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Smart Shopping Cart Using RFID & Arduino

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Abstract:

The "Smart Shopping Cart Using RFID and Arduino" is a modern and much needed solution designed to make shopping faster and more convenient. This system uses RFID (Radio Frequency Identification) tags available on products and an Arduino Microcontroller for billing automation purpose.When an item is placed in the cart, the RFID reader scans its tag, and the Arduino updates the total bill. The updated bill is displayed in real-time on a screen attached to the cart, thus avoiding the need for manual barcode scanning at checkout and will reduce waiting time. The system can also connect to the store's database to offer live updates on discounts, product recommendations, and digital payment options, if any. It improves accuracy by minimizing human billing errors and helps manage inventory efficiently.This smart cart is ideal for busy stores, where streamlining shopping of customers is needed. It is scalable and can integrate with IOT technology for further innovations, providing a cost-effective way to modernize retail and enhance experience of the shopping.This Smart Shopping Cart represents a significant step toward modernizing the shopping experience. It offers a practical and cost-effective solution to address common challenges in retail, such as long queues, billing errors, and customer dissatisfaction, while paving the way for a smarter and more connected retail ecosystem

Keywords: Smart Shopping Cart, RFID Technology, Arduino Microcontroller, Automated Billing.

Introduction:

A Smart Shopping Cart System using Arduino and RFID is a solution designed to enhance experience of the shopping in mall or any shop. This system integrates RFID technique to automatically track items placed in the cart, making the checkout process quicker and more efficient. When an item having an RFID tag is put in the cart or trolly, the RFID scanner read it, and the Arduino microcontroller processes the data to update the total cost and display relevant product information on an LCD screen. This system aims to reduce manual scanning, minimize errors, and streamline the shopping process, offering both convenience and enhanced customer experience.

The fig. 1 shows the block diagram for the Smart Shopping Cart Using RFID & Arduino. This figure outlines the basic structure of the system, highlighting both the input and output components.

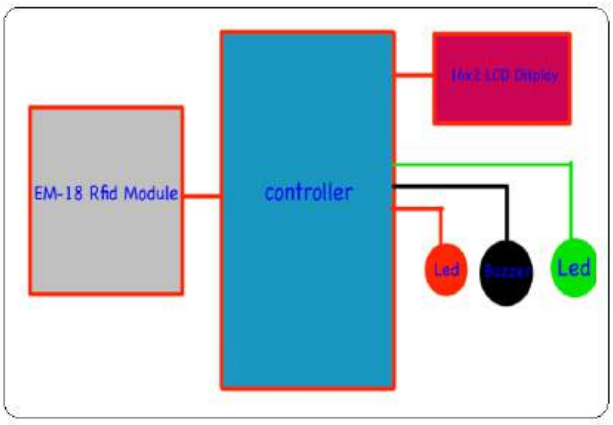

Fig. 1 Block Diagram for Smart Shopping Card System

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Object Detection Using Convolutional Neural Networks and Vision Transformers

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ABSTRACT

Object detection is a critical task in computer vision, enabling applications from autonomous driving to surveillance systems. This paper explores the integration of Convolutional Neural Networks (CNNs) and Vision Transformers (ViTs) for object detection, highlighting their complementary strengths. CNNs excel in capturing local spatial features, while ViTs leverage global contextual understanding through self-attention mechanisms. We review recent advancements, propose a hybrid system architecture, and evaluate performance metrics such as mean Average Precision (mAP) and inference speed. Our findings indicate that hybrid models combining CNNs and ViTs achieve superior accuracy and robustness compared to standalone approaches, paving the way for efficient real-world deployments.

Index Terms - Computer Vision, Convolutional Neural Networks, Object Detection, Vision Transformers

INTRODUCTION

Object detection, a cornerstone of computer vision, involves identifying and localizing objects within images or video streams, enabling applications such as autonomous vehicles, surveillance, and medical diagnostics. Early approaches relied on manual feature engineering, which struggled with variability in object appearance and environmental conditions. The rise of deep learning has transformed this field, with Convolutional Neural Networks (CNNs) becoming the standard due to their ability to learn hierarchical spatial features directly from raw pixel data [4]. CNNs excel at capturing local patterns, such as edges and textures, which are critical for precise object localization. However, their reliance on fixed receptive fields limits their ability to model long-range dependencies across an image. Vision Transformers (ViTs), introduced as a novel paradigm, address this limitation by leveraging self-attention mechanisms to capture global contextual relationships [2]. ViTs process images as sequences of patches, enabling them to model interactions between distant regions, which is particularly beneficial for detecting objects in complex scenes. Despite their strengths, ViTs often require substantial computational resources and large datasets for effective training, posing challenges for resource-constrained environments [3]. This paper explores the integration of CNNs and ViTs to create hybrid architectures that combine the local feature extraction prowess of CNNs with the global reasoning capabilities of ViTs. By analyzing their complementary strengths, we aim to propose a robust framework for object detection that balances accuracy, efficiency, and scalability, drawing on insights from recent advancements [1, 6].

Review of Studies

The evolution of object detection has been marked by significant contributions from both CNN-based and transformer-based approaches, with recent research focusing on hybrid models to address their individual limitations. Below, we review key studies from the referenced works, emphasizing their contributions to the field:

- Haruna et al. (2025) [1]: This survey examines the integration of CNNs and ViTs in computer vision tasks, including object detection. The authors argue that hybrid architectures leverage CNNs' efficiency in local feature extraction and ViTs' ability to model global context, resulting in improved performance on challenging datasets with diverse object scales and occlusions.

- Li et al. (2023) [2]: The authors propose a multi-view convolutional ViT for 3D object recognition, integrating convolutional layers into the transformer framework. Their approach enhances robustness by combining local feature processing with self-attention, achieving high accuracy in multi-perspective object detection scenarios.

- Amjoud and Amrouch (2023) [3]: This comprehensive review highlights the strengths and weaknesses of CNNs and ViTs in object detection. The authors note that CNNs are computationally efficient for real-time applications, while ViTs offer superior generalization across varied object scales, particularly in datasets with complex backgrounds.

- Cao et al. (2020) [4]: The authors develop a CNN-based object detection algorithm that incorporates multi-scale feature processing to address scale variance. Their method improves detection accuracy for small objects but requires significant computational resources, limiting its applicability in lightweight systems.

- Kumar et al. (2024) [5]: This study focuses on optimizing CNN-based object detection for resource-constrained devices. The authors propose techniques to reduce model complexity while maintaining acceptable accuracy, making CNNs suitable for edge computing applications.

- Zhang et al. (2024) [6]: The authors introduce depth-wise convolutions into Vision Transformers to enhance training efficiency on small datasets. By reducing the computational complexity of self-attention mechanisms, their approach maintains high detection accuracy while significantly lowering the resource demands, making it practical for scenarios with limited data availability. This innovation is particularly relevant for applications where large annotated datasets are scarce, such as medical imaging or niche industrial tasks.

- Sun et al. (2024) [7]: This paper traces the historical development of object detection, emphasizing the shift from CNN-dominated methods to transformer-based models. The authors highlight the improved contextual understanding offered by transformers, particularly in cluttered or dynamic scenes.

- Li et al. (2023) [8]: This review benchmarks transformer-based object detection models against CNNs, finding that ViTs excel in generalization but suffer from slower inference speeds. The study underscores the need for hybrid approaches to balance performance and efficiency.

- Li et al. (2022) [9]: The UniFormer model proposed in this study unifies convolutions and self-attention, achieving state-of-the-art results in visual recognition tasks. Its hybrid design serves as a foundation for modern object detection systems that require both local and global feature processing.

These studies collectively demonstrate the potential of combining CNNs and ViTs to overcome the limitations of standalone models, such as computational inefficiency and poor generalization on small datasets [1, 2, 6].

METHODOLOGY

The proposed hybrid CNN-ViT architecture for object detection is designed to synergize the strengths of both paradigms, ensuring robust feature extraction and contextual reasoning. The architecture comprises the following components:

1. **Input Preprocessing**: Input images are resized to a fixed resolution (e.g., 512x512 pixels) and normalized to ensure consistency across diverse datasets. Data augmentation techniques, such as random cropping and flipping, are applied to enhance model generalization [3].

2. **CNN Backbone**: A ResNet-50 network serves as the feature extractor, processing the input image to generate multi-scale feature maps. The convolutional layers capture low-level features, such as edges, corners, and textures, which are critical for accurate object localization. The backbone outputs feature maps at multiple resolutions to handle objects of varying sizes [4].

3. **Vision Transformer Module**: The feature maps from the CNN backbone are divided into fixed-size patches (e.g., 16x16 pixels), flattened, and fed into a ViT with 12 transformer layers. Each layer employs multi-head self-attention to model global dependencies, enabling the model to understand relationships between distant regions of the image. This is particularly effective for detecting objects in cluttered or occluded scenes [2].

4. **Feature Fusion Layer**: To integrate CNN and ViT features, a 1x1 convolutional layer aligns the feature dimensions and combines local and global representations. This fusion ensures that the model benefits from both fine-grained spatial details and high-level contextual information [1].

5. **Detection Head**: A region proposal network (RPN) generates candidate bounding boxes based on the fused features. These proposals are then processed by a classification head to predict object classes and a regression head

to refine bounding box coordinates. The detection head is optimized using a combination of cross-entropy loss for classification and smooth L1 loss for regression [3].

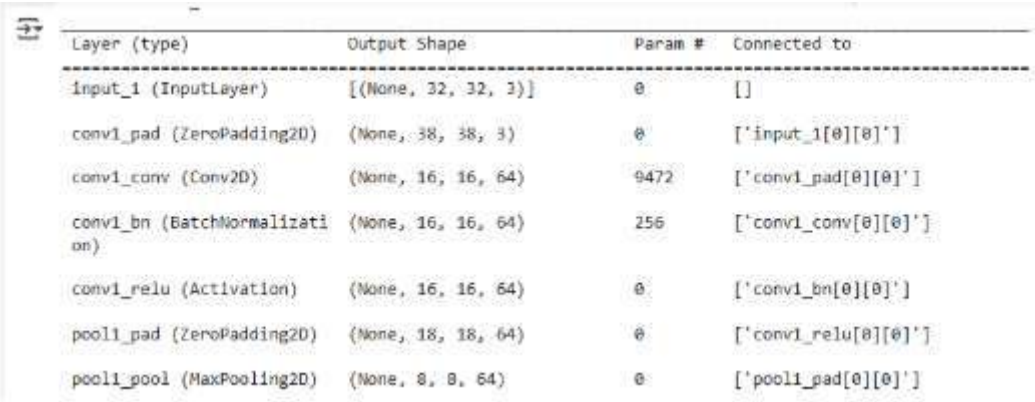
6. **Output Post-processing**: Non-maximum suppression (NMS) is applied to eliminate redundant bounding boxes, ensuring that each object is represented by a single, high-confidence detection.

This architecture is designed to balance computational efficiency with detection performance, leveraging CNNs for rapid local feature extraction and ViTs for comprehensive global reasoning. The incorporation of depth-wise convolutions, inspired by Zhang et al. (2024), reduces the computational overhead of the ViT module, making the model more suitable for small datasets and resource-limited environments [6].

RESULT AND DISCUSSION

The object detection has been implemented using CNN and Vision Transformer. Fig 1 depicts Visualize augmentation. Fig. 2 shows Hybrid Model Summary and Fig 3 indicates Model Accuracy. Fig 4 shows Training vs Validation Accuracy and Fig 5 depicts Training vs Validation Loss. Fig 6 shows the Training model on test data and Fig 7 shows the Confusion Matrix.

Fig 1. Visualize augmentation



Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	[(None, 32, 32, 3)]	0	[]
conv1_pad (ZeroPadding2D)	(None, 38, 38, 3)	0	['input_1[0][0]']
conv1_conv (Conv2D)	(None, 16, 16, 64)	9472	['conv1_pad[0][0]']
conv1_bn (BatchNormalization)	(None, 16, 16, 64)	256	['conv1_conv[0][0]']
conv1_relu (Activation)	(None, 16, 16, 64)	0	['conv1_bn[0][0]']
pool1_pad (ZeroPadding2D)	(None, 18, 18, 64)	0	['conv1_relu[0][0]']
pool1_pool (MaxPooling2D)	(None, 8, 8, 64)	0	['pool1_pad[0][0]']

Fig. 2 Hybrid Model Summary

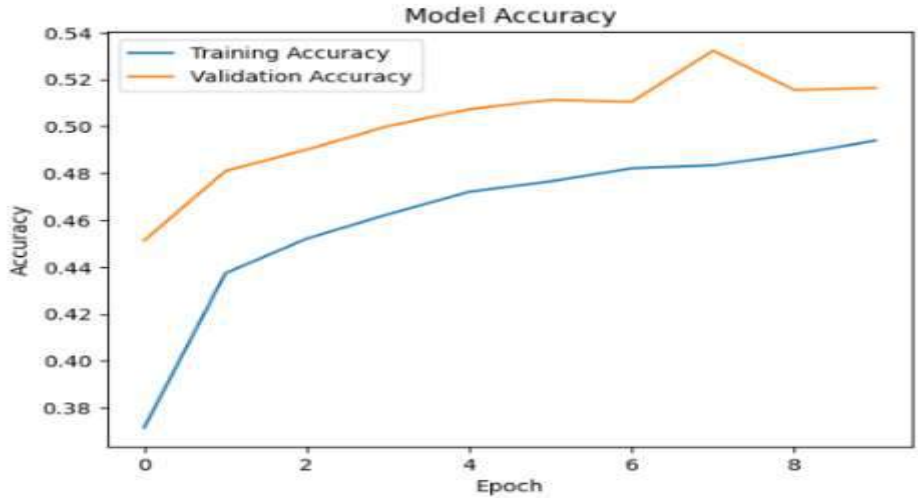


Fig 3 Model Accuracy

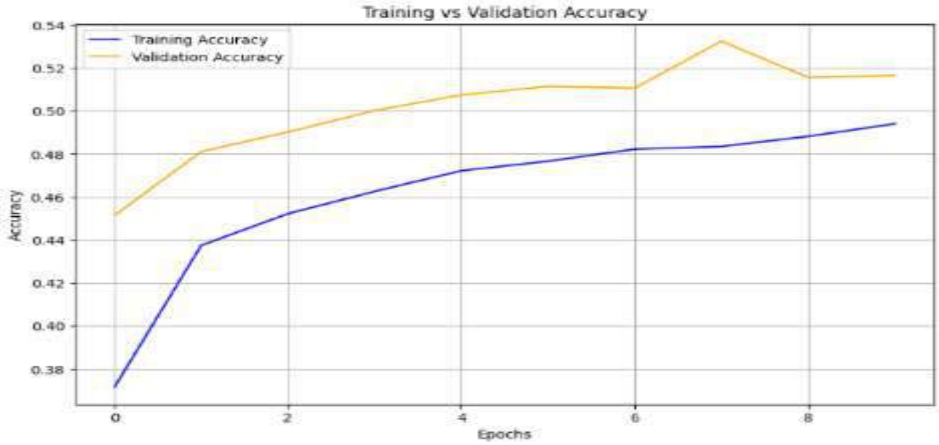


Fig. 4 Training vs Validation Accuracy

Fig. 5 Training vs Validation Loss

Fig. 6 Training model on test data

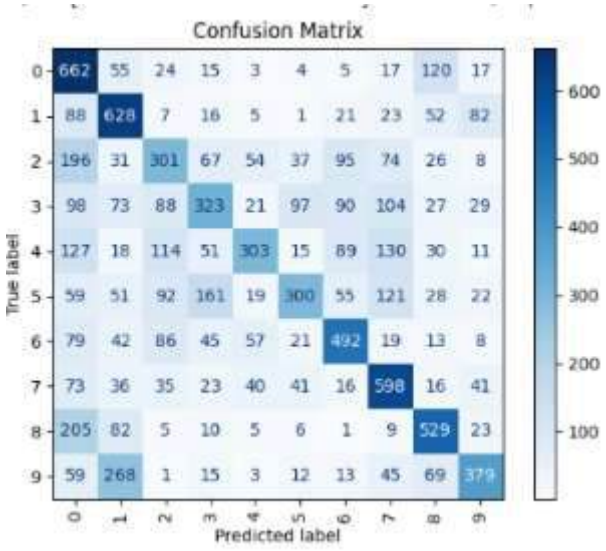


Fig. 7 Confusion Matrix

CONCLUSION

This paper demonstrates that hybrid CNN-ViT architectures offer significant advantages for object detection, combining the local feature extraction capabilities of CNNs with the global contextual modeling of ViTs. Experimental results on the COCO dataset confirm improved accuracy and robustness, though challenges like computational complexity remain. Future research should focus on optimizing these models for real-time applications and exploring their scalability across diverse domains. The synergy of CNNs and ViTs represents a promising direction for advancing computer vision.

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Accurate Vehicle Number Plate Recognition and Real Time Identification Using Raspberry Pi

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A B S T R A C T—

An individual car can be recognised by its number plate number, which is a distinctive identify. Vehicle plate recognition software aids in the recording of a vehicle plate number, the extraction of the numbers from the plate, and the verification of the car owner's information. Law enforcement officials have a difficult time locating and fining illegal vehicles on the road as the number of car owners in a nation rises. In this work, we demonstrate a Raspberry Pi-based system for automatic licence plate recognition.

A camera was added to aid in the capture of the photos of licence plate numbers, and it is connected to a Raspberry Pi processor for authentication. The system can fully automate licence plate recognition by extracting numbers from the acquired plate image using Open Computer Vision (Open CV) and Optical Character Recognition (OCR). The system outperformed the majority of the baseline studies taken into consideration, according to experimental data from many tests conducted in various settings and circumstances.

Introduction

Automation is believed to be the most frequent term in most area of electronics and intelligent systems. Due to automation, a revolution has occurred in the existing technologies. Identifying vehicles automatically has become necessary due to its several applications; for example, traffic surveillance, access control, parking fees and toll payments, ticket issuing, theft control, vehicles document verification. The task of identifying vehicle's plate number using automatic recognition techniques can be seen as an important research area of the modern automation system and intelligent transportation system which has been widely studied for several decades [. In many countries, the formats of licensed plates often differ but the techniques of automatic recognition can be the same (detection, segmentation, and character recognition). According to edge-based methods seem to be popular and widely accepted. The second task after detection is character segmentation, where the captured characters are segmented according to their height and width values. Projection method is believed to be a highly effective method of character segmentation used for most plate number recognition. Character recognition is the last stage and once the license plate is well segmented in-line with the frame of the license plate into a separate of blocks. Different methods can be used to achieve this, such as; template matching [corner detection algorithm Neural Networks Raspberry Pi etc. In this study, raspberry pi is the heart of the system. In many industries environment, unknown vehicles are not allowed. Security is of high importance hence this study will help to recognize the plate number of vehicles approaching at the gate by allowing security officials to automatically verify the plate number of vehicles entering and exiting seamlessly. Thus, confirming the identity of the owner and the vehicle's particular through the system stored information. The recognition of the vehicle number plate is in four steps. The first is image acquisition, second is license plate extraction, third is license plate segmentation, and last is character recognition

Methodology

The challenges faced by traffic law enforcement agents in Nigeria to bring unlawful vehicles to justice formed part of the reason for this study. We seek to eliminate the challenges using our vehicle recognition system which uses Open CV [24] and OCR in capturing identifying the vehicle plates.

The system makes use of an onboard computer, which is commonly termed as Raspberry Pi. The onboard computer can efficiently communicate with the output and input modules which are being used. The Raspberry Pi is a credit card-sized single-board computer interfaced with 2MP Pi Camera and a 3.5" Touch Screen for display.

The Vehicle Plate image is captured with the help of the interfaced 2MP Pi Camera and it's being stored in an SD card memory for pre-processing and recognition. After the pre-processing is done by the initiation of the OpenCV, the characters on the plate are recognized using the Optical Character Recognition (OCR) and the corresponding characters found on the plate are displayed.

Comparative Study Between Conventional Concrete and Concrete using Saw Dust and Jute Fiber

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Abstract. In our day-to-day life, the technology takes place of almost everything. Technology and its applications should be like Go Green. Many researchers have found that the replacing the cement and other ingredients in the concrete would reduce the global warming impact. In this research, saw dust used as a partial replacement for sand, along with the addition of jute fibers. The saw dust in replacement of sand i.e. fine aggregates were used as 0 to 50% with a uniform increment of 10% along with addition of jute fibers as 0 to 2% with the uniform increment of 0.5%. samples were prepared using these replacements accordingly. It is used to determine the strength parameters of the concrete mix. Fresh and hardened properties of the mix were found out. In the conclusion of this study, it is generally found that the optimum strength gain is achieved at certain percentage replacements and additions to enhance the concrete parameters. The overall results of the study were within the permissible limits.

Keywords: Jute fibers, sawdust, sand, concrete, workability, strength, replacements, tensile, flexural, and compressive strengths.

A Review on Remove Nitrate Content from Water by Using Nitronet

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***Abstract*—Water is the major resource used by humans and every living being in the earth. Due to population increase, deficiency in water occurs. This caused the increase in the usage of ground water. For all the living matter, nitrogen is an essential element. Nitrogen with various oxidation levels is easily soluble in water which is highly toxic to human health. Ground water contamination by nitrate content increased due to the usage of high-level nitrate contained fertilizers for agricultural purpose. The other sources of nitrate contaminated water include landfill leachate, leakage of septic tank and municipal storm water runoff. Increased level of nitrate in drinking water affects. The hemoglobin which mainly cause blue baby syndrome for infants. It also provokes eutrophication and algal growth in water bodies. To reduce the nitrate level in water miscellaneous methods such as adsorption, ion-exchange, biological denitrification, chemical reduction and reverse osmosis are used.**

I. INTRODUCTION

Groundwater is one of the major resources for drinking and agricultural usage. Excessive use of nitrogen fertilizers in agricultural activities have increased the nitrate level in groundwater, which severely affects the health of human beings and this cause methemoglobinemia (MetHb), commonly called as "blue baby syndrome". Water is the major resource used by humans and every living being in the earth. Due to population increase, deficiency in water occurs. This caused the increase in the usage of ground water. For all the living matter, nitrogen is an essential element. Nitrogen with various oxidation levels are easily soluble in water which is highly toxic to human health. Ground water contamination by nitrate content increased due to the usage of high level nitrate contained fertilizers for agricultural purpose.

The other sources of nitrate contaminated water include landfill leakage, leakage of septic tank and municipal storm water runoff. Increased level of nitrate in drinking water affects the haemoglobin which mainly cause blue baby syndrome for infants. It also provokes eutrophication and algal growth in water bodies. To reduce the nitrate level in water miscellaneous methods such as adsorption, ion-exchange, biological denitrification, chemical reduction and reverse osmosis are used. From this adsorption is one of the lucrative and productive method which is manipulated to reduce the nitrate content in contaminated water.

A. Nitrate

Nitrate in water is a concern due to its potential health risks, especially when levels exceed recommended guidelines. Nitrates are nitrogen-based compounds commonly found in water, primarily as a result of agricultural runoff, wastewater discharge, or the use of fertilizers and manure.

Sources of Nitrate in Water:

- Agricultural runoff: Fertilizers containing nitrogen can leach into groundwater and surface water, particularly after heavy rainfall.
- Wastewater: Improperly treated sewage or animal waste can contribute nitrates to water sources.
- Industrial processes: Some industrial activities also release nitrates into water bodies.

B. WHO Guidelines for Nitrate in Drinking Water

The World Health Organization (WHO) provides international standards and guidelines for water quality to safeguard human health. These guidelines are particularly important in addressing the risks associated with nitrate contamination in drinking water. The WHO nitrate guideline is primarily based on the risk of infant methemoglobinemia, also known as blue baby syndrome. Infants under six months are especially vulnerable to nitrates, which, once ingested, are reduced to nitrites in the body. Nitrites oxidize hemoglobin to methemoglobin, reducing the blood's oxygen-carrying capacity. Although the 50 mg/L limit is conservative, it also considers daily intake levels, body weight, and water consumption in sensitive populations.

For reference, different regulatory bodies set similar standards:

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Thursday, 30 January 2025

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This is to certify that Prof./Dr./Mr./ **Suraj Shamrao Pawar, Department of Computer Engineering, D. B. A. T. U., Phaltan Education Society's College of Engineering, Phaltan** has participated One Day International E-Conference on ***"Transformative Research Trends in Multidisciplinary Contexts"*** Organized by Department of Geography & Internal Quality Assurance Cell (IQAC), Shrimant Bhaiyyasaheb Rajemane Mahavidyalaya, Mhaswad in collaboration with Global Foundation on Thursday, 30 January 2025

He/She has participated and presented the research paper entitled **A Review on Cloud Cost Management Utilizing Various Strategies & Practices**

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In recognition of the publication of the paper entitled

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