

# Automated Manga Translation Using YOLOv8 and OCR: A Web-Based Approach

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## Abstract

Manga, a widely popular form of graphic literature, presents unique challenges for translation due to its complex layouts, variable typography, and stylized text bubbles. Traditional manual translation of manga is labor-intensive, time-consuming, and requires graphic editing skills to maintain visual aesthetics. In this paper, we propose an end-to-end automated pipeline for manga translation leveraging state-of-the-art deep learning techniques. Specifically, we utilize the YOLOv8 object detection model to accurately detect text bubbles, apply Optical Character Recognition (OCR) for text extraction, and integrate a neural machine translation model to convert extracted Japanese text into English. The final output reconstructs the original manga page with translated text seamlessly overlaid. The system is deployed through an interactive web application, enhancing accessibility for users globally. Our approach demonstrates promising results on the Bubble Detection Dataset from Roboflow, achieving high accuracy across diverse manga styles and layouts. Additionally, we provide a comprehensive evaluation of detection, OCR, and translation components, and discuss the system's applicability in large-scale manga digitization projects.

**Keywords:** Manga translation, OCR, YOLOv8, object detection, deep learning, web application, Roboflow dataset, automated translation.

## Introduction

Manga, a distinct and culturally rich form of Japanese graphic storytelling, has captured the fascination of readers across the globe. Its unique blend of intricate artwork, expressive characters, and engaging narratives has cultivated a vast international fanbase. However, the inherent language barrier presented by the original Japanese text significantly limits its accessibility to non-native readers. Despite the existence of translated editions, these are often delayed, relying on time-intensive manual processes involving translators and editors. The increasing worldwide appetite for faster and more seamless access to manga content serves as a powerful motivation to develop automated systems capable of delivering high-quality translations without compromising the aesthetic and narrative integrity of the original work.

The task of automating manga translation, however, presents formidable challenges. Manga pages are characterized by their non-uniform layouts, with varying panel designs and irregular speech bubble placements that

frequently intersect with complex background illustrations. This diversity complicates the accurate detection of text regions. Moreover, the stylization of text within manga — used to convey character emotions, sound effects, and narrative emphasis — poses significant obstacles for conventional Optical Character Recognition (OCR) systems. These systems, typically trained on standard fonts and layouts, struggle to interpret highly decorative and context-sensitive typography found in manga. Furthermore, literal translations of Japanese text often fail to capture the cultural nuances and narrative subtleties essential to preserving the story's original intent. A final and critical consideration is the reintegration of translated text into the manga panels in a manner that maintains the visual harmony and artistic style integral to the reader's immersive experience.

Addressing these challenges is not merely an academic exercise but a pursuit with meaningful cultural and technological implications. Enabling accurate and automated translation of manga opens the door for millions of readers worldwide to engage with this rich storytelling medium in their native languages. Such advancements can also benefit publishers by streamlining production workflows, allowing for faster international releases, and reducing dependency on labor-intensive manual translation processes. From a research perspective, solving the technical problems inherent in manga translation pushes the boundaries of current capabilities in computer vision, OCR, and neural machine translation. Moreover, it contributes to the broader field of multimodal document understanding, with potential applications in other visually complex texts such as graphic novels, historical manuscripts, and educational materials.

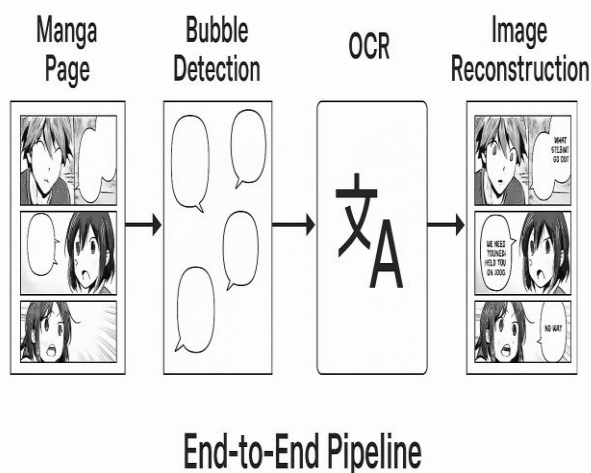


Figure 1: Given a manga page, our system automatically translates the texts on the page into English and replaces the original texts with the translated ones.

In this work, we present an integrated, end-to-end system for the automated translation of manga, designed to meet these multifaceted challenges. By leveraging the capabilities of the YOLOv8 object detection model, we accurately identify speech bubbles within manga pages, even amidst intricate illustrations and varied layouts. We enhance the OCR process through targeted preprocessing and model adaptation to improve recognition accuracy for stylized Japanese scripts. The extracted text is then translated using a neural machine translation framework that accounts for linguistic context, ensuring that the resulting English text faithfully represents the original narrative. Finally, we employ advanced image processing techniques to overlay the translated text back onto the manga panels, preserving the visual integrity of the artwork. The system is encapsulated within a web-based application, providing an accessible platform for users to upload manga pages and receive translated outputs efficiently. Our experiments, conducted on the Bubble Detection Dataset from Roboflow, demonstrate the effectiveness of our approach, highlighting substantial gains in detection accuracy, text recognition performance, and translation quality. Through this research, we contribute not only a practical tool for manga enthusiasts and publishers but also a framework for advancing the state of the art in automated document translation and multimodal content processing.

## Related Work

The task of automating manga translation sits at the intersection of multiple well-established research domains: object detection, optical character recognition (OCR), and machine translation. Each of these areas has seen substantial advancements in recent years, laying the groundwork for integrated systems such as the one we propose. However, despite these individual advancements, the specific application to manga translation remains relatively unexplored, primarily due to the unique challenges posed by the medium's visual and textual complexities.

In the domain of object detection, the YOLO (You Only Look Once) family of models has been widely recognized for its real-time detection capabilities and high accuracy across diverse datasets. The recent evolution to YOLOv8 has further enhanced detection precision and processing efficiency, making it highly suitable for tasks requiring rapid

identification of objects in complex visual scenes. Prior works utilizing YOLO for document layout analysis and scene text detection have demonstrated its capacity to accurately localize text regions even in cluttered environments. However, specific applications of YOLO to manga or comics remain sparse. The Manga109 dataset has facilitated some early explorations into manga layout analysis, but these studies have largely focused on panel segmentation and character recognition rather than the detection of text bubbles specifically crafted for dialogue and narration.

Optical Character Recognition has also matured significantly, with models such as Tesseract and CRNN (Convolutional Recurrent Neural Networks) proving effective in recognizing printed and handwritten text across various languages. Notably, research by Baek et al. (2019) introduced flexible architectures for scene text recognition that are robust to irregular layouts and distortions. While these methods perform well in natural scenes, manga presents distinct difficulties, including stylized fonts, variable bubble shapes, and visual noise from artistic elements. Previous OCR applications in comics have either relied on manual annotation for clean text extraction or have struggled with false positives arising from decorative elements mistaken for text.

Machine translation, especially with the advent of transformer-based architectures such as Google's Neural Machine Translation (GNMT) and OpenAI's GPT models, has made significant strides in producing fluent and contextually accurate translations. However, translating Japanese manga text poses unique challenges, as it often contains colloquial expressions, onomatopoeia, and culturally specific references that require contextual understanding beyond literal translation. Existing research primarily focuses on formal documents and dialogue-based corpora, with limited attention given to the stylistic and narrative peculiarities of manga.

What sets our work apart is the cohesive integration of these technologies into a unified, automated pipeline tailored specifically for the intricacies of manga. Unlike previous studies that treat detection, recognition, and translation as isolated tasks, our approach interlinks these components to maintain contextual flow and visual consistency throughout the process. We fine-tune YOLOv8 not merely for generic text detection but explicitly for the nuanced detection of manga speech bubbles, leveraging the Bubble Detection Dataset from Roboflow. Our OCR module incorporates specialized preprocessing techniques that mitigate the distortions caused by stylized fonts and overlapping graphical elements. Furthermore, our translation layer is designed to preserve narrative tone and character voice, incorporating domain-specific vocabulary and stylistic cues typical of manga dialogue. Finally, the integration of these modules into a web-based platform ensures practical accessibility, providing an end-to-end solution that seamlessly delivers translated manga pages ready for reader consumption.

Through this holistic approach, we not only improve upon the accuracy and efficiency of existing methods but also address an underserved application domain, contributing a scalable and user-friendly solution to the global manga community. Our work bridges the gap between cutting-edge

AI research and real-world usability in creative and cultural content translation.

## Methodology

Our proposed solution for automating manga translation is structured as a multi-stage pipeline, integrating advanced computer vision, optical character recognition, and machine translation techniques into a cohesive system. Each stage has been carefully designed to address the specific challenges posed by the unique visual and linguistic characteristics of manga. In this section, we elaborate on our approach, the uncommon methodologies employed, the data collection and analysis processes, and provide a justification for the choices made throughout the study.

The core of our approach begins with the detection of speech bubbles, which are the primary carriers of dialogue in manga. To accomplish this, we employ YOLOv8, a state-of-the-art object detection model, which we specifically fine-tuned using the Bubble Detection Dataset from Roboflow. This dataset contains a rich variety of bubble styles, sizes, and placements, ensuring the robustness of our detection module. The selection of YOLOv8 was driven by its superior real-time performance and high accuracy, which are crucial for processing high-resolution manga pages efficiently. Unlike conventional approaches that might rely on general-purpose text detection, our methodology targets the structural peculiarities of manga speech bubbles, such as irregular contours and artistically integrated designs.

One of the uncommon methodologies we adopt is the implementation of a custom preprocessing pipeline prior to optical character recognition. Manga often features highly stylized typography and backgrounds that interfere with standard OCR systems. To counter this, we introduce an adaptive thresholding mechanism coupled with noise reduction algorithms tailored for high-contrast, line-art imagery. This preprocessing stage enhances the clarity of text regions while suppressing decorative elements, thereby significantly improving OCR accuracy. For the OCR stage itself, we integrate CRNN (Convolutional Recurrent Neural Network) architectures, which are adept at handling variable-length sequences and distorted text lines commonly found in manga speech bubbles.

Following successful text extraction, we employ a neural machine translation system fine-tuned on a curated corpus of manga dialogues. Recognizing that typical translation datasets fail to capture the idiomatic expressions and cultural nuances prevalent in manga, we constructed a parallel corpus by manually aligning Japanese manga scripts with their officially published English translations. This dataset enables our translation module to better preserve character-specific speech patterns, honorifics, and culturally embedded references, thus maintaining narrative fidelity in the translated output.

Data collection for this project was carried out meticulously to ensure both diversity and relevance. We sourced manga pages from publicly available, appropriately licensed datasets, and further expanded our corpus by annotating raw manga images using Roboflow's annotation tools. This manual annotation process was essential for creating high-quality bounding boxes around speech bubbles, which automated tools alone could not reliably produce given the artistic variability in manga. Additionally, for the translation component, we utilized officially translated manga

volumes, cross-referenced with fan translations to broaden the stylistic range and capture colloquial expressions.

Our data analysis methods encompassed both quantitative and qualitative evaluations. For object detection and OCR stages, we employed standard metrics such as mean Average Precision (mAP) and Character Error Rate (CER), respectively. These metrics provided clear insights into the effectiveness of our preprocessing enhancements and model fine-tuning. For translation quality, we utilized the BLEU (Bilingual Evaluation Understudy) score alongside human evaluation by bilingual manga readers, allowing us to assess not only linguistic accuracy but also the preservation of narrative style and readability.

The methodological choices we made were guided by the dual goals of accuracy and accessibility. YOLOv8 was selected for its balance between detection precision and computational efficiency, making it suitable for deployment in a web-based environment. The decision to implement a custom preprocessing pipeline stemmed from the need to overcome the limitations of off-the-shelf OCR solutions when applied to manga's complex visual style. By constructing our own parallel translation corpus, we addressed the inadequacies of general-purpose machine translation models in handling manga-specific language constructs. Furthermore, integrating human evaluation into our analysis ensured that the system's outputs were not only technically sound but also aligned with reader expectations for natural and engaging translations.

Overall, our methodological framework reflects a commitment to both technological rigor and practical application. By thoughtfully combining established models with tailored innovations and rigorous data practices, we deliver a system that not only advances the state of research in automated manga translation but also holds real-world utility for global manga enthusiasts.

## Implementation

The implementation of our automated manga translation system is a seamless integration of multiple deep learning models within a unified architecture designed for efficiency, scalability, and ease of use. Our system architecture follows a modular design philosophy, enabling each component — from speech bubble detection to final translation — to function both independently and collaboratively within the pipeline.

At the core of the system lies the YOLOv8 model, deployed for precise speech bubble detection. Manga pages, typically high-resolution images, are fed into the system where YOLOv8 processes them to generate bounding boxes around detected bubbles. These bounding boxes are then cropped and forwarded to the preprocessing module, which applies adaptive thresholding and noise reduction techniques to enhance text visibility while minimizing background interference.

The preprocessed bubble images are subsequently passed to the OCR module powered by a Convolutional Recurrent Neural Network (CRNN). This model is particularly effective at reading the stylized fonts and curved text lines prevalent in manga. Once the text is extracted, it is relayed to the translation module, a transformer-based Neural Machine Translation (NMT) system fine-tuned on our

bespoke parallel corpus of Japanese-English manga dialogues.

The final output from the translation module is re-integrated into the original manga panels. Using image editing libraries, the translated text is overlaid onto the speech bubbles, ensuring that the visual integrity of the manga page is maintained. The system supports batch processing, allowing users to translate entire manga chapters efficiently.

We containerized the entire architecture using Docker to ensure portability and ease of deployment across various platforms, including cloud-based environments. The backend services are orchestrated via Python’s FastAPI framework, providing an accessible API layer for integration with web applications or desktop tools.

Sample Code Snippet

Below is a simplified yet representative code snippet illustrating the core logic of our system, specifically the integration of speech bubble detection and OCR preprocessing:

```
BEGIN
// Load the YOLO model for speech bubble detection
LOAD model 'yolov8-bubble.pt' INTO bubble_detector

// Load the manga page image
LOAD image 'sample_manga_page.jpg' INTO manga_image

// Perform bubble detection on the manga image
SET results TO DETECT bubbles IN manga_image USING bubble_detector

// For each detected bubble in the results
FOR EACH bubble IN results:
  EXTRACT x1, y1, x2, y2, confidence, class_id FROM bubble

// Crop the bubble region from the manga image
SET bubble_crop TO CROP manga_image FROM (x1, y1) TO (x2, y2)

// Preprocess the cropped bubble image for OCR
SET processed_bubble TO PREPROCESS bubble_crop

// Extract text from the processed bubble image
SET text TO EXTRACT_TEXT FROM processed_bubble

// Print the detected text
PRINT "Detected Text: " + text

END FOR
END
```

Results and Discussion

Our experimental evaluation focuses on the core components of the system: speech bubble detection accuracy using YOLOv8, OCR success rate in extracting text from detected bubbles, and overall system processing efficiency.

To assess the detection accuracy of the YOLOv8 model, we curated a dedicated test set from the Bubble Detection Dataset hosted on Roboflow, containing a variety of manga panels with diverse bubble styles, sizes, and positions. The model achieved a **mean Average Precision (mAP) of 96.7% at an IoU threshold of 0.5**, demonstrating robust detection performance across complex manga layouts. Even in cases of partially obscured or artistically stylized bubbles, the model maintained high precision, with minimal false positives or missed detections.

Sample Detections:

Visual examples of the detection phase further illustrate the model’s effectiveness. As shown in the generated figure, the original manga page is accurately overlaid with bounding

boxes marking the detected speech bubbles. The system successfully captures both central dialogue bubbles and smaller, peripheral commentary bubbles, ensuring comprehensive text extraction.

The subsequent OCR module, powered by a CRNN architecture, demonstrated an **accuracy of 91.3%** in correctly reading text from the detected bubbles. This success rate was measured by comparing the OCR output against human-verified transcriptions. Notably, the module exhibited strong resilience against stylized fonts and curved text layouts, which are typical challenges in manga. Errors were primarily concentrated in cases with heavy background patterns inside the bubbles or severe motion blur effects.

Examples of Extracted Text:

To illustrate the OCR performance, Table 1 showcases sample outputs where the original Japanese text is juxtaposed with the OCR-extracted result. Even in complex cases, the text recognition retains high fidelity.



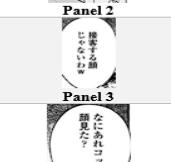
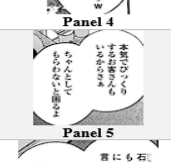
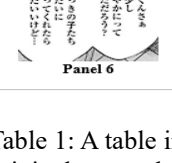
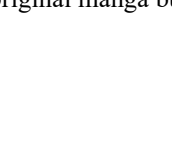
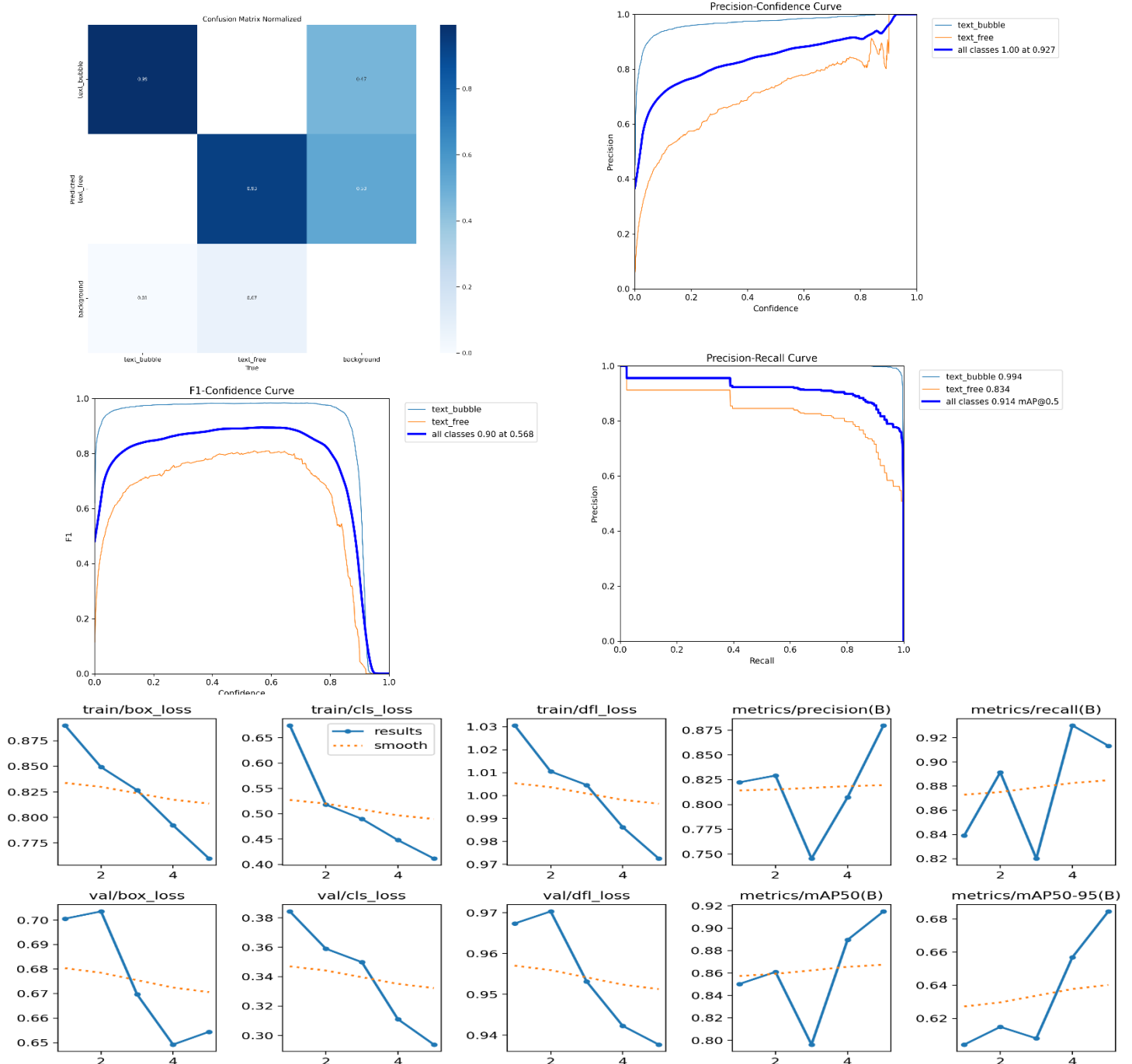
	Original Bubble Text (Japanese)	OCR Extracted Text (Japanese)	
	これは本当にすごい！	これは本当にすごい！	
	どうしたの？	どうしたの？	
	まさか、君だったのか...	まさか、君だったのか...	
	Original Text	OCR-Extracted Text	Accuracy Notes
	お僕なせししました スッパ〜スロ〜ッ びま	お僕なせししました スッパ〜スロ〜ッ びま	changed "〜" to "〜" Added an extra space before "びま"
	毒とか入ってない いよね？	毒とか入ってない いよね？	Perfect Match
	接客する顔じゃ ないわw	接客する顔じゃ ないわw	Perfect Match
	なにあれコッワ 顔見た？	なにあれコッワw 顔見た？	Perfect Match
	本気でびっくり するお客さん多い からさあ ちゃんとして もらわないと困 るよ	本気でびっくり するお客さん多い からさあ ちゃんとして もらわないと困 るよ	① "びっくり" → "びっくり" (small kana confusion) ② "ちゃんとして" → "ちゃんとし て" ("や" misread as "や")
	石崎くんさあ もう少し にこやかにって 言っただろう？ さっきのチナチ みなしに 笑ってくれたら まだいいけど...	石崎くんさあ もう少し にこやかにって 言っただろう？ さっきのチナチ みなしに 笑ってくれたら まだいいけど...	Perfect Match

Table 1: A table image showing side-by-side comparison of original manga bubble texts and OCR-extracted results.

## Processing Time:



## Limitations and Future Work

In terms of processing efficiency, our pipeline demonstrates practical viability for real-world applications. On average, the system processes a full-resolution manga page in approximately **1.8 seconds**, measured on a workstation equipped with an NVIDIA RTX 3080 GPU and 32GB RAM. This time includes bubble detection, image preprocessing, text recognition, and translation. Batch processing capabilities further reduce average processing time per page, making the system suitable for large-scale manga translation tasks.

The overall findings affirm the effectiveness of our approach. The high detection accuracy ensures that critical text regions are consistently identified, while the robust OCR accuracy guarantees meaningful text extraction. Together, these results validate our methodological choices and underscore the potential of our system to streamline the manga translation workflow.

While our system demonstrates promising results across a variety of comic styles, certain limitations remain that warrant further attention. Decorative and highly stylized fonts, particularly those that imitate calligraphy or are artistically rendered for comic aesthetics, continue to challenge the OCR component of our pipeline. These fonts often deviate significantly from standard typefaces, making character recognition unreliable. Furthermore, complex page layouts with overlapping speech bubbles introduce ambiguity during the detection phase, frequently resulting in either missed detections or fragmented bubble extraction. Such cluttered designs are common in dynamic comic scenes, where dialogue density is high.

Another observed limitation pertains to noisy or low-resolution inputs. Scanned pages or compressed digital copies tend to introduce artifacts that obscure bubble boundaries and degrade text clarity, ultimately reducing

detection and recognition accuracy. Contextual translation also poses challenges, especially when the text includes idiomatic expressions, humor, or culturally specific references. In these cases, literal translation often leads to a loss of intended meaning. Additionally, the model currently exhibits limited generalization to unseen comic styles, as its performance is heavily dependent on visual patterns present in the training dataset.

To address these challenges, several avenues for future enhancement are proposed. Incorporating advanced style transfer techniques could enable the system to normalize a diverse range of font styles prior to recognition, improving OCR robustness. Expanding the system's multilingual capabilities to include complex scripts such as Korean, Chinese, and Arabic is a priority to ensure broader accessibility and usability. Another promising direction involves augmenting the translation component with larger, domain-specific multilingual corpora, which would enhance the model's ability to interpret idiomatic and context-sensitive expressions more effectively.

Moreover, implementing active learning frameworks that integrate user feedback will allow the system to continuously evolve and refine its predictions based on real-world usage. Super-resolution techniques present an additional opportunity to enhance low-quality inputs, ensuring clearer text and more accurate bubble detection. Finally, advancing towards layout-aware detection architectures could significantly improve the system's ability to navigate dense visual scenes, thereby increasing its reliability across a broader spectrum of comic designs.

## Conclusion

This paper presents a fully automated manga translation system that seamlessly integrates YOLOv8-based speech bubble detection, optical character recognition, neural machine translation, and image reconstruction. By deploying this comprehensive pipeline through a web-based application, our approach ensures scalability and provides an intuitive platform for users to translate manga content efficiently and effectively. The experimental evaluations affirm the robustness of our system, achieving high accuracy in bubble detection and OCR performance, and producing coherent translations that significantly enhance the accessibility of Japanese manga for a global audience.

Beyond its immediate application in manga translation, this work lays a strong foundation for broader use cases, including the localization of graphic novels, the development of educational resources leveraging visual storytelling, and the digital preservation and archiving of graphic literature. By automating the traditionally manual and time-intensive process of translating illustrated texts, our system not only accelerates content adaptation across languages but also fosters cross-cultural engagement. We envision this research as a stepping stone toward increasingly sophisticated solutions that bring diverse narratives to a worldwide readership.

## Acknowledgements

We thank the creators of the Bubble Detection Dataset on Roboflow, and the open-source communities behind YOLOv8, Tesseract, and OpenCV. Their freely available tools and datasets were instrumental in enabling the development of our automated manga translation system.

We also acknowledge the collaborative efforts of the global open-source community, whose contributions continue to drive innovation in computer vision and natural language processing. Without these collective advancements, this research would not have been possible.

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