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Abstract Index

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Designing Human-Robot Communication in the Indonesian Language Using the Deep Bidirectional Long Short-Term Memory Algorithm

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Humanoid robots closely resemble humans and engage in various human-like activities while responding to queries from their users, facilitating two-way communication between humans and robots. This bidirectional interaction is enabled through the integration of speech-to-text and text-to-speech systems within the robot. However, research on two-way communication system for humanoid robots utilizing speech-to-text and text-to-speech technologies has predominantly focused on the English language. This study aims to develop a real-time two-way communication system between humans and a robot, with data collected from ten respondents, including eight males and two females. The sentences used adhere to the standard rules of the Indonesian language. The speech-to-text system employs a deep bidirectional long short-term memory algorithm, coupled with feature extraction via the Mel frequency cepstral coefficients, to convert spoken language into text. Conversely, the text-to-speech system utilizes the Pythonpyttsx3 module to translate text into spoken responses delivered by the robot. The results indicate that the speech-to-text model achieves a high level of accuracy under quiet-room conditions, with noise levels ranging from 57.5 to 60 dB, boasting an average word error rate (WER) of 24.99% and 25.31% for speakers within and outside the dataset, respectively. In settings with engine noise and crowds, where noise levels range from 62.4 to 86 dB, the measured WER is 36.36% and 36.96% for speakers within and outside the dataset, respectively. This study demonstrates the feasibility of implementing a two-way communication system between humans and a robot, enabling the robot to respond to various vocal inputs effectively.

Keywords: deep learning, humanoid robots, two-way communication, text-to-speech system, speech-to-text system.

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Enhancing Urban Waste Management: An IoT-based Automated Trash Monitoring System

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Industrial development nowadays affects the increase in types of packaging waste, which causes the accumulation of waste that has the potential to damage the environment. This research uses an Internet of Things (IoT) platform for an automatic waste volume monitoring system so that waste management in an area can be improved. The purpose of this research is to make it easier for the trashman to monitor the volume of the garbage collector through the notification feature. The research method used is the rapid application development methodology, starting with the requirement planning stage to analyze and identify the purpose of the system. Then, tools and system designs were created, followed by the development of the tools and system. Testing is used to evaluate the results of the tools and system. The result of the research is a prototype of an IoT-based automatic waste volume monitoring system featuring a volume detector for trash bins that indicates empty, almost full, and full conditions. The aim is to provide information to waste management officers more efficiently. The system also incorporates sensors for automatic opening and closing for user safety. Experimental testing demonstrates an average accuracy of 97%, with a 3% error margin, endorsing the system's effectiveness. However, it also highlights the need for further refinement to meet stringent waste measurement standards. These quantitative outcomes advocate for IoT-driven

waste management solutions, emphasizing the continuous necessity for accuracy improvements.

Keywords: Internet of Things, monitoring system, waste, waste volume.

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The Effect of Window Size and Shape in STFT for Pre-Processing FMCW Radar Data in Human Activity Recognition

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Many studies use radars for Human Activity Recognition (HAR), and numerous techniques for preprocessing FMCW radar data have been explored to improve HAR performances. Our approach employs 1-D radar to classify four human activities, i.e., walking, standing, crouching, and sitting. We use Fast Fourier Transform (FFT) and Short-Time Fourier Transform (STFT) with Kaiser window to generate range-time and Doppler-time data from in-phase and quadrature (I/Q) radar signals. Common belief considers that the choice of windowing parameters, i.e., window size and window shape represented by the beta parameter in Kaiser window, has significant impacts on the performances of deep learning LSTM models, such as measured by the F1-score. However, our study in this paper using t-tests statistical analysis shows otherwise. Our results consistently support the null hypothesis, which means that variations in window size and window shape do not significantly affect the F1-score. In essence, our findings underscore the robustness of our preprocessing methodology, emphasizing the stability and reliability of the selected configurations. This research provides valuable insights into the preprocessing techniques for radar data in the context of human activity recognition, enhancing the consistency and credibility of deep learning models in this domain.

Keywords: Human Activity Recognition, Radar, Preprocessing Techniques, Kaiser Windowing.

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Two-Stage Object Detection for Autonomous Vehicles With VGG-16 Based Faster R-CNN

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The implementation of object detection for autonomous vehicles is essential because it is necessary to identify common objects on the street so that a proper response can be designed. While single-stage object detection may require fewer computations, two stage object detection is preferred due to its ability to localize objects. Finding the optimum setup for multiple hyperparameters can enhance the performance of the two-stage object detection method. In this paper, we propose using Faster region-based convolutional neural network (R-CNN) as a two-stage object detection method with a visual geometry group (VGG)-16 backbone for detecting objects on the street. We evaluate the method using an open image subset by selecting common street objects (traffic lights, traffic signs, and vehicles). We explore several hyperparameter setups, such as learning rate and the number of region of interest (RoI), to find the optimum configuration. We found that using a learning rate of 0.000001 with the Adam optimizer is the optimum value for this task. Additionally, we discovered that increasing the number of RoI may improve performance. This suggests that there is potential for achieving a higher mAP (mean Average Precision) by increasing the number of RoI.

Keywords: object detection, faster r-cnn, autonomous vehicles, convolutional neural networks.

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Nutrition, pH, Temperature, and Humidity Monitoring Hydroponics System based on Android

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Agriculture plays a crucial role in the lives of Indonesian people. Technological advances and the increasing limitation of agricultural land have

changed the patterns of matching crops in societies. Innovations have been implemented, including using technology such as hydroponic systems. Temperature and humidity are two of main factors influencing the success of hydroponic methods. The research aims to design and develop an autoLowc control system that uses Fuzzy Logic to regulate the temperature and moisture of hydroponic plants, and to design the control of the nutrition and pH supply of hydrogen plants. Hydroponics plant control systems are implemented using microcontrollers and DHT22, TDS sensors, and pH sensors. In addition, an Android-based interface has been developed to monitor and control the system remotely via an internet connection. In this study, the accuracy of the TDS sensor is 96.5%, the pH sensor was 98.19%, and the precision of the Fuzzy logic system at temperature and humidity is 100%.

Keywords: hydroponic system, NodeMCU ESP32, fuzzy Logic.

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Screen-Printed Carbon Electrode Modified GNPs/ZnO for Electrochemical Sensing

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Screen-printed carbon electrodes (SPCEs) modified with graphene nanoplatelets (GNPs) and zinc oxide (ZnO) are widely used in electrochemical sensors due to their enhanced electrochemical properties and biocompatibility. Screen-printed carbon electrodes modified with Graphene nanoplatelets (GNPs) /Zinc oxide (ZnO) nanocomposite are described. Thus, in this study, GNPs/ZnO nanocomposite was synthesized, characterized, and applied to an electrochemical sensor. The formation of GNPs/ZnO nanocomposite was characterized by UV-Vis spectroscopy and scanning electron microscopy. Moreover, SPCE-GNPs/ZnO nanocomposite were characterized using cyclic voltammetry to optimize the concentration of nanocomposite. Then, the analytical performance of the sensor was studied by measuring methylparaben as an organic compound using differential pulse voltammetry (DPV) as a preliminary study before using it for biosensing. The result showed a significant improvement in electrocatalytic activity and reproducibility. The ratio of GNPs/ZnO nanocomposite with a concentration of 1 mg/mL produced the highest current response. Moreover, the detection of methylparaben showed high sensitivity with a limit of detection (LOD) around 9.7 μM, indicating high selectivity and good reproducibility of SPCE-GNPs/ZnO. Hence, the proposed sensor of SPCE-GNPs/ZnO displayed good performance, sensitivity, and reproducibility.

Keywords: SPCE, GNPs/ZnO nanocomposite, electrochemical.

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Ground Penetrating Radar Data Inversion Using Dual-Input Convolutional Autoencoder for Ferroconcrete Inspection

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Ground penetrating radar (GPR) is a non-destructive tool for exploring an underground object. Currently, GPR is also considered for reinforced concrete inspection. However, the image produced by GPR cannot be easily interpreted. Besides, the large observation of building concrete inspection motivates researchers to fasten and ease radar image interpretation. Thus, this research proposes a new method to translate the GPR scattering data image to its internal structure visualization. The proposed employs a convolutional autoencoder model using amplitude and phase radar data as input of the algorithm. As an evaluation, in this stage, we perform numerical analysis by using finite-difference time-domain-based synthetic data that considers three cases: concrete with rebar, concrete with crack, and concrete with rebar and crack. All those cases are simulated with randomized dimensions and positions that are possible in real applications. Compared with the baseline method, our method shows superiority, especially in the semantic segmentation perspective. The parameter size of the proposed model is also much smaller, around one third of the previous method. Therefore, the method is feasible enough to be implemented in real applications addressing an automatic internal structure reinforced concrete visualization.

Keywords: radar, ground penetrating radar, wave inversion, full wave inversion, deep learning,

machine learning, autoencoder, convolutional neural networks.

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Comparison of YOLOv3-tiny and YOLOv4-tiny in the Implementation Handgun, Shotgun, and Rifle Detection Using Raspberry Pi 4B

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Criminal activities frequently involve carriable weapons such as handguns, shotguns, and rifle classes. Frequently, the targets of these weapons that are captured are concealed from plain sight by the people of the crowd. The detection process for these weapons can be assisted by using deep learning. In this case, we intend to identify the model of the firearm that was detected. This research aims to apply one of the deep learning concepts, namely, You Only Look Once (YOLO). The authors use versions of YOLOv3-tiny and Yolov4-tiny for the detection and classification of types of weapons, which are one of the fastest and most accurate methods of object detection, outperforming other detection algorithms. However, both require heavy computer architecture. Therefore, YOLOv3-tiny and YOLOv4-tiny, lighter versions of YOLOv3, can be solutions for smaller architectures. YOLOv3-tiny and YOLOv4-tiny have higher FPS, which is supposed to yield faster performance. Since YOLOv3-tiny and YOLOv4-tiny are modified versions of YOLOv3, the accuracy is improved, and YOLOv3 is already outperforming Faster Single Shot Detector (SSD) and Faster Region with Convolutional Neural Network (R-CNN). The authors employ YOLOv3-tiny and YOLOv4-tiny due to the fact that the Frame Per Second (FPS) and Mean Average Precision (mAP) performance of both approaches are superior in object detection. The study found that YOLOv3-tiny had a high FPS and low mAP performance: an average Intersection over Union (IoU) score of 71.54%, an accuracy of 90%, a recall score of 78%, an F1 score of 84%, and a mAP of 86.7%. While YOLOv4-tiny has low FPS and high mAP: an average IoU score of 73.19%, an accuracy of 90%, a recall score of 84%, an F1 score of 87%, and a mAP of 90.7%.

Keywords: Gun detection, deep learning, YOLO, YOLOv3-tiny, YOLOv4-tiny.

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Computational Analysis of Electrical Impedance Spectroscopy for Margin Tissue Detection in Laparoscopic Liver Resection

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Margin tissue detection during intraoperative laparoscopic liver resection (LLR) is required to prevent tumor recurrence and reduce the likelihood of further surgery. This study proposes an electrical impedance spectroscopy (EIS) method for margin tissue detection in LLR to determine the boundary interface of normal and cancerous tissue. This study has three objectives: (1) designs the electrode array configuration to collect multiple EIS impedance measurements, (2) implements the Feedforward Neural Network (FNN) to classify the orientation of margin tissue relative to the electrode array by using time-difference impedance indexes, and (3) governs the inflection point method based on impedance indexes to detect the margin tissue location. The proposed method was evaluated by a 3D numerical simulation of liver tissue composed of cancerous lumps with I_{ac} = 1 mA alternating injection current at frequencies lf = 1 kHz and hf = 100 kHz. The electrode array consists of 16 electrode pairs each for injection current and voltage measurements. The variation of margin tissue orientation relative to the electrode array direction was considered to occur in unidirectional, perpendicular, and diagonal direction with noise variations (Signal-to-Noise-Ratio: 50 to 90 dB). The FNN trained on 2,400 data points achieves True Positive Rate (TPR) value of 90.2%, 99.4%, and 96.6% for diagonal, perpendicular, and unidirectional respectively in margin tissue orientation classification, while the inflection point method detects margin tissue location with 75% location at the unidirectional orientation (y-axis).

Keywords: Laparoscopy liver resection, Electrical impedance spectroscopy, Machine learning

algorithm, Time-difference Impedance indexes, Margin tissue detection.

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Performance Comparison of PID, FOPID, and NN-PID Controller for AUV Steering Problem

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This study examines and compares three autonomous underwater vehicles (AUV) steering control techniques using the following three control algorithms: proportional-integral-derivative (PID), fractional order PID (FOPID), and neural network PID (NN-PID). This investigation aims to comprehensively understand each controller's response regarding step input scenarios, trajectory changes, and when encountering disturbances. The response analysis will evaluate the strengths and weaknesses of the controller by examining parameters such as rise time, settling time, settling min, settling max, overshoot, peak, and peak time for each controller response. The root mean square error (RMSE) technique will be applied to determine the accuracy performance of each controller strategy, allowing users to select the most suitable controller option confidently. FOPID displays the best settling time of 3.2218 seconds, while PID stands out in rise time, achieving 0.4725 seconds. The results indicate that NN-PID is the top performer as it reduces overshoot to 0.3022%. Among the three controllers tested, FOPID had the smallest RMSE value, while the NN-PID control's slower response and larger error resulted in a smaller overshoot than PID and FOPID. This factor is due to the online learning process on NN-PID, which requires time. Based on the simulation results, FOPID outperforms PID in settling time and produces the smallest error due to the inclusion of parameters λ and μ, leading to improved control performance.

Keywords: Autonomous Underwater Vehicles (AUV), steering, PID, FOPID, NN-PID.

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