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ExpirySense: Expiry Date Detection and Proactive Alerts

Jyoti Madake[1], Krushna Kalamkar[2], Prathmesh Katepallewar[3]
Dept of E&TC Engineering, Vishwakarma Institute of Technology, Pune, India

Abstract: An ExpirySense is an edge-deployable system which is designed to detect the Expiry dates on the product packaging and generate a proactive alert to enhance consumer safety and product lifecycle monitoring. It uses a combination of MobileNet and PaddleOCR to detect and understand date information, even under poor lighting conditions and curved surface designs. This system employs a Region of Interest (ROI) selection logic, identifying patterns around keywords such as MFG and EXP to locate date text. It achieves a detection accuracy of 97.7% on a custom dataset of over 5,000 images, with a precision of 96.2%, recall of 94.8% and the F1-score of 95.5% including curved, dotted, and skewed text formats. Inference time is reduced by 25%, achieving 25–30 ms per image and the system supports multi-language recognition (6 languages). Also, the model size is 9.4 MB which is reduced by 40% with respect to existing models like PaddleOCR v3, easyOCR.
Index Terms – Expiry data detection, PaddleOCR, MobileNet, image preprocessing, real-time alerts.

I. INTRODUCTION

In today’s fast-paced retail and consumer markets, accurately detecting the expiry dates on consumer products remains a critical challenge in the real-world. Also, the challenges like health issues faced by customers due to consumption of the expired products which results in serious problems. In Gandhi Nagar D-Mart faced a lawsuit of 1 lakh due to sale of expired products. These types of challenges highlight the model safety and accuracy towards the detection of the expiry date in real-world environments. In retail environments, up to 20% of food wastage is created due to unread or misinterpreted expiry dates on the product [1]. For the curved or rotated data prints on packaging, earlier Optical Character Recognition (OCR) models can only achieve 75% accuracy under such situations. The failure rates of the traditional OCR models are above 25% due to complex visual backgrounds and inconsistent lighting across more than 30 different date-format layouts [2]. Also, by using the standard text recognition pipelines, it fails to detect the text on the packaging in multiple different languages; for instance, Arabic expiry dates incorporate error rates by 15% [3]. And if suppose there exists a model which can solve all the above challenges then that model needs high computational speed and power to detect the date and generate a proactive alert. But the retailers do not have that speed and power at their edge devices like mobile and desktop. So, using such models is impractical to detect dates [4]. Lastly, when the product packaging text is printed on curved shaped design and has many different patterns and design, or low-contrast surfaces slow the detection performance of the model, more commonly for the food packaging [5]. The existing systems solving expired product problems are Barcode based detection, RFID based detection and Amazon GO is also a solution to this. But the problem with that is it requires high-cost maintenance and it is not able to identify mislabelling and damaged labels. ExpirySense an OCR based solution solves that problem and generates alerts when the expiry date is detected and it has low-cost maintenance and can easily be used by small shopkeepers.

II. LITERATURE REVIEW

The increasing demand of the expiry date detection system in the field of retail and healthcare leads to research of IoT based system, machine learning based systems. A system solves problems of managing medication schedules due to aging, illness, and busy lifestyles. By extracting expiry and manufacturing dates through PaddleOCR, the system checks that the medication being dispensed is valid or not, reducing the risk of expired drug consumption. The accuracy of the system is 92.4% across various label types [6]. A system is developed for the detection and classification of 9 types of date fruits using YOLOv7 and YOLOv8 in comparative manner. The system is compared with human judgment by using deep learning. Among the models tested, YOLOv8 outperformed YOLOv5 and YOLOv7, achieving an accuracy of 97.7% on their custom dataset [7].

The system works on two parts; first is a fully convolutional network (FCN) for ROI selection and Convolutional Recurrent Neural Network (CRNN) which is used for recognition of the product. Both the networks were fine-tuned for handling printed text on food packaging, including fonts, textures, and backgrounds. The feature extraction follows VGG architecture and achieved accuracy is 98.20% [8].

The system collects raw data by taking screenshots and videotaping, detects data areas using the trained YOLOv8 model, and then recognizes and saves them using the optimized OCR model which uses the text renderer algorithm for text layout adjustment and font variation. The achieved accuracy of the system is 95.70% [9].

The proposed system deals with expiry date detection on water bottles to solve problems of transparency, curved shaped, and reflective nature of water bottles, as well as the often low-quality, dotted printing of expiration dates. By segmenting the bottle from the image and applying specific pre-processing like finding contours using OpenCV, the system isolates and recognizes the text region. The system achieves an accuracy of 97.2% on their dataset [10]. The growing demand for efficient traffic monitoring has led to the AI-driven solutions like Automated Number Plate Recognition (ANPR), which minimize human work by using real-time data and uses PaddleOCR an optical character recognition model for identifying vehicle number plates. The system pipeline includes image capture, plate detection, edge detection, character segmentation, and recognition [11].

A system uses PP-OCRv4 model, implemented through Baidu's AI Studio platform. The method integrates a text detection module based on the Differentiable Binarization algorithm and a lightweight SVTR_LCNet recognition network for efficient and accurate text recognition. For improving model's performance various image augmentation techniques like random rotation, flipping, and contrast/brightness adjustments were performed. [12]. A food and beverage business license recognition method based on OCR recognition technology. This method can extract key fields such as unified social credit code and company name. Compared with traditional manual management, this method saves manpower and material resources to a certain extent intelligence of business license information management method, and plays an important role in promoting the development and promotion of business license information management [13]. It analyses the performance of widely used OCR tools Tesseract, Keras, EasyOCR, and PaddleOCR on a varied dataset containing multiple languages, text styles, and image conditions. PaddleOCR and EasyOCR often outperform in multilingual and low-quality image scenarios, whereas Tesseract offers simplicity and flexibility [14]. The use of CNN with Keras and supported by OpenCV and PaddleOCR, the system identifies pills based on their shape, colour, and imprint. The CNN model offers real-time performance suited for dispensaries and achieves an accuracy of 97.5% on a structured database [15]. A three-module framework was proposed to identify and recognize retail products. The first module utilizes the YOLOv5 object detection algorithm to localize both on-the-shelf and off-the-shelf items in static images and video frames. The second module modifies a state-of-the-art detection network by integrating a ResNet50 + FPN as backbone. The third module implements text recognition model to extract key product details such as brand name, product name, price, and expiration date. The accuracy achieved by the system is 84.6 % [16].

Although existing systems provide promising results in expiry date detection, most of them focus primarily on detection rather than proactive alerting. Furthermore, their heavy model architectures are unsuitable for edge deployment as it requires substantial computational resources. In contrast, ExpirySense not only detects expiry dates but also triggers alerts proactively, using a lightweight architecture that combines MobileNet with a PaddleOCR which is suitable for real-time processing on edge devices. Additionally, it excels at detecting compact date formats, which are often missed by existing models.

III. METHODOLOGY

ExpirySense system is designed to automate the detection of expiry and manufacturing dates from the product packaging using Optical Character Recognition (OCR) and generate a proactive alert. Also, for the retailers and consumers, detecting the expiry date is crucial in terms of wastage and safety especially in food product category. Apart from the traditional methods of detecting dates, ExpirySense has reduced inference time by 25% that is it has 25-30ms of inference time as compared to the existing models, it supports multi-language detection and due to its ROI selection logic, it is able to handle the product with the curved expiry related information and the product image with expiry in different formats like numbers or texts.

A. *System level block diagram – ExpirySense*

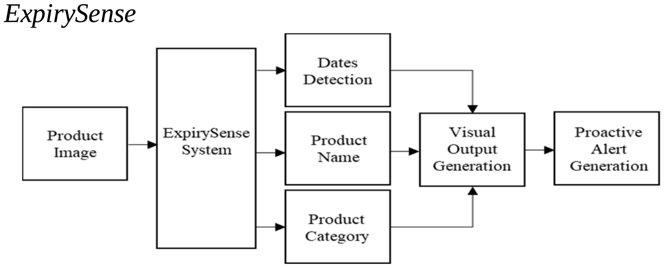

Fig 1. ExpirySense System Block Diagram.

Figure 1. illustrates the system level block diagram with the input as the product image and output as an alert when the product is near to expiry. The proposed system takes the input of the product image from user camera or by drag and drop option in the format of jpg, jpeg or png of the resolution of 1280 × 680px from the user. Then this image is processed in ExpirySense which gives output as detected expiry date, name of the product and the category of the product. All such things are visually shown on the interface which is further responsible for generating the proactive alerts on the device of the user. This helps user to make the decision for that expired or the nearly expiring product to use it or not, if the alert is generated for that product.

B. Dataset and Pre-processing Details

The objective of this implementation is to detect expiry date and generate proactive alert in real time, which is a challenging task due to typically low-resolution image, compact date formats, curved shaped images and also sometimes the date is in dotted format on the product. The custom dataset is used for detection of the dates and the product name.

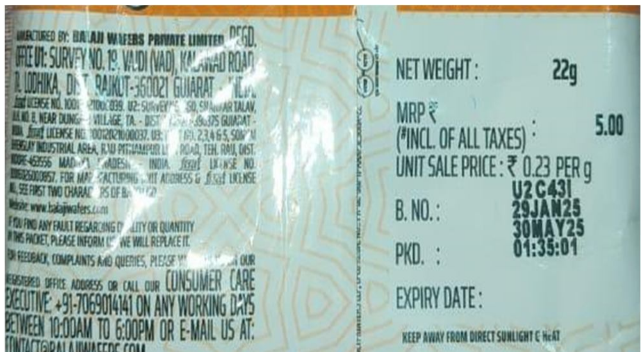

Fig 2(a). compact text Image from custom dataset

Fig 2(a) compact text dates which is generally hard to detect with any text recognition model, because the date is not aligned with the labels (EXP, MFG).

Fig 2(b). Curved shaped Image from custom dataset

In Fig 2(b) the product shown in the image has the curved shape, because of that the text on the product is appeared spread from the user point of view which makes the text hard to detect.

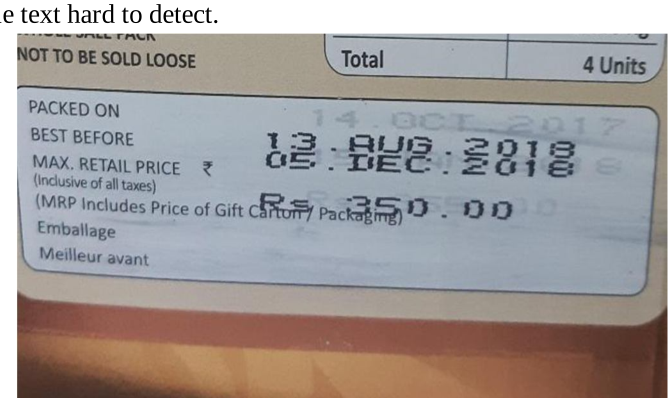

Fig 2(c). Dotted expiry Image from custom dataset

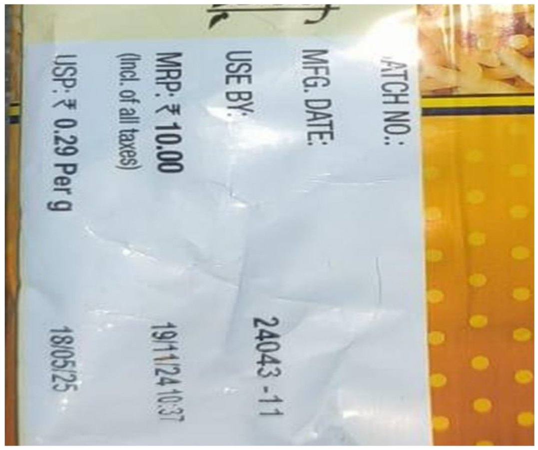

Fig 2(d). Rotated Image from custom dataset

In Fig 2(c) and Fig 2(d) the images shown has the date printed in dotted and skewed format respectively. Also, in skewed format which is another challenge for detecting the dates on the product. For solving these problems occurring in the product images the ExpirySense system is proposed.

For training and testing of the proposed system the custom images dataset is used with the resolution of 1280px × 680px. These images were further processed to extract the dates of that product which is used by the user to take the necessary action on that product.

C. Region of Interest (ROI) Selection

ExpirySense aims to detect the manufacturing and expiry date of the product from the input image but fails to do so because of the image text format like compact, dotted, curved, skewed, etc. To solve this formatting issue ExpirySense uses the ROI selection method. For detecting the date, we are generally interested in the region where the expiry and manufacturing dates are mentioned. All other text on the product is not significant while detecting the dates. So, to detect that region where the dates are present is the necessary for further processing. To do so, first of all the entire image goes under text detection model (PaddleOCR) which results in detecting the entire text on that product. Once text regions are identified, the labels like "EXP" and "MFG" are searched in the region, once they are found the separate bounding box are made on them.

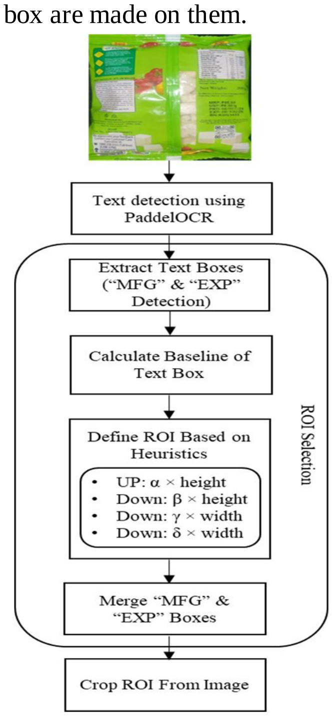

Fig 3. ROI Selection Workflow for Target Text Detection

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The Fig 3. Illustrate that, how the ROI is calculated and how the bounding box is made on it. So as mentioned earlier firstly the image goes under the text detection using PaddleOCR which extract all the mentioned text on the product. And this extracted result is stored for further processing. After the text is detected and stored, we search for the keywords like "EXP" and "MFG" in the detected text. Once it is found the bounding box are made on them.

The extracted bounding box are then verified to check if the corresponding dates are included in the bounding boxes or not. This is done by calculating the baseline of the bounding box which refers to identifying the imaginary horizontal line on which the characters of the text rest. To calculate the baseline, we first calculate the centroid of the bounding box by using all the four co-ordinates of the box which are defined as –

1) Top-left: (x_1, y_1)
2) Top-right: (x_2, y_2)
3) Bottom-right: (x_3, y_3)
4) Bottom-left: (x_4, y_4)

The centroid point is computed by averaging the x and y values of opposite corners:

Centre X-coordinate -

$$x_{center} = \frac{x1+x2}{2} \quad \text{...... (1)}$$

Centre Y-coordinate -

$$y_{center} = \frac{y1+y2}{2} \quad \text{...... (2)}$$

The imaginary horizontal line that is baseline is passed to this centroid which is calculate as per the equation (1) and (2) to verify the dates. This also help in detecting the dates of the products which images are captured at an angle as show in Fig. 2.b, that is it support the skew correction.

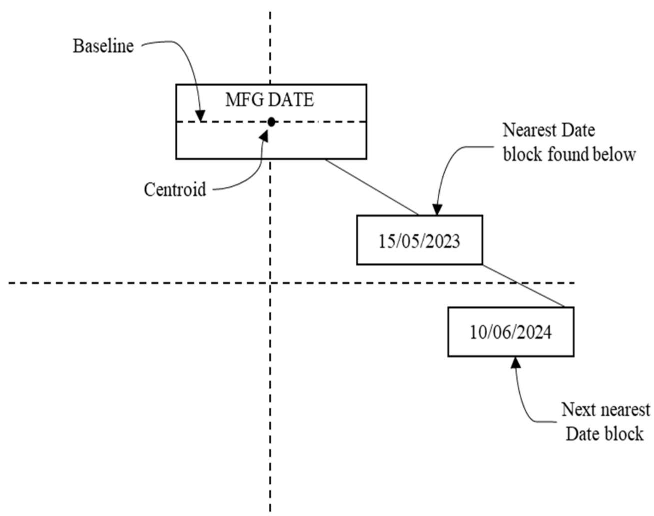

Fig 4. Date Detection via ROI Centre Matching

While on some product the label and the dates are not aligned on the same, they both are present on the different lines as show in Fig. 2.b. Also, in some case the date is sightly move upward or downward from the label alignment as show in Fig. 2.c. So, all these types of special condition are solved using the ExpirySense system. After detection of label if the special case arrives, the system search for the nearest dates as shown in Fig. 4 that are stored in the starting while extracting the text of all the product using PaddleOCR. By doing this proper bounding box are generated on the "MFG" and "EXP" separately.

The heuristic is defined on these bounding boxes to ensure that the text in the bounding box is completely covered and not get cut which resulting the error in detected text. As we know the height and width of the bounding box, just applied some padding on each side on the box to avoid the text cutting problem and the full text content is captured that is required to detect the dates properly. To pad the bounding box, we use some scaling factors(heuristics) like α, β, γ, δ. These scaling factors are fined-tune based on how much padding is typically needed in the dataset.

The final part after generating the bounding boxes on both of the labels separately is to merged them. To merge them we just take the top-left coordinate (x_1, y_1) of the "MFG" label and the bottom-right coordinate (x_3, y_3) of the "EXP" label and make a new combined bounding box which is generally our ROI. Below show is the comparison on the ROI selection using an existing OCR model and with ExpirySense system. These shows that ROI selection is a crucial step when it comes to improving the accuracy of date detection.

Fig 5(a). Output of PaddleOCR V3

Fig 5(a) is the image from custom dataset, which captures real-world product packaging under low-light, low-resolution conditions. The existing PaddleOCR model is not able to identify the damaged label and the as shown in figure and the bounding box is formed around wrong detected content.

Fig 5(b). ROI output using PaddleOCR

ExpirySense is able to solve such damaged label detection problem using the ROI selection method and in Fig 5(b) the bounding box is formed around the region in which we were interested.

D. Preprocessing on Extracted ROI

An ExpirySense focuses on detect expiration and manufacturing dates from retail product images using an OCR-based pipeline. The ExpirySense uses PaddleOCR as its core detection engine and several preprocessing image conditions such as curvature, blur, and low contrast.

Fig 6(a). ROI Extracted input image

The extracted ROI is converted into the image for preprocessing. Then for detection process, the system takes a ROI image as input as shown in Fig 6(a). This image is first preprocessed using grayscale conversion, Gaussian blurring, and adaptive thresholding to enhance text visibility. The preprocessed ROI image is then again passed to the PaddleOCR model, which extracts text lines. Once the text is extracted, the system proceeds to compile regular expressions to identify manufacturing and expiry date indicators.

1) Grayscale Conversion :- The first step for detecting the date input color image of ROI is converted to grayscale. This reduces the image from three color channels (RGB) to a signal channel intensity. It is performed using a weighted sum of the RGB channels, as show in the equation 3 –

$$\text{Gray} = 0.299 \times R + 0.587 \times G + 0.114 \times B \quad \dots (3)$$

Firstly, each pixel in a color ROI image has individual values for read, green, and blue (R, G, B) are extracted. Then applying the formula as show in equation 3, we get a single grayscale value for each RGB pixels value. This calculates grayscale value replaces the original R, G, and B values of the pixel. This process is repeated for every pixel in the image, which results in grayscale image. The weights 0.299, 0.587, and 0.114 are chosen to match the human eye's sensitivity to different colors.

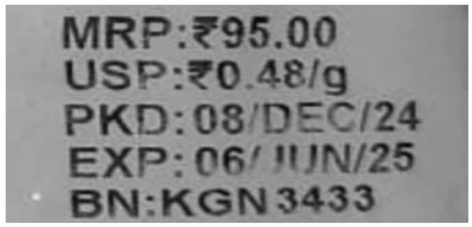

Fig 6(b). Input image to Grayscale Conversion

The input image is converted into Grayscale image which helps in simplify the text and make edge detection task easier as show in Fig 6(b).

2) Gaussian Blurring: - Once the grayscale image is obtained, Gaussian blurring is applied on image which reduce high-frequency noise and smooth the image. A gaussian filter is used which is a convolution operation with a Gaussian kernel to average the pixel values within a neighborhood. This minimize the small-scale variations which is defined by the gaussian function –

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2 + y^2}{2\sigma^2}} \quad \dots..(4)$$

In equation 4, x represents the distance from the origin in the horizontal axis, y represents the distance from origin in the vertical axis, and σ denotes the standard deviation of the Gaussian distribution. The origin on these axes is at the center (0, 0). This step is crucail in enhancing the uniformity of background regions.

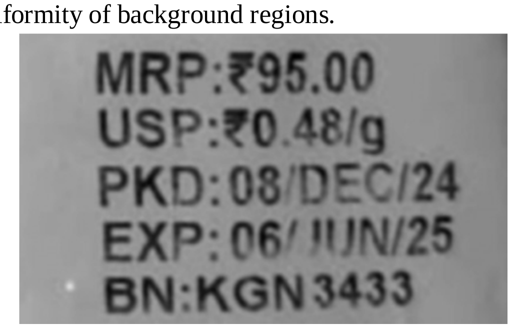

Fig 6(c). Grayscale to Gaussian Blur Conversion

Then on the grayscale image Gaussian blurring is applied which helps in reducing noise and soften the edges of the image as shown in Fig 6(c).

3) Adaptive Thresholding: - The final preprocessing step is adaptive thresholding, which is applied to binarize the image. It dynamically adjusts the threshold value for each pixel or small region of an image based on local characteristics. This is different from global thresholding, where a single threshold value is applied to the entire image. The threshold $T(x, y)$ for each pixel can be caculated using the local mean or Gaussian-weighted sum of neighborhood intensities, which is expressed as –

$$T(x, y) = mean(N(x, y)) - C \quad \dots\dots (5)$$

In equation 5, $N(x, y)$ is the neighbourhood of pixel (x, y) and C is a constant used to fine-tune binarization. This step effectively handles varying lighting conditions and shadows.

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Fig 6(d). Gaussian Blur to Thresholding conversion

Then Adaptive Thresholding is applied to the Gaussian Blur image which helps in enhancing image quality and improving accuracy for data detection process as shown in Fig 6(d).

The preprocessing pipeline plays a crucial role in preparing the ROI image for text detection. By enhancing contrast, reducing noise, and normalizing lighting conditions, these steps of preprocessing significantly improve the clarity of textual regions, which help to detect the dates more accurately in different types of images.

E. Modified PaddleOCR for Date Extraction

The ExpirySense uses PaddleOCR over Tesseract or EasyOCR due to its customizable architecture and support of 80+ languages. Also, it is suitable for edge device deployment. In contrast, Tesseract and EasyOCR requires more computation resources. Also, PaddleOCR handles skewed orientations which is not possible in EasyOCR and Tesseract OCR.

The proposed ExpirySense system leverages a modified PaddleOCR pipeline which is integrated with MobileNETv3 as the backbone for detecting ROI. As we discuss earlier, at the initial stage of the data detection the modified PaddleOCR model is initialized to extract all the content on the product, but specifically targeting expiry and manufacturing dates and also the labels associated with it. So overall, this modified OCR model with MobileNET integrated in it which helps in detecting the text content on the product and also the corresponding ROI selection. For this implementation pre-trained PaddleOCR model was used and then it is fine-tuned like recognition thresholds were optimized. Moving forward in the pipeline, after detection the dates should be recognition which is basically done using Convolutional Recurrent Neural Network (RCNN). Then this recognized text string is passed through the regex-based filter which is used to extract the date string format such as – “DD/MM/YYYY”, “MM/DD/YYYY”, etc.,. For the further enhancement custom layers were added into post-processing which includes heuristics and pattern-based filtering. The ExpirySense system has made feasible to work on the edges device because of integration of MobileNET model in it which consumes less power. The traditional PaddleOCR framework leverages all high-speed data computational model which consume high power which is not efficient for the edge device as all the user does not have the required hardware compatibility to run this traditional model. Also, ExpirySense system is a multi-language system which is capable to handle 80 plus languages and it also support the detection of skewed images. So that why, ExpirySense system with integrated MobileNET model is much more compatible to use on the user edges devices. The Modified PaddleOCR model has two stages for extracting the dates from the product that is, first detecting the text and then recognition of text. These two stages are totally responsible for the overall dates extracting. Both of the stages different models for performing the desire task assign to them.

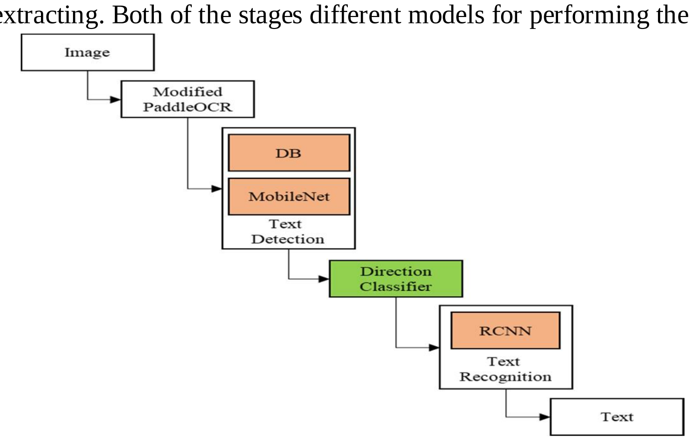

Fig 7. Modified PaddleOCR Working Procedure

The above Fig 7 illustrates the pipeline for Modified PaddleOCR in which the two stages as mentioned before. The task of these two stages is done using MobileNet model and RCNN. Also, a Differentiable Binarization (DB) algorithm is use in text detection. After detecting the text, the orientation of that detected text is analysis and classify it accordingly. That is if the text is urinated vertically then it is made horizontal orientation which helps in recognizing the text easily.

1) Text Detection: - This stage is used to detect the text on the product and generate the bounding boxes on them using the DB algorithm which has a backbone of MobileNet model. The DB algorithm is a text detection approach based on segmentation that aims to accurately localize text areas in natural scene images. In traditional OCR pipelines it employs fixed binarization thresholds or anchor-free object detection. The DB algorithm presents a new learnable method for binarization so that it can be easily incorporated into an end-to-end trainable neural network. The major concept of DB is to generate not just a probability map telling us how likely each pixel is to be a part of a text region but also dynamically predicated threshold map.

Internally, the DB architecture begins with a lightweight backbone network such as MobileNet, which extracts multi-scale visual features from the input image. These features are then fused using a feature pyramid-like structure.

Algorithm 1: Expiry Date Detection using MobileNetV3 and PaddleOCR
Input: Image I Output: Expiry date string D 1. Preprocess image I (resize, normalize, enhance contrast). 2. Load MobileNetV3 model trained for expiry date region detection. 3. Detect text regions B = {b1, ..., bn} with confidence > threshold θ. 4. For each bi ∈ B: a. Crop region Ri from I b. Pass Ri to PaddleOCR for text recognition → Ti 5. Aggregate all recognized texts T = {T1, ..., Tn} 6. Apply regex or pattern matching to extract valid date(s) from T. 7. Prioritize text near keywords (e.g., “EXP”, “Expiry”) if multiple dates found. 8. Return most probable expiry date D.

The above Algorithm 1 illustrates how internally the MobileNet model is working. After the feature is fused it is pass through a segmentation head yielding three outputs: a text probability map, a threshold map, and a differentiable binary map. The differentiable binary map output is generated from the features prototype by applying a sigmoid-based approximation function that smooths the binarization process as it relates to the binary decision (text vs background pixels). the binary map is thresholder to produce clear segmentation masks of text regions, from which bounding boxes or polygons are extracted to represent detected text areas. The high precision and recall performance, along with real-time capability on lightweight backbones like MobileNetV3, make it an ideal choice for embedded applications such as expiry date detection in consumer product images.

2) Text Recognition: - The text recognition step in PaddleOCR takes text areas and transforms them into human-readable character strings. Typically, a Convolutional Recurrent Neural Network (CRNN) architecture is used for this step, as it is specially designed to handle some kind of sequence with the purpose of inferring meaning in the input, such as a word or a line of text. At its core, the CRNN model combines convolutional layers for feature extraction, recurrent layers for sequence modelling, and a Connectionist Temporal Classification (CTC) decoder for transcription. The CRNN model can also transfer knowledge in recognizing text of different lengths and styles without requiring character-level segmentation.

The model starts by resizing cropped text images and feeding them into convolutional layers (e.g., MobileNet) to extract spatial features before using bidirectional LSTM layers to model character sequences. Then a Connectionist Temporal Classification (CTC) decoder alignment is applied to the predicted character sequence without needing precise character boundaries. For improved performance, the modern implementations can utilize transformer-based recognizers that replaced LSTMs with attention mechanisms for capturing long-range dependencies.

This is how the date string is obtained for the image which is then used in generating the proactive alerts. The product name is also been extracted from the product. After the text detection, the bounding box are generated on the text present on the product. So, to extract the name of the product the bounding box with the highest area is generally detect as the product name. Because most of the time the product name is return in bold and big font as compare to other text present on the product.

F. Text Recognition Matrix

The evaluation of the performance of the proposed system is carried out using standard text metrics, including Character Error Rate(CER), Word Accuracy and Edit distance of date extraction for manufacturing ("MFG") and expiry ("EXP") information. These metrics help assess the effectiveness of the system in detecting and recognizing date-related information on product packaging in challenging real-world scenarios.

Character Error Rate (CER) is a metric used in Optical Character Recognition (OCR) systems to evaluate text-level accuracy. It is defined as the ratio of the total number of character-level edit operations such as insertions, deletions, substitutions to transform the predicted text into the ground truth, divided by the total number of characters in the ground truth. In the Equation (1) a lower CER value indicates better OCR performance. CER is especially useful in measuring the fine-grained accuracy of OCR outputs, particularly in noisy text regions.

$$CER = \frac{Edit\ Distance}{Total\ Characters\ in\ Ground\ Truth} \qquad (6)$$

Word Accuracy is defined as the correctness of the predicted OCR words with respect to the actual words. The Equation (2) is particularly more important in case of date detection and the product label detection. Higher word accuracy indicates the ExpirySense is able to predict the correct words.

$$Word\ Accuracy = \frac{No.\ of\ Correctly\ predicted\ words}{Total\ No.\ of\ ground\ truth\ word} \qquad (7)$$

Edit Distance(d) is used to measure minimum number of single character edits that is number of insertions, deletions or substitutions it is required to convert the to verify the predicted output by ExpirySense with the ground truth. As shown in Equation (3) lower the 'd' value lower will be the errors.

$$d = Min(Insertions, Deletions, Sunstitution) \qquad (8)$$

In addition to text-recognition metrics, we define a custom Date Detection Accuracy (DDA) metric to evaluate if the correct "MFG" and "EXP" dates were both identified and correctly normalized. This metric is calculated as:

$$DDA = \frac{Total\ Images\ Correctly\ identified}{Detected\ MFG\ and\ EXP\ Dates} \qquad (9)$$

By combining these evaluation metrics, the system's ability to detect, extract, and track date-related information, such as manufacturing and expiry dates, can be effectively assessed. These metrics demonstrate the system's robustness and performance in real-world conditions, ensuring accurate and reliable product date extraction for further analysis and inventory management.

IV. RESULT AND DISCUSSION

The aim of the ExpirySense model was to develop an effective system for expiry detection of a product. By integrating the PaddleOCR model for character recognition and object detection, ExpirySense aims to enhance the accuracy and efficiency of expiry date detection and generation of alert for expired products.

The validation of the ExpirySense is done using multiple evaluation strategies. Firstly, the model was tested on a 5000 images dataset with multiple date formats such as dotted, curved and compact styles. In the dotted format the achieved accuracy is 93.3%, while in curved format the accuracy was 95.8% and in the compact date format style the accuracy is improved to 97.2%. Also, the expiry alert generation accuracy is 97.7% and it is tested in the retail store environment.

Table 1. Performance Metrics of ExpirySense

Metric	Value	Description
Precision	96.2%	Accuracy of correctly detected expiry/manufacturing date text
Recall	94.8%	Ability to identify all relevant date-related information in images
F1-Score	95.5%	Balanced measure combining both precision and recall
DDA Score	97.7%	Accuracy of detecting expiry dates and generating correct expiry alerts

Table 1 shows that while evaluating the result of this metrices, ExpirySense significantly improves the tracking accuracy. The high precision and recall show correct product detection. Also, DDA score shows the overall product detection and alert generation accuracy.

Table 2. PaddleOCR vs other OCR Models

OCR Algorithm	Detector	Recognizer	Model Size	Energy Consumption
YOLOv5 + CRNN	YOLOv5	CRNN	~25–30 MB	Moderate
VGG+ RNN	Handcrafted	RNN	~500 MB	High
PaddleOCR Mobile	DB (Mobile Net)	CRNN	8–12 MB	Low
PaddleOCR Server v3	DB (ResNet/ SVTR)	SVTR/Transformer	~90–120 MB	Moderate

Table 2 shows that other OCR algorithms lags behind as compared to PaddleOCR Mobile model which has the lowest energy consumption which is more significant in edge devices as it will consume less computation power. Also, it has 8-12MB model size so it can be easily deployed to the edge devices.

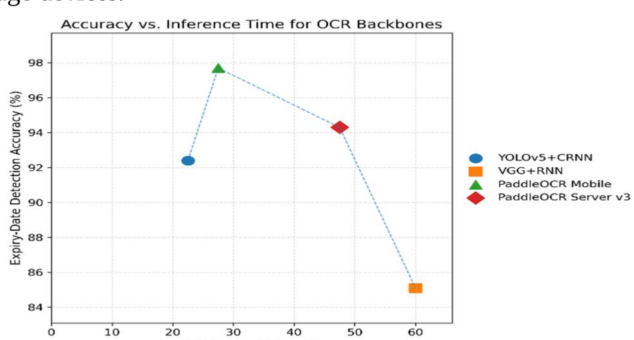

Fig 8. Comparison of tested models

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The output achieved with the accuracy of 97.7% and it is compared with the above models as shown in Fig 8 and it also has the lowest energy consumption with the inference time of 25-30ms.

The statistical analysis was conducted across five independent test datasets, each consisting of 5000 labelled samples collected under varying conditions such as different lighting environments, products and font styles. The analysis revealed that the model maintained a high mean precision of 96.2% with a standard deviation of ±1.3%, and a mean recall of 94.8% with a standard deviation of ±1.7%. At a 95% confidence level, the confidence interval for precision was calculated to be between 95.2% and 97.2%, while the recall confidence interval ranged from 93.5% to 96.1%.

Fig 9. Ablation Study on ExpirySense

As shown in Fig 9 an ablation study was also conducted on ExpirySense to measure the impact of preprocessing and ROI strategies. When edge detection and adaptive thresholding were excluded, model's accuracy dropped by 5.6%, while removing the MobileNet based ROI localization it led to a 7.3% decrease in correct date extraction. This clearly demonstrates that the significance of the lightweight MobileNet backbone and preprocessing stages in boosting text localization and readability which will help in alert generation later.

The scalability assessment of the ExpirySense was done, the test was conducted under varying conditions of lighting and batch processing. The ExpirySense maintained low memory consumption and stable CPU usage not only during single-image inference but also in suboptimal lighting conditions. When evaluated for batch inference scenarios, the system demonstrated scaling doubling the batch size from 4 to 8 led to nearly proportional increases in inference speed from 54.8 FPS to 97.1 FPS with adjustable rises in memory and CPU load.

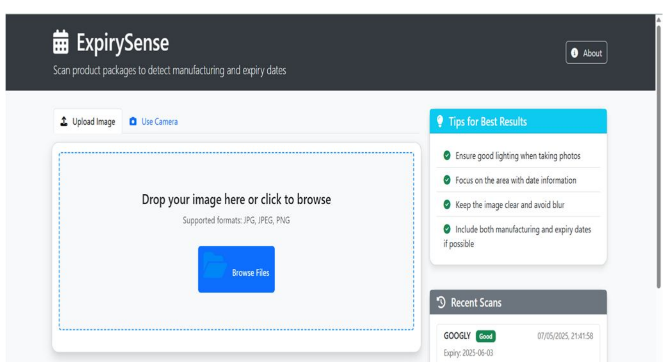


Fig 10. UI of an ExpirySense

Figure 10 shows the UI of the expiry sense where shopkeeper or retailer can upload the product image keeping tips of best result in mind. Also, user can capture the image using the ExpirySense and then it will be given to model to process and depend on that the output will be generated.

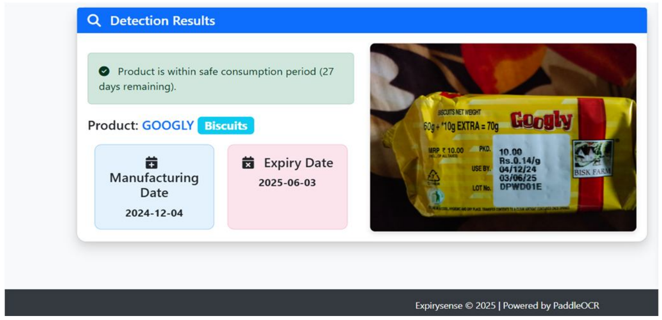


Fig 11. Expiry date detection using ExpirySense

Figure 11 shows the result of the ExpirySense model, here as we can see that model successfully able to detect the product name, manufacturing date and expiry date. As, here product is within the guidelines the alert is not generated.

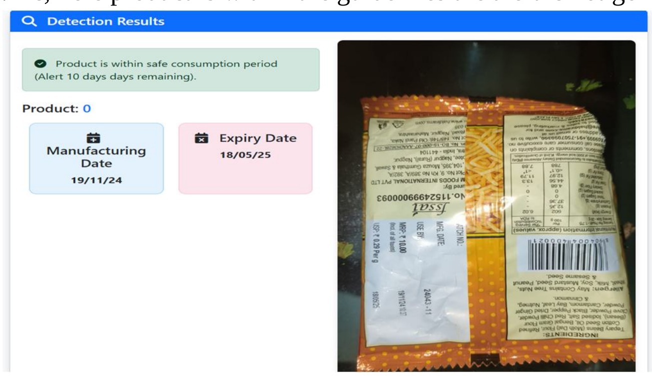


Fig 12. Output with alert generation

The Fig 12 shows that ExpirySense successfully detected the skewed image expiry and manufacturing dates and generates alert for it as it's expiry is within 10 days.

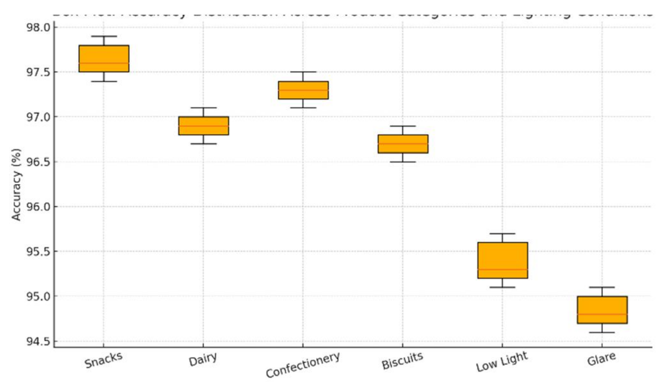


Fig 13. ExpirySense accuracy in under different lighting conditions

The Fig 13 shows that ExpirySense achieves much higher accuracy that is around 97.7% in each product category under the different lighting conditions. However, under challenging conditions like low lighting and glare, there is a slight dip in performance, with accuracy values falling to the range of 94.6% to 95.7%.

An error analysis was conducted to understand the limitations and edge cases where the ExpirySense model underperforms. An error arose in cases where expiry or manufacturing dates were smudged, faded or given in black background on older and poorly maintained packaging. In such cases, the ExpirySense struggled to segment and recognize characters due to lack of contrast. Another source of failure was poor lighting, especially in dimly lit retail environments or with glare reflecting off glossy packaging. These insights were on the custom datasets and after some further improvements it can be solved.

Overall, these results collectively validate that ExpirySense not only achieves high recognition accuracy of 97.7 % but it is also lightweight and efficient for real-time deployment on mobile and embedded platforms. Future iterations may explore advanced text recognition under extreme distortions and lack of contrast date formats.

V. CONCLUSION

ExpirySense – Expiry date detection and proactive alert is a highly effective approach to track products expiry related info in retail environment. By integrating PaddleOCR model for expiry date detection and alert generation, it achieved the high accuracy for expiry date in dotted printing like case. It has achieved overall 97.7% accuracy for detecting expiry date and their respective manufacturing dates to solve the overhead in retail store. Furthermore, the extracted info given to MobileNET and CRNN which is acting as an alert generation engine here it will decide based on input the alert will be generated or not. The combination of all this advanced notification techniques for expired products. ExpirySense ensures that it can handle real-world situations effectively in retail environment. We used different types of input images products with different types of fonts, but with the same text position, orientation and black shade intensity. The results can be improved by upgrading the dataset. In future work we will try to tackle other problems such as different product name with smaller area, shape and intensity of the expiry date text area. For the improvement of the robustness of this system we will try to enhance our solution to work in any uncontrolled environment.

REFERENCES

[1] Rani, S. Jansi, and N. Saranya. "Medical Prescription Analysis Using Machine Learning." In 2025 International Conference on Machine Learning and Autonomous Systems (ICMLAS), pp. 376-379. IEEE, 2025.

[2] Lu, Yangyu, Yuru Chen, and Shibiao Zhang. "Research on the Method of Recognizing Book Titles Based on Paddle OCR." In 2024 4th International Signal Processing, Communications and Engineering Management Conference (ISPCEM), pp. 1044-1048. IEEE, 2024.

[3] Song, Qinghua, Yajun Liu, Haoyue Sun, Yong Chen, and Zheng Zhou. "Multi-Device Universal Automation Data Acquisition and Integration System." IEEE Access (2024).

[4] Honari, Mohammad Mahdi, Hossein Saghlatoon, Rashid Mirzavand, and Pedram Mousavi. "An RFID sensor for early expiry detection of packaged foods." In 2018 18th International Symposium on Antenna Technology and Applied Electromagnetics (ANTEM), pp. 1-2. IEEE, 2018.

[5] Muresan, Mircea Paul, Paul Andrei Szabo, and Sergiu Nedevschi. "Dot matrix OCR for bottle validity inspection." In 2019 IEEE 15th international conference on intelligent computer communication and processing (ICCP), pp. 395-401. IEEE, 2019.

[6] Raj, A. Nirmal, G. Santhosh Kumar, Vellayan Srinivasan, DV Lokeswar Reddy, B. V. Febiyola Justin, and R. Priyadharshini. "Analysis of Internet of Things based Medication Dispenser Reminder and Drug Expiration Health Monitoring and its Applications." In 2024 4th International Conference on Sustainable Expert Systems (ICSES), pp. 241-244. IEEE, 2024.

[7] Almutairi, Ahad, Jawza Alharbi, Shouq Alharbi, Haifa F. Alhasson, Shuaa S. Alharbi, and Shabana Habib. "Date fruit detection and classification based on its variety using deep learning technology." IEEE Access (2024).

[8] Gong, Liyun, Mamatha Thota, Miao Yu, Wenting Duan, Mark Swainson, Xujiong Ye, and Stefanos Kollias. "A novel unified deep neural networks methodology for use by date recognition in retail food package image." Signal, Image and Video Processing 15 (2021): 449-457.

[9] Song, Qinghua, Yajun Liu, Haoyue Sun, Yong Chen, and Zheng Zhou. "Multi-Device Universal Automation Data Acquisition and Integration System." IEEE Access (2024).

[10] Muresan, Mircea Paul, Paul Andrei Szabo, and Sergiu Nedevschi. "Dot matrix OCR for bottle validity inspection." In 2019 IEEE 15th international conference on intelligent computer communication and processing (ICCP), pp. 395-401. IEEE, 2019.

[11] Lu, Yangyu, Yuru Chen, and Shibiao Zhang. "Research on the Method of Recognizing Book Titles Based on Paddle OCR." In 2024 4th International Signal Processing, Communications and Engineering Management Conference (ISPCEM), pp. 1044-1048. IEEE, 2024.

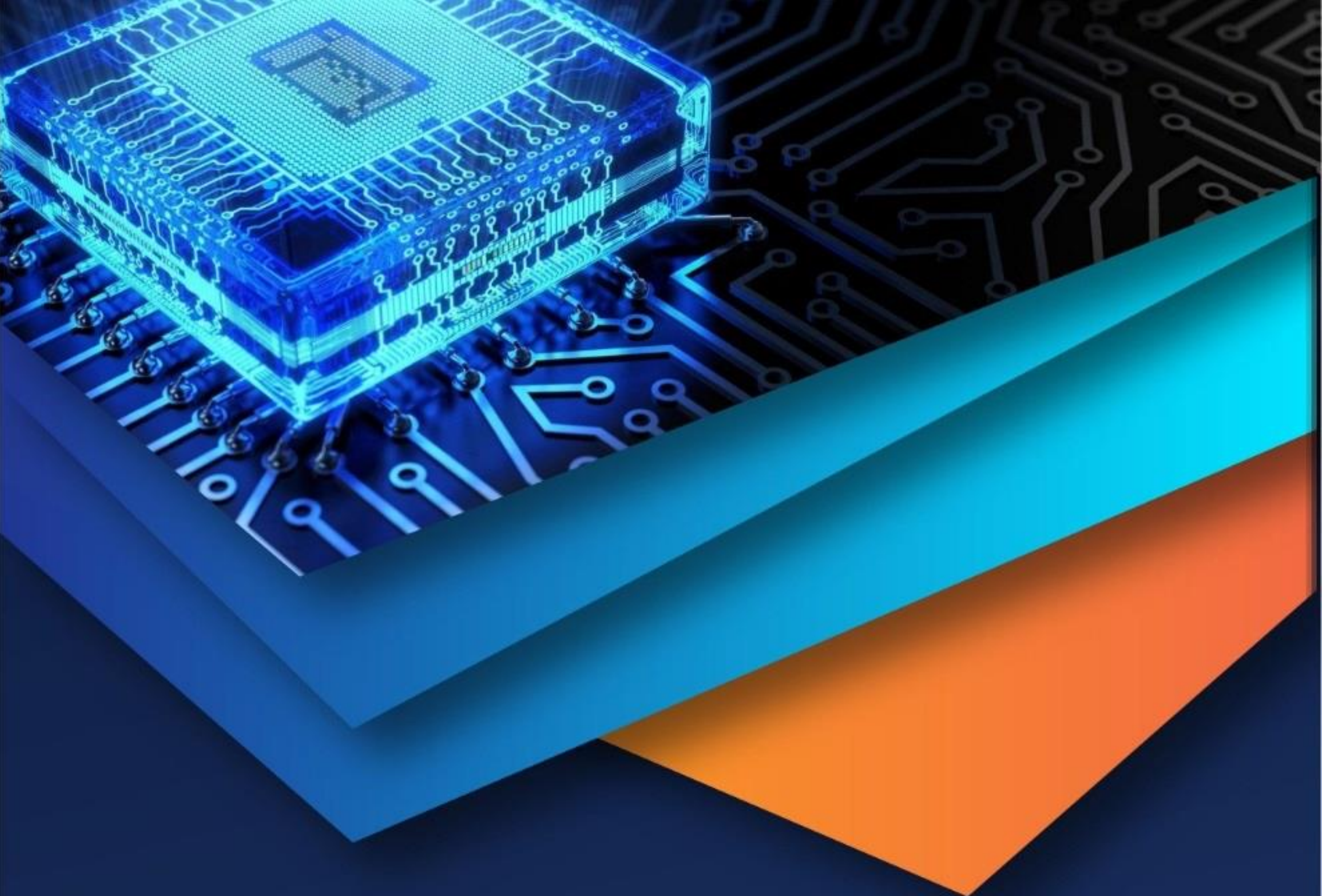
[12] Ma, Chenbo, Fang Li, Zichen Wang, Yaozhong Zhang, and Fengxiang Li. "Application and Practice of PaddleOCR Based Image Recognition Technology in Business License." In 2024 2nd International Conference on Signal Processing and Intelligent Computing (SPIC), pp. 741-745. IEEE, 2024.

[13] Rani, S. Jansi, and N. Saranya. "Medical Prescription Analysis Using Machine Learning." In 2025 International Conference on Machine Learning and Autonomous Systems (ICMLAS), pp. 376-379. IEEE, 2025.

[14] Karanth, KV Ujwal, A. T. Sujan, YR Thanay Kumar, SudhanvaS Joshi, KP Asha Rani, and S. Gowrishankar. "Breaking Barriers in Text Analysis: Leveraging Lightweight OCR and Innovative Technologies for Efficient Text Analysis." In 2023 2nd International Conference on Automation, Computing and Renewable Systems (ICACRS), pp. 359-366. IEEE, 2023.

[15] Ponte, Eric, Xavier Amparo, Kuan Huang, and Daehan Kwak. "Automatic Pill Identification System based on Deep Learning and Image Preprocessing." In 2023 Congress in Computer Science, Computer Engineering, & Applied Computing (CSCE), pp. 1-6. IEEE, 2023.

[16] Selvam, Prabu, and Joseph Abraham Sundar Koilraj. "A deep learning framework for grocery product detection and recognition." Food Analytical Methods 15, no. 12 (2022): 3498-3522.



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