriers children face in accessing quality tennis instruction, particularly those with special needs who require personalized learning approaches. Traditional programs often lack individualized teaching methods and accessibility, with approximately 60% of children dropping out of organized sports by age 13 due to cost, limited access, and engagement challenges. To overcome these issues, the proposed AI-powered tennis training application leverages OpenAI's ChatGPT API, Firebase cloud infrastructure, and progressive level systems to deliver personalized, narrative-driven training experiences [1]. Its three core systems include AI content generation for individualized exercise descriptions, Firebase authentication for secure user management, and real time progress tracking with visual feedback [2]. Key design challenges were resolved through caching strategies, fallback content mechanisms, and autism-specific personalization features. User testing with five participants yielded an average satisfaction score of 4.32/5.0, with particularly high ratings for age-appropriate content (4.8/5.0) and progression clarity (4.6/5.0). By eliminating cost barriers and offering therapeutic benefits through individualized AI-generated content, this solution makes tennis instruction more accessible while fostering sustainable engagement through imaginative, personalized adventure narratives.

KEYWORDS

AI-powered training, Personalized learning, Tennis accessibility, Autism-friendly design.

Rhythmiq: An AI-powered Mobile Application for Accessible, Interactive, and Social Dance Learning

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ABSTRACT

Rhythmiq is a mobile app that seeks to make dance learning available for all in a less expensive, interactive, and social manner [1]. It addresses the problem of expensiveness, non-interactivity, and inaccessibility of dance learning apps, especially for beginners and low-income groups. Rhythmiq combines AI-powered choreography, music sync, and an in-app posting feature to provide a comprehensive and user-friendly dance experience [2]. The application makes use of technologies such as Flutter for development, Firebase for real-time data and authentication, and pose estimation for enabling precise movement feedback. The notable systems include the Authentication System, Choreography Generation System, and Community Posting System. While developing, we addressed design issues by considering user flow, accessibility, and responsive UI. To evaluate the app, we employed a 10-item user survey involving five participants that yielded a high mean score of 4.2/5, where top recommendation was the feature rating. Rhythmiq provides everyone with the ability to dance socially and freely with confidence, and it is therefore an asset to creative expression and physical well-being.

KEYWORDS

Dance Learning, AI-Powered Choreography, Mobile Application, Pose Estimation.

An Intelligent Mobile Application to Improve Users Shooting Motion and Compare Them with NBA Players using Machine Learning and Large Language Models

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ABSTRACT

Basketball is one of the most popular sports worldwide, with over 610 million people aged 6 to 54 playing the game at least twice a month, according to FIBA. However, access to systematic and professional basketball training remains limited, especially in developing countries, where only 1%–3% of players may receive professional coaching. This lack of access makes it difficult for most basketball enthusiasts to learn and refine proper shooting techniques. To address this issue, we propose Sharp Shooter—a mobile application that helps users improve their shooting form without requiring professional training or expensive equipment. Our solution combines several cutting-edge technologies: MediaPipe is used to extract key body landmarks from users uploaded shooting videos; these landmarks are then analyzed by a large language model (LLM) to provide expert-level feedback [10]. Additionally, the app matches users' shooting forms with those of professional NBA players stored in a custom database, allowing users to see which NBA player their form most resembles—further enhancing engagement and motivation. The project integrates several key components, including a cross-platform front end built with Flutter, a Flask-based backend hosted on AWS, and a machine learning pipeline utilizing YOLOv5 for object detection and Random Forest or LSTM for motion quality assessment [11]. During development, we encountered challenges related to efficient video processing, backend scalability, data security, and precise motion evaluation. These were addressed through asynchronous data handling, load balancing, encrypted communications, and model optimization. The app was tested in various real-world use cases, including indoor and outdoor shooting scenarios, different lighting conditions, and varied camera positions. It consistently delivered actionable feedback, helping users recognize flaws in their form and track improvement over time. Our findings demonstrate that Sharp Shooter is a scalable, accessible, and affordable tool for basketball players at all levels. It offers a novel way for individuals—

especially in under-resourced communities—to receive professional style feedback and engage with the game in a more meaningful and data-driven way.

KEYWORDS

MediaPipe, Random Forest, Mobile Application, Shooting Motion, Large Language Model.

Implementation of an Electronic Circuit to Study the Performance Parameters of the Modbus-rtu Protocol and Verify Its Model Ability Using the Opnet Simulation

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ABSTRACT

Industrial protocols exchange data between different automation devices. MODBUS is the most widely used industrial protocol. This paper presented a practical circuit consisting of two units that exchange data with each other according to the MODBUS-RTU protocol in order to study performance parameters such as (frame delay, frame rate) and to verify the model ability of this type of protocol using the OPNET simulator by conducting comparisons between the values of the studied parameters. The results showed high performance of the MODBUS-RTU protocol in automating industrial processes and confirmed the ability of the OPNET simulator to characterize the behavior of networks operating on the studied protocol.

KEYWORDS

MODBUS protocol, industrial network performance analysis, study of factors affecting performance, MODBUS protocol modeling using OPNET, industrial protocol modeling using OPNET

Automated Morphological Analysis of Neurons in Fluorescence Microscopy Using Yolov8

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ABSTRACT

Accurate segmentation and precise morphological analysis of neuronal cells in fluorescence microscopy images are crucial steps in neuroscience and biomedical imaging applications. However, this process is time-consuming and labor-intensive, requiring significant manual effort and expertise to ensure reliable results. This work presents a pipeline for neuron instance segmentation and measurement based on a high-resolution dataset of stem-cell-derived neurons. The proposed method uses YOLOv8, trained on manually annotated microscopy images. The model achieved high segmentation accuracy, exceeding 97%. In addition, the pipeline utilized both ground truth and predicted masks to extract biologically significant features, including cell length, width, area, and grayscale intensity values. The overall accuracy of the extracted morphological measurements reached 75.32%, further supporting the effectiveness of the proposed approach. This integrated framework offers a valuable tool for automated analysis in cell imaging and neuroscience research, reducing the need for manual annotation and enabling scalable, precise quantification of neuron morphology.

KEYWORDS

Neuron Segmentation, Fluorescence Microscopy, YOLOv8, Morphological Analysis, Instance Segmentation.

A Desktop Application to Assist in Detecting and Predicting Alzheimer's Disease using Facial Recognition and Brainwave Monitoring

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ABSTRACT

The project aims to address the lack of convenient tools to identify early signs of Alzheimer's disease [4]. Current tools are challenging to utilize, costly, and inaccessible to many. Our proposed solution is a straightforward computer program utilizing face recognition and brainwave data to detect potential early signs of Alzheimer's. The solution utilizes MediaPipe to analyze facial movements, a Muse2 EEG headband to record data, and OpenAI's API to analyze data using prompts [5]. We encountered challenges with low-quality EEG data and required improved prompts and stable face tracking. We conducted two experiments to test how effective the prompts were and how well MediaPipe performed, and both demonstrated that the system is responsive to a set of words and the user's states. Our proposal is affordable, easily scalable, and user-friendly for non-tech users relative to alternative services. The program assists in keeping track of cognitive functions, making screening for Alzheimer's more accessible using readily available technology.

KEYWORDS

Alzheimer's Disease, Face Recognition, Brainwave Analysis, Prompt Engineering.

Design and Evaluation of a Low-cost 3d Scanning System using ToF Imaging and Raspberry Pi

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ABSTRACT

This paper presents the design and evaluation of a low-cost 3D scanning system that integrates an Arducam Time-ofFlight (ToF) camera, a Raspberry Pi for data processing, and a custom motorized turntable driven by an RP2040 microcontroller [1]. The objective was to create an accessible and affordable alternative to professional 3D scanners while maintaining sufficient accuracy for prototyping and educational use [2]. The system captures depth images as the turntable rotates the object, producing a complete set of views for reconstruction. Experiments demonstrated strong dimensional accuracy, with deviations under $\pm 0.7\%$, and reliable performance under low and moderate lighting conditions, though bright light increased noise. Comparisons with related methodologies highlighted how our approach prioritizes affordability, modularity, and static object scanning, contrasting with solutions aimed at

robotics or large-scale mapping. Overall, the system provides a practical pathway toward democratizing 3D scanning technology, balancing cost with usability and performance.

KEYWORDS

3D Scanning, ToF Camera, Raspberry Pi, Data Processing, Biomedical Engineering.

Enhancing User Safety with Real-time Object Detection and Vibration Feedback: A Mobile Application Integrated with Yolov5, Flutter, and Nrf52 Hardware

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ABSTRACT

Providing a means of navigation for hard of seeing individuals has always been a challenge. The most infamous is the white walking cane that people usually associate with the hard of seeing. However, while the cane has undoubtedly helped many navigate their surroundings, the limitations posed are overtly clear when it comes to navigating with a white cane. The solution posed in this paper, the EchoSense, is a vest composed of an onboard microprocessor, distance sensors, haptic motors, and a corresponding mobile application. The vest will alert the user of immediate obstructions to their path using the distance sensors and haptic motors, while the mobile app uses advanced real-time object detection to alert the user of specific objects in their path via vibrations from the mobile app as well as vibrations from the vest in the direction of the recognized object [1]. The onboard microprocessor is a bluefruit nRF52, and uses Adafruit distance sensors and haptic motor controllers. The mobile application was built using the Flutter framework, and is available on both iOS and Google Play stores [2]. During the development process, many challenges were encountered and overcome. The biggest challenge posed was the development of the mobile application, as compiling many different libraries in a very bleeding edge framework is bound to have some conflicting dependencies. To test to ensure the efficacy and efficiency of the EchoSense project, multiple rounds of experimenting were performed to find the response time of the real-time object detection and hardware [3]. All experimental results were satisfactory, and can be viewed in this paper. The EchoSense is a great choice for the hard of seeing to rely on for their daily navigation, as it is cost effective, efficient, and provides a great deal of information about the user's surroundings without overwhelming their senses.

KEYWORDS

Real-time object detection, Mobile application, Yolov5, Bluetooth connectivity, Vibration feedback.

An Adaptive Mobile Application for Children With Disabilities: Combining AI-generated Storytelling, Gamification, and Exercise Engagement

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ABSTRACT

This paper addresses the persistent challenges children with autism and other disabilities face in engaging with regular physical activity, a factor strongly linked to long-term health outcomes. Many existing interventions rely on rigid rehabilitation methods that fail to sustain motivation or adapt to individual needs. To overcome this gap, we propose a mobile application that combines exercise tasks, gamification, and AI-generated storytelling. Built with Flutter, Firebase, and the ChatGPT API, the system integrates three components: secure authentication and profile management, personalized storytelling to enhance engagement, and a reward-based progression system [12]. Major challenges include ensuring age-appropriate content, balancing extrinsic and intrinsic motivation, and maintaining secure data storage. Experiments tested the personalization accuracy of AI-generated stories, revealing significantly higher engagement compared to generic narratives. The results highlight the importance of detailed profiles and adaptive feedback. Ultimately, this project demonstrates a scalable, inclusive, and enjoyable approach to motivating healthier lifestyles in children with disabilities.

KEYWORDS

Assistive Technology, AI Storytelling, Gamification, Autism and Disabilities, Mobile Health Applications.

A Computational Approach to Feature Selection and Enrollment Forecasting in Brazilian Schools

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ABSTRACT

The lack of accurate information about the estimated number of students to enroll in a school can lead to losses for the government, the school, and, mainly, for the students. Examples include (insufficient or excessive) financial transfers from the government to schools and the inadequate allocation of resources (e.g., number of teachers and availability of teaching materials) to students. In our experiments, we used a dataset from the Brazilian school census provided by the Ministry of Education, which contains 340 characteristic attributes of schools and their respective teaching stages. The large quantity and nature of this data make data analysis more complex, which requires an appropriate method for feature selection to enrollment predictive models. In this sense, this study explores the application of Machine Learning algorithms as a solution to the problem of predicting enrollment. The ML algorithms used in this study included random forest, multilayer perceptron, linear regression, and support vector regression. We evaluated the performance of the models using the cross-validation method, calculating the MAE, MSE, and RMSE metrics, in addition to the execution time and descriptive statistics about the number of features suggested by the selection methods employed. The results revealed that the Spearman correlation method with thresholds of 0.6 and 0.65 can reduce the dimensionality of the data and the execution time of the predictive models tested for enrollment prediction.

KEYWORDS

Feature Selection, Comparative Analysis, Forecasting, Enrollment Schools, Brazil.

An Intelligent Headlight Device to Assist with Medical Procedures using Voice Recognition

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ABSTRACT

This project introduces a wearable, voice-controlled surgical headlight designed to improve efficiency and sterility during medical procedures. Traditional headlights require manual adjustment, which can distract surgeons and increase the risk of contamination. Our solution integrates a mobile application, Bluetooth communication, and a microcontroller-driven LED system to enable hands-free control of light settings [1]. Key challenges addressed included voice recognition reliability, cross-platform compatibility, and ergonomic hardware design [2]. Experiments showed high recognition accuracy in quiet and moderately noisy environments, with Bluetooth stability remaining strong up to ten meters. Comparisons with existing methodologies revealed that while other approaches improve cost efficiency or overall lighting design, they lack the interactivity and adaptability provided by our system. Limitations such as battery life, noise interference, and hardware comfort remain, but potential improvements could overcome these issues. Ultimately, this project demonstrates a practical advancement toward smarter surgical tools that directly enhance surgeon workflow and patient safety.

KEYWORDS

Wearable Technology, Voice Control, LED system.

An Adaptive Mobile Application for Children with Disabilities: Combining AI-generated Storytelling, Gamification, and Exercise Engagement

Xihao Ning, Marisabel Chang, Santa Margarita, California State Polytechnic University, Pomona, CA 91768

ABSTRACT

This paper addresses the persistent challenges children with autism and other disabilities face in engaging with regular physical activity, a factor strongly linked to long-term health outcomes. Many existing interventions rely on rigid rehabilitation methods that fail to sustain motivation or adapt to individual needs. To overcome this gap, we propose a mobile application that combines exercise tasks, gamification, and AI-generated storytelling. Built with Flutter, Firebase, and the ChatGPT API, the system integrates three components: secure authentication and profile management, personalized storytelling to enhance engagement, and a reward-based progression system [12]. Major challenges include ensuring age-appropriate content, balancing extrinsic and intrinsic motivation, and maintaining secure data storage. Experiments tested the personalization accuracy of AI-generated stories, revealing significantly higher engagement compared to generic narratives. The results highlight the importance of detailed profiles and adaptive feedback. Ultimately, this project demonstrates a scalable, inclusive, and enjoyable approach to motivating healthier lifestyles in children with disabilities.

KEYWORDS

Assistive Technology, AI Storytelling, Gamification, Autism and Disabilities, Mobile Health Applications.

Reinforcement Learning From AI Feedback: A Cross-model Analysis of Performance, Scalability and Bias

Le Van Nguyen, Rory Sie, University of Wollongong, Australia

ABSTRACT

Reinforcement Learning with Human Feedback (RLHF) is commonly used to fine-tune large language models, improving summarization, dialogue generation, and content moderation. However, reliance on human annotations makes RLHF expensive and difficult to scale. Reinforcement Learning from AI Feedback (RLAIF) offers a promising alternative by using AI-generated preference labels. This paper evaluates RLAIF across three model families—T5, Phi-3.5, and LLaMA 3.2—spanning different sizes and architectures. We compare RLAIF with supervised fine-tuning (SFT) and assess scaling effects. Findings show RLAIF improves alignment across all models, though gains differ by architecture. These results highlight RLAIF's robustness and provide practical guidance for applying AI feedback to language model training.

KEYWORDS

Reinforcement Learning, AI Feedback, Large Language Models, Alignment, Scaling.

An Intelligent Assistance Extension to Assist in the Common Application Process

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ABSTRACT

College applications involve repetitive data entry across multiple platforms, creating inefficiencies and potential errors for students. Our Chrome extension addresses this through automated form-filling, progress tracking, and AI-powered writing assistance [7]. The system comprises three core components: a user-friendly frontend with popup and options interfaces, an AI integration system using OpenAI APIs, and a secure local data management system [8]. Key challenges included form field detection across varying website structures and balancing AI assistance with authentic voice preservation. We addressed detection issues through multiple CSS selector strategies and maintained authenticity through contextual suggestions rather than direct generation [9]. Experiments demonstrated 83% form detection accuracy and 76% AI suggestion acceptance rates. The extension significantly reduces application time while improving accuracy and essay quality, making it valuable for students navigating the complex college application process efficiently.

KEYWORDS

LLM, Artificial Intelligence, OpenAI API.

Melodydrop: A Portable Led-guided Piano Learning System With Real-time Midi Synchronization via Ble

Yuelin Cheng¹ and Jonathan Sahagun², ¹USA, ²California State Polytechnic University, Pomona, CA, 91768

ABSTRACT

MelodyDrop is a mobile application designed to improve piano learning by synchronizing MIDI playback with both falling-note animations and physical LED guidance via an ESP32-S3 microcontroller [1]. It addresses the difficulty beginners face when reading sheet music by offering a game-like interface and lighting up the exact keys to press. The system is composed of a Flutter app, a MIDI parsing engine, a custom BLE protocol, and an LED strip mounted on a piano [2]. Experiments showed that BLE latency remains low enough for real-time use and that LED-guided learning significantly improves accuracy compared to screen-only visualization. MelodyDrop builds on prior methods that used tactile or MusicXML-based feedback, but does so wirelessly and with greater portability. Its cross-platform nature and low-cost hardware make it widely accessible for casual learners and schools alike. Future improvements could include adaptive practice modes, cloud syncing, and expanded accessibility features. MelodyDrop provides a compelling, intuitive way to practice piano.

KEYWORDS

Piano Learning, MIDI, BLE, LED Guidance.

RBR: Recovering Bitcoin with Rarimo

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ABSTRACT

This paper outlines the set of approaches for Bitcoin recovery supported by the Rarimo protocol. While this task is resolved for assets on blockchains with smart contracts (through verification proofs of the Rarimo execution correctness), it becomes quite a challenge when we try to support networks that can't verify even SNARK proofs for a reasonable cost or at all. We introduce the RBR protocol that allows to realize recovery through a trustless escrow and show how it can be combined with existing Bitcoin recovery options.

KEYWORDS

Bitcoin recovery, Trustless escrow, SPV connector, Zero-knowledge proofs, Account abstraction.

Optimal Warehouse Distribution Center Placement using Evolutionary Algorithms

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ABSTRACT

In this paper, we offer a possible solution to one of the most important tasks a utility company must undertake: the management of warehouses containing equipment to be installed at various sites throughout the territory by specialized personnel. The challenges to be addressed include their distribution, so as not to slow down work, but also the fact that tasks to complete change constantly, requiring the opening, closing, and relocation of the corresponding warehouses. The study models the problem as an optimization problem and investigates how to compose multiple objectives, required by the company to select the warehouse location, in a single objective function, necessary to obtain a single solution, and evaluates the performance of a set of stochastic optimization algorithms, implemented in-house, to generate cost-effective solutions while adhering to the constraints of the problem. The results demonstrate that metaheuristic algorithms are highly effective in identifying optimal solutions, with Binary Particle Swarm Optimization and Population Based Incremental Learning having good performances.

KEYWORDS

Warehouse distribution, Logistics, Operations research, Metaheuristic Algorithms.

Melodydrop: A Portable Led-guided Piano Learning System with Real-Time Midi Synchronization via BLE

Yuelin Cheng¹, Jonathan Sahagun², ¹USA, ²California State Polytechnic University, Pomona, CA, 91768

ABSTRACT

MelodyDrop is a mobile application designed to improve piano learning by synchronizing MIDI playback with both falling-note animations and physical LED guidance via an ESP32-S3 microcontroller [1]. It addresses the difficulty beginners face when reading sheet music by offering a game-like interface and lighting up the exact keys to press. The system is composed of a Flutter app, a MIDI parsing engine, a custom BLE protocol, and an LED strip mounted on a piano [2]. Experiments showed that BLE latency remains low enough for real-time use and that LED-guided learning significantly improves accuracy compared to screen-only visualization. MelodyDrop builds on prior methods that used tactile or MusicXML-based feedback, but does so wirelessly and with greater portability. Its cross-platform nature and low-cost hardware make it widely accessible for casual learners and schools alike. Future improvements could include adaptive practice modes, cloud syncing, and expanded accessibility features. MelodyDrop provides a compelling, intuitive way to practice piano.

KEYWORDS

Piano Learning, MIDI, BLE, LED Guidance.

A Health and Budget Focused AI Powered Adaptive Meal Recommendation Application Integrating Predictive Nutritional Analytics and Continuous Weekly Dietary Profiling for Hyper Personalized Wellness Optimization

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ABSTRACT

Nutrition tracking tools often focus narrowly on macronutrients, and they completely neglect micronutritional accuracy, ingredient complexity, and personalization. This project addresses these gaps by developing an AI-powered adaptive meal recommendation application that integrates ingredient inventories, user health profiles, and predictive analytics to generate individualized meal plans [1]. Built with Flutter, Firebase, and large language models, the system provides real-time ingredient parsing, dietary restriction enforcement, and tailored nutrition guidance. Several challenges were encountered during development, including inconsistent food classification, data synchronization issues across app pages, and ensuring the AI generated consistent outputs in the required JSON schema. These were resolved through backend integration, stricter prompting, and external database support. Two experiments evaluated blind spots: dietary restriction enforcement (mean accuracy 90.7) and nutritional information generation across food categories (perfect accuracy for meat, lower for complex foods) [2]. Results confirm strong baseline reliability but highlight the need for refinement in parsing compound ingredients and micronutrients. Ultimately, this system demonstrates the feasibility of delivering hyper-personalized, health-focused meal recommendations that advance beyond existing static or generalized solutions.

KEYWORDS

Health, Nutritional Info, Mobile application development via flutter, Inventory food management, Meal recommendation via health issues

Ultrasonic Acoustic Standing Waves for Efficient Microplastic Removal: A Scalable and Sustainable Approach to Wastewater Treatment

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ABSTRACT

Microplastic contamination poses severe environmental and public health risks due to their persistence, bioaccumulation, and potential toxicity. Existing removal methods are limited by inefficiency, clogging, or by-product generation [1]. This project introduces an ultrasonic-based system for microplastic removal that leverages acoustic standing waves to concentrate particles for continuous filtration. The system integrates three main components: a controlled water circulation pump, an AD9833-driven ultrasonic transducer for frequency sweeps, and a turbidity sensing module for real-time performance evaluation. Two experiments were conducted to assess performance. Frequency sweeps identified 1.20 MHz as the optimal resonance for focusing, while pump testing revealed 50% duty as the best balance between residence time and throughput. Compared to prior methodologies that relied on degradation, aggregation, or microfluidics, our approach provides a scalable, low-maintenance, and environmentally sustainable solution [2]. The results confirm the promise of acoustics for practical wastewater treatment and set the foundation for further development.

KEYWORDS

Ultrasonic, Environmental engineering, Water filtration, Water pollution, Microplastics

A Wearable Iot-based Alert System for Infant Drowning Prevention Using Water Detection and Real-time Mobile Notifications

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ABSTRACT

Drowning remains a leading cause of preventable death among children, particularly infants, due to its rapid onset and silent nature [6]. Existing prevention methods such as pool fencing, supervision, and swim lessons reduce risk but are not foolproof. This paper presents a wearable drowning-prevention device that provides immediate alerts when water submersion is detected [7]. The system integrates a water sensor, an Adafruit RP2040 Prop-Maker Feather microcontroller, a surface transducer alarm, and a companion mobile app. Upon submersion, the device triggers both a loud audible alarm and a real-time smartphone notification to ensure rapid caregiver response. Experiments confirmed submersion detection in approximately 1.3 seconds on average, with minimal false alarms limited to heavy splash conditions. Compared to other methodologies, this solution offers a lightweight, infant-specific, and highly portable approach. Ultimately, the system demonstrates that wearable IoT devices can play a critical role in complementing traditional safety measures to prevent infant drownings.

KEYWORDS

Infant drowning prevention, Wearable safety device, IoT water detection, Real-time alerts, Child water safety.

An Intelligent Mobile Application Paired With a Book Flipper to Assist in Reading and Learning Using Artificial Intelligence and Image Parsing

Ethan Zhang¹, Tyler Boulom², ¹USA, ²California State Polytechnic University, USA

ABSTRACT

This research presents a combined mechanical and artificial intelligence solution designed to assist individuals with learning or physical disabilities in reading books more effectively [3]. The system consists of a low-cost book flipper, a camera for page capture, a Raspberry Pi for text extraction, and an AI module for summarization and explanation. Experiments evaluated two potential blind spots: mechanical accuracy of page flipping and the effect of lighting on OCR performance [4]. The page-flipping mechanism averaged 1.6 errors per trial, while OCR accuracy peaked at 91% under moderate exposure, highlighting the importance of environmental conditions. Comparisons with existing methodologies showed that previous systems emphasized digitization and preservation but did not address comprehension or accessibility. By contrast, this project enhances accessibility by not only digitizing books but also tailoring content through summarization. Ultimately, the system provides both a functional and educational tool, bridging the gap between traditional books and adaptive learning technologies.

KEYWORDS

Servo, Arduino, Raspberry Pi, Flutter.

Advancing Heart Disease Prognosis with a Hybrid Machine and Deep Learning Approach

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ABSTRACT

Heart disease is a leading cause of death globally, claiming approximately 17 million lives each year. Often, these deaths are due to heart failure, a condition where the heart cannot supply enough blood to meet the body's needs. To improve diagnosis and treatment, healthcare professionals increasingly rely on electronic medical records. These records are invaluable for detecting subtle patterns in symptoms and test results that might otherwise go unnoticed. In the realm of medical data analysis, data mining techniques have shown promise in predicting the outcomes of cardiovascular diseases. However, major challenges can occur—overfitting and managing large dimensions of data—can hinder their effectiveness. To address these issues, this paper proposes a novel method that simplifies the data through feature selection, making this model not only more efficient but also easier to understand. Specifically, we introduce a new framework that combines advanced feature selection algorithms (sequential forward and backward, or CSFB) with a blend of traditional machine learning and cutting-edge deep learning techniques. Utilizing algorithms like Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Random Forest (RF), and a deep learning classifier (Dl4jMlpClassifier), this method refines the data to improve predictions of heart disease outcomes. This work findings confirm that this integrated approach -CSFB feature selection combined with the CMD (Combined Machine and Deep learning) algorithm effectively identifies crucial data features and reliably predicts patient survival rates. This advancement holds significant potential for enhancing heart disease diagnostics and patient care strategies.

KEYWORDS

Heart disease prediction, Cardiovascular disease (CVD) prognosis, Deep learning, Feature selection, Overfitting prevention.

Solar-powered Auto-evaporative Car Cooling System with Smart Monitoring

Bill Yu¹, Jonathan Sahagun², ¹USA, ²California State Polytechnic University, Pomona, CA, 91768

ABSTRACT

StayCool is a portable, solar-powered evaporative cooling system designed to reduce extreme heat buildup inside parked vehicles [1]. The system addresses a critical comfort and safety issue, especially in hot climates where children, pets, and drivers are at risk of heatstroke [2]. It uses a Nordic nRF52840 microcontroller with temperature, humidity, and water level sensors to determine when to activate an onboard fan and misting system. Real-time data is sent to Firebase via an LTE Cat M1 modem, allowing users to monitor and control the system remotely through a mobile app. Experiments confirmed the

cooling system reliably activates at threshold temperatures and that cloud-based data synchronization remains fast in most conditions [3]. Challenges like water usage, power availability, and network latency were identified and addressed through hardware safeguards and app integration. Ultimately, StayCool demonstrates a smart, autonomous, and energy-efficient approach to keeping vehicle interiors safe and comfortable.

KEYWORDS

Automatic Evaporative cooler, Comfort, Portable Unit, Solar panel, Application

Enhancing Museum Engagement Through AI-powered Augmented Reality: Real-time Artwork Recognition and Contextual Description via AR Glasses

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ABSTRACT

Visitors often struggle to fully understand and appreciate museum artworks due to limited contextual information. This project proposes AR glasses that scan artworks and display real-time, AI-generated descriptions, providing historical background, artistic techniques, and symbolic meanings [1]. The system integrates three core components: image capture, AI-based classification and description, and real-time on-screen display. Key challenges addressed include accurate recognition under variable conditions, personalized content delivery, and accessibility for diverse users. Experiments measured recognition accuracy and system latency, identifying areas for improvement such as low-light performance and network optimization. Comparisons with prior methodologies show advancements in portability, adaptability, and real-time personalization [2]. The results indicate that the system significantly enhances engagement, understanding, and accessibility in museum learning environments. By merging augmented reality with AI-driven context delivery, this solution has the potential to transform art appreciation, offering visitors an immersive, adaptive, and more meaningful connection to cultural heritage.

KEYWORDS

Augmented Reality (AR), Artificial Intelligence (AI), Museum Learning, Artwork Recognition

Safelink: An IoT-enabled Smart Necklace for Real-time Personal Safety and Emergency Response

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ABSTRACT

Personal safety is a pressing issue, particularly for women and teenage girls, who face elevated risks in both public and private spaces [1]. Traditional safety devices and smartphone apps are often unreliable due to connectivity issues, ease of confiscation, or conspicuous designs. To address these challenges, we developed SafeLink, a discreet smart necklace integrating a Particle Boron microcontroller with LTE connectivity, a PA1010D GPS module, and an LSM6DSOX accelerometer/gyroscope [2]. Data is transmitted to Firebase, where it is accessed through a Flutter-based mobile app that manages emergency

contacts and provides real-time tracking. Experiments demonstrated that SafeLink performs reliably outdoors with minimal GPS error, though accuracy decreases indoors and in urban canyons [3]. Battery testing showed sufficient daily use but limited runtime in extended emergency scenarios. Compared with prior SMS-based child safety wearables, SafeLink improves responsiveness, automation, and usability. Ultimately, SafeLink provides a proactive, IoT-enabled solution that empowers women and teens with accessible, real-time personal safety technology.

KEYWORDS

Personal safety, Wearable technology, GPS tracking, IoT devices.

Design-based Supply Chain Operations Research Model: Fostering Resilience and Sustainability in Modern Supply Chains

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ABSTRACT

In the rapidly evolving landscape of global supply chains, where digital disruptions and sustainability imperatives converge, traditional operational frameworks often struggle to adapt. This paper introduces the Design-Based Supply Chain Operations Research Model (DSCORM), a novel extension of the Design SCOR (D-SCOR) framework, which embeds operational research (OR) techniques to enhance decision-making, resilience, and environmental stewardship. Building on the foundational processes of D-SCOR—such as Design, Orchestrate, Plan, Order, Source, Transform, Fulfil, and Return—DSCORM incorporates predictive analytics, simulation modelling, and optimization algorithms to address contemporary challenges like supply chain volatility and ESG (environmental, social, governance) compliance. Through a comprehensive literature synthesis and methodological approach involving case-based simulations, we explore DSCORMs hierarchical structure, performance metrics, implementation strategies, and digital modernization pathways. Results from simulated scenarios indicate potential efficiency gains of 15-25%, reduced carbon footprints by up to 20%, and improved agility in dynamic markets. Discussions delve into practical implications for industries like manufacturing and logistics, highlighting barriers such as data integration hurdles and the need for skilled workforces. By humanizing supply chain management—emphasizing collaborative, adaptive strategies over rigid automation—DSCORM positions itself as a blueprint for sustainable growth. Conclusions underscore its role in advancing digital transformation, with recommendations for future empirical validations in real-world settings [1][2]. This work contributes to the discourse on technology-driven sustainability, aligning with initiatives like the IOGP Digital Transformation Committee and broader efforts in green logistics. Keywords: Supply Chain Management, DSCORM, Operational Research, Digital Transformation, Sustainability, Resilience.

KEYWORDS

SCOR Operations, Design SCOR, Design for Supply Chain.

A Health and Budget Focused Ai Powered Adaptive Meal Recommendation Application Integrating Predictive Nutritional Analytics and Continuous Weekly Dietary Profiling for Hyper Personalized Wellness Optimization

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ABSTRACT

Nutrition tracking tools often focus narrowly on macronutrients, and they completely neglect micronutritional accuracy, ingredient complexity, and personalization. This project addresses these gaps by developing an AI-powered adaptive meal recommendation application that integrates ingredient inventories, user health profiles, and predictive analytics to generate individualized meal plans [1]. Built with Flutter, Firebase, and large language models, the system provides real-time ingredient parsing, dietary restriction enforcement, and tailored nutrition guidance. Several challenges were encountered during development, including inconsistent food classification, data synchronization issues across app pages, and ensuring the AI generated consistent outputs in the required JSON schema. These were resolved through backend integration, stricter prompting, and external database support. Two experiments evaluated blind spots: dietary restriction enforcement (mean accuracy 90.7) and nutritional information generation across food categories (perfect accuracy for meat, lower for complex foods) [2]. Results confirm strong baseline reliability but highlight the need for refinement in parsing compound ingredients and micronutrients. Ultimately, this system demonstrates the feasibility of delivering hyper-personalized, health-focused meal recommendations that advance beyond existing static or generalized solutions.

KEYWORDS

Health, Nutritional Info, Mobile application development via flutter, Inventory food management, Meal recommendation via health issues.

AI-driven Programming Education for Beginners:integrating Interactive Lessons, Natural Language Coding, and Secure Learning Systems

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ABSTRACT

This paper addresses the challenge of improving accessibility and engagement in programming education for beginners who often struggle with motivation and practical application. To tackle this issue, an interactive application was developed that integrates AI-assisted coding lessons, natural language input, voice-to-code generation, and secure login through Firebase [1]. The system relies on machine learning to produce structured lessons, process user prompts, and generate usable robotics code in real time [2]. Three central components—the lessons module, the voice input system, and the login mechanism—were analyzed in detail to illustrate their functionality. A survey experiment demonstrated strong results in usability, usefulness, and satisfaction, though accuracy was identified as an area for refinement. Comparisons with existing research highlighted that while other projects emphasize classroom evaluation or AI benchmarking, this system uniquely combines teaching and practice within one platform [3]. Overall, the findings suggest that the application provides an effective and scalable solution for programming education.

Keywords

AI coding education, Interactive learning app, Voice-to-code, Beginner programming.

ACompanion Connect: An Ai-enhanced Digital Platform for Reducing Student Loneliness and Promoting Mental Well-being in Higher Education

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ABSTRACT

Companion Connect, an innovative digital application designed to mitigate student loneliness and promote positive mental health outcomes through a blend of AI-powered companionship and human volunteer support. Recognizing loneliness as a rising issue in higher education impacting student well-being, the app aims to address limitations of traditional support systems by offering accessible, on-demand resources. Companion Connect, powered by OpenAI's ChatGPT, is specialized for mental health tasks, featuring customizable AI personality and name, mood detection capabilities, and weekly social challenges to encourage engagement in therapeutic activities [7]. It also includes an MBTI quiz to further tailor AI responses to the users personality. A survey conducted with 15 participants across various demographics evaluated the apps effectiveness. Results indicate a notable improvement in overall average mood scores, rising from 2.27 before app use to 4.73 after. Furthermore, 14 of 15 respondents reported that the app improved their mental state, with common alleviated symptoms including loneliness, anxiety, and lack of motivation [8]. The app also demonstrated a high recommendation rate, with 14 out of 15 participants willing to recommend it to others. These findings suggest Companion Connect is a promising tool for fostering emotional balance and well-being among students.

Keywords

AI, Language Model, Website, Mental Health

A Smart Psychology Self-therapy and Relationship Bonding Enhancing Mobile Platform With Generative AI using Machine Learning and Nature Language Processing

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ABSTRACT

This study explores the development and evaluation of an AI-powered chatbot designed to provide empathetic mental health support [1]. The chatbot leverages Natural Language Processing (NLP) to engage users in reflective conversations while ensuring privacy and accessibility [2]. Through two survey-based experiments, the chatbot was tested for emotional engagement and user trust, revealing high comfort levels but also highlighting the need for improved emotion detection and transparency in data handling. Future improvements will focus on fine-tuning AI responses, increasing privacy assurance, and enhancing long-term user engagement. The chatbot serves as an accessible mental health tool, offering a judgment-free space for self-expression.

Keywords

AI Chatbot, Mental Health, NLP, Privacy, Emotional Support.

AI-enhanced Meditation: Leveraging Personalization and Journaling to Promote Stress Reduction and Emotional Well-being

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ABSTRACT

The benefits of regular meditation can improve the daily lives of a lot of people. These benefits can be seen by the research of Sala and Ratna which includes the promotion of stress reduction and a positive increase in emotional well-being [2][11]. We aim to create a more convenient and beneficial way for people to meditate and keep track of their practices. Our goal is to reach as many people as possible, offering support to ease their stress and lift the weight of the challenges of the world. Some of the key technologies we are using are AI meditation exercises, personality tracking, and journaling. The AI meditation exercises allow for guided exercise in the meditation practice that the user selects. This takes into account the user's religion, personality, location, and time available in order to create a curated exercise. The personality tracker allows users to discover the pros and cons of their own personality as well as retaking a test to see if their personality has changed over time. Lastly, the journal allows users to write down their thoughts for the day as well as save previous exercises to reference in the future. Through the anecdotes and feedback of the users we were able to improve parts of the app and see how effective it was at building consistent meditation practices.

Keywords

Meditation Technology, Emotional Well-Being, AI Personalization, Stress Reduction.

AI-powered Mobile App for Rare Disease Support: Design, Implementation, and Evaluation

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ABSTRACT

This paper presents the design, implementation, and evaluation of an AI-driven mobile application for rare disease support [1]. Rare diseases are often misdiagnosed, with high costs and limited awareness restricting access to proper care. Our system addresses these issues through four components: an AI Doctor that answers medical queries, a networking module that locates hospitals and experts, a genetic testing feature that supports result uploads and scheduling, and a research hub that simplifies scientific findings [2]. We conducted an accurate experiment with 20 queries, achieving an 85% correct response rate and consistent disclaimers for safety. A comparison with related research showed our system to be more patient-centered, bilingual, and accessible than data-intensive clinical tools. While challenges remain in ensuring accuracy and privacy, the project demonstrates that AI can play a valuable role in bridging information gaps for rare disease patients, offering practical, accessible support beyond traditional healthcare systems.

KEYWORDS

AI health app, Rare disease support, Medical query system, Patient-centered care.

Ego-psy: A Personalized and Accessible Mobile Platform for Holistic Mental Health Support

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ABSTRACT

This paper presents Ego-psy, a mobile application designed to improve accessibility and personalization in mental health support [1]. The app integrates several features, including mood logging with AI-generated feedback, medication tracking, psychology-related courses, and a searchable database of professionals. Using Firebase Authentication and Firestore, the app ensures secure data handling while maintaining scalability [2]. Three major systems—course creation, authentication, and AI feedback—are analyzed in detail. An experiment was conducted using a survey of five participants, which revealed strong usability and satisfaction scores, particularly for mood logging and design, while also identifying the improvement areas such as motivation and medical features. Comparisons with existing research demonstrated how Ego-psy builds upon proven strengths of conversational agents while addressing their shortcomings by offering more holistic and ethical support. Limitations and future improvements are also discussed. Overall, Ego-psy provides a unique, multi-faceted approach to digital mental health, emphasizing accessibility, engagement, and safety [3].

KEYWORDS

Mental Health, Personalization, Accessibility, Artificial Intelligence.

Optimizing CNN Models for Real-time Hardware Classification on Resource Constrained Hardware: A Raspberry Pi 5 Powered Hardware Sorting System

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ABSTRACT

Within a work environment, the cleanliness and organization of tools contribute greatly to the workers' mental state and psychological well-being, allowing for more creativity and productivity in the workplace [1]. This is largely an issue within the industrial industry, where machines need to be built, maintained, and repaired. While being automated in larger factories, the tedious task of sorting hardware, such as screws, nuts, and bolts, is often performed manually in the context of smallscale factories and repair centers. However, the tediousness of this task often undermines the importance of the task and is often neglected or performed poorly. Existing industrial solutions to this issue are expensive and inflexible. This paper presents a lowcost, autonomous hardware sorting system that uses a custombuilt Convolutional Neural Network (CNN) object detection model trained using TensorFlow and Keras. The system runs entirely on a Raspberry Pi 5 and uses a Microsoft Lifecam Studio webcam together with an H-bot gantry for mechanical sorting. The primary focus of research is on the optimization of the CNN for real-time deployment on resource-constrained hardware. Multiple lightweight architectures such as YOLOv8-Nano and MobileNetV2-SSD are proposed for examination and evaluated. A custom dataset was created and labeled using Roboflow, with images consisting of three hardware classes: screws, nuts, and standoffs. The trained model reached a mean average precision (mAP) of 91.5%, with ~125 ms for each inference while on the Raspberry Pi. When integrated with the mechanical system, the full pipeline sorted hardware at an average rate of 18.6 parts per minute with an accuracy of 90.0%. As the project is

built with a budget of \$300, this project demonstrates the feasibility of deploying lightweight deep learning models for automation tasks on embedded systems.

KEYWORDS

Convolutional Neural Network, Keras, Tensorflow, Edge AI, Model Optimization.

Sleepease: An AI-integrated Mobile and Hardware System for Personalized Sleep Monitoring and Adaptive Soundscapes

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ABSTRACT

Sleep is essential for human health, yet millions suffer from insufficient or poor-quality rest. Traditional solutions such as polysomnography are accurate but impractical for continuous home use, while commercial devices often provide limited insights [1]. This paper introduces SleepEase, a mobile application and sensor-equipped hardware system that monitors sleep and delivers adaptive soundscapes to support faster sleep onset. Three core components— mobile app, hardware device, and Firebase backend—work together to provide monitoring, real-time feedback, and long-term data storage [2]. Challenges such as sleep detection accuracy, hardware design, and sound personalization were addressed through careful integration of multiple sensors and adaptive audio options. Experiments demonstrated that white noise and ocean sound reduced sleep latency, while enhanced detection algorithms achieved higher precision and recall compared to baseline methods. Compared with prior methodologies, SleepEase improves accuracy and personalization by combining monitoring with intervention. Ultimately, it presents a practical, scalable solution for at-home sleep improvement.

KEYWORDS

Sleep onset latency, Adaptive audio, White noise, Home health technology, Mobile health.

Towards Cognizant Environments: A Novel Framework for Real-Time, Multi-Modal Knowledge Fusion in IoT Ecosystems via Hybrid Neuro-Symbolic NLP

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ABSTRACT

The convergence of Big Data, IoT, and NLP necessitates a paradigm shift from reactive intelligence to cognizant environments. This paper proposes a rigorous neurosymbolic architecture enabling real-time semantic fusion across heterogeneous modalities including sensor telemetry, natural language discourse, and social media streams. We formalize the problem using tensor-based data representations, stochastic optimization frameworks, and hybrid symbolic-deep reasoning pipelines. To address the latency and privacy limitations of cloud-centric infrastructures, we introduce edge-aware NLP models optimized for constrained devices, supported by two novel algorithms: the Neuro-Symbolic Contextual Fusion Algorithm (NSCFA) and the Edge-Aware Semantic Reinforcement Algorithm (EASRA). We evaluate our framework on large-scale smart city simulations and demonstrate superior accuracy, semantic consistency,

and decisionmaking agility. Beyond technical novelty, our results underscore the transformative role of neuro-symbolic AI in advancing IoT-enabled ambient intelligence and business intelligence pipelines.

Keywords

Neuro-Symbolic AI, Semantic IoT, Multi-Modal Data Fusion, Edge NLP, Ambient Intelligence, Real-Time Business Intelligence, Knowledge Graphs, Resource-Constrained Deep Learning.

How Generalizable Are Deep Contextual Models?

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ABSTRACT

We investigate the generalizability of the deep contextual models along two dimensions: (i) when data includes unreliable or noisy categories and (ii) when data is out-of-distribution (OOD). Specifically, we focus on the Transformer-based BERT (Bidirectional Encoder Representation from Transformer) model for recognizing COVID-19 misinformation data from online social media. A set of studies are designed to examine the generalizability of a diverse array of BERT-based transfer learning techniques. The investigation also includes shallow non-contextual models. Results obtained from extensive systematic experimentation show that the BERT-based models generalize poorly on the OOD data as well as when the domain contains un-verified samples. Notably, these deep contextual models are not more effective, and at times worse, than shallow non-contextual models. We explain possible reasons for the poor generalizability of deep contextual models.

KEYWORDS

Deep Contextual Models, Generalizability, Natural Language Processing, COVID-19, Noisy Data