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## A Review on SnapChef -Recipe Generation from Food Image

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**ABSTRACT:** The increasing advancements in machine learning and computer vision have created new opportunities in the culinary domain, particularly in automating recipe generation. This project, titled "Recipe Generation from Food Image Using Machine Learning," aims to develop an intelligent system that generates detailed cooking recipes from food images. Traditional recipe search methods are often time-consuming and lack personalization, especially when users have only a visual reference without any textual information. To overcome this, the proposed system leverages Convolutional Neural Networks (CNNs) for accurate food image classification and Natural Language Processing (NLP) models to generate corresponding recipes.

The methodology involves preprocessing the input images, extracting features using CNNs, and employing NLP algorithms such as LSTM or Transformer models to synthesize recipes that include ingredients, quantities, and step-by-step instructions. The system also incorporates user interface components for image input, dietary customization, and feedback integration. Testing revealed an image recognition accuracy of over 85% and high relevance between the generated and actual recipes, even under variable lighting and complex dish conditions.

- Problem Statement: Manual recipe searches are time-consuming and lack precision.
- **Objective:** Develop an AI-powered system to generate recipes from food images using CNNs and NLP models.
- Methodology: Preprocess images, classify food items with CNNs, and use NLP for recipe generation.
- Key Results: Achieved high accuracy in dish recognition and recipe formulation.
- Conclusion: The system enhances user experience in meal planning, food blogging, and dietary management.

**KEYWORDS:** Recipe Generation, Food Image Recognition, Machine Learning, Convolutional Neural Network (CNN), Natural Language Processing (NLP), Automated Cooking Assistant.

#### I. INTRODUCTION

#### 1. Background of the problem or System

Recent advancements in machine learning and computer vision have significantly transformed various industries, including the culinary sector. Traditional recipe discovery methods rely heavily on manual search and predefined keywords, which can be inefficient and limiting. This has led to the exploration of AI-based solutions that can interpret food images and generate relevant recipes, offering a seamless and intelligent way to access culinary information.

#### 2. Motivation for the project

In daily life, users often come across food items they would like to recreate but lack the recipe or even the name of the dish. This gap inspired the development of an AI-powered system capable of automatically generating recipes from food images. Such a tool could be invaluable not only for individual users but also for food bloggers, content creators, and dietary management applications.

#### 3. Problem Statement

Current methods for finding recipes are mostly text-based and require prior knowledge of the dish name or ingredients. These methods are time-consuming and often inaccurate when only a food image is available. There is a clear need for





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an intelligent system that can accurately interpret food images and generate detailed, structured recipes.

#### **Objectives of the Project**

- To develop a system that uses machine learning to generate recipes from food images.
- To apply Convolutional Neural Networks (CNNs) for accurate food classification.
- To use Natural Language Processing (NLP) for generating step-by-step recipe instructions.
- To personalize recipe suggestions based on user preferences such as dietary restrictions.

#### **Scope and Limitations**

The scope of this project includes image-based food classification, recipe generation, and user interaction through a web interface. It supports multiple dish types and allows for basic personalization. However, it is limited by the diversity of the training dataset, challenges in recognizing visually similar dishes, and environmental factors like lighting and image quality. Advanced features such as real-time AR cooking support and multi-dish recognition remain areas for future work.

#### Structure of the Paper

- Chapter I presents a literature review of related work.
- Chapter II outlines the proposed system architecture and methodology.
- Chapter III discusses system requirements.
- Chapter IV details the scope of the project.
- Chapter V presents the results and analysis.
- Chapter VI covers testing and evaluation metrics.
- Chapter VII concludes the paper and suggests future improvements.
- Chapter VIII lists the references used.

#### **II.LITERATURE SURVEY**

Title	Author Name	Description
Reinforcement Learning for Logic Recipe Generation: Bridging Gaps from Images to Plans	Mengyang Zhang, Guohui Tian	The research promote the generation of effective cooking recipes, a NN-based recipe generation system. Instead of producing texts from static image information directly, they regard ingredients in food cooking as medium steps and design a criterion conditioned on them, to guide recipe generation.
Health-Aware Food Recommendation Based on Knowledge Graph and Multi- Task Learning	Yi Chen, Yandi Guo	This work applies food-related knowledge to food recommendation and proposes a healthy food recommendation model FKGM that considers both health requirements and user dietary preferences. FKGM is a knowledge graph-based multi-task learning model that learns semantic information between users and recipes through knowledge graph embedding and message-passing mechanisms.
Recipe Recommendation With Hierarchical Graph Attention Network	Yijun Tian, Chuxu Zhang	In this paper, they propose to leverage the relational information into recipe recommendation. To achieve this, they design HGAT, a novel hierarchical graph attention network for solving the problem. HGAT is able to capture user history behaviors, recipe content, and relational information through several neural network





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		modules. They further introduce a score predictor and a ranking-based objective function to optimize the model.
A Literature Survey on Recipe Generation From Food Images using AIML	Tejas D, Varun C M	Paper conclusion, a recipe generation system from food images holds significant potential across various domains, offering innovative solutions and enhancing user experiences. The applications span from assisting home cooks with personalized recipes to revolutionizing restaurant menus and contributing to educational and wellness initiatives. The system's adaptability and integration capabilities with existing platforms are crucial for its success in the dynamic and ever-evolving culinary landscape.
Pixel To Plate: Generating Recipes From Food Images Using CNN	Haleema Begum, Asst.Prof.Akkanagamma.	This research project aimed to investigate the feasibility of using deep-learning models to generate recipes based on food photographs. The results show that the deep learning model can effectively create recipes with high accuracy. They developed a system that can generate a recipe by analysing a food image

#### III. SYSTEM DESIGN AND ARCHITECTURE

- 1. User Interface (UI): The system's user interface is designed to be intuitive, allowing users to upload food images easily through a web or mobile app. It also enables users to specify dietary preferences, like vegan or low-carb options, to personalize their experience. This initial input stage is key to ensuring the system can cater to individual needs and improve user satisfaction.
- 2. **Image Preprocessing**: The uploaded images undergo preprocessing to ensure they are suitable for analysis. This stage involves resizing the image to standard dimensions, filtering out noise to improve clarity, and normalizing pixel values. These steps help the system standardize image inputs, which reduces variations caused by factors like lighting or angle and optimizes the image for accurate classification.
- 3. Feature Extraction with CNN: After preprocessing, the image is passed through a convolutional neural network (CNN) such as ResNet or Inception, which identifies essential visual features like color, texture, and shape. These features are crucial for differentiating various food items, and a fine-tuned CNN trained on food-specific datasets enhances the system's accuracy in identifying a wide variety of dishes.
- 4. **Food Classification**: Once features are extracted, the system classifies the food using a deep learning model trained on extensive food datasets. This classification step predicts the most likely dish type along with a confidence score. For complex images containing multiple food items, the system can detect and classify each component separately, improving its versatility in handling multi-item meals.
- 5. **Recipe Generation**: Based on the identified dish, the system either retrieves an existing recipe from a database or, if unavailable, uses an NLP model (such as an LSTM or Transformer) to generate a recipe. The generated recipe includes an ingredient list, quantities, and preparation steps, enabling users to follow clear instructions. This module also allows for customization based on user preferences, further enhancing personalization.
- 6. **Recipe Display and Interaction**: The generated recipe is displayed to the user in a structured format, including ingredients and step-by-step instructions. Users can modify ingredients based on availability or save recipes for later. This interactive module also enables users to provide feedback on recipe quality, which can be used to improve the system's performance over time.
- 7. **Backend and Database**: The system's backend manages recipe data, user preferences, and model processes. A relational database, like MySQL, stores recipe data, while a backend framework such as Flask or Django handles user interactions and API requests. This robust backend infrastructure supports data storage and retrieval, ensuring a smooth and efficient experience.





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## SYSTEM ARCHITECTURE



#### Fig. System Architecture

#### **IV. SYSTEM REQUIREMENTS**

#### Hardware Requirements :-

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IDE Tools	: PyCharm	
Web Server	: Nginx	
Web Browser	: IE6 or upwards, Google Chrome, Mozilla Firefox	
<b>Operating System</b>	: windows 7, windows 8 and Upper version	
Software Requirements :-		
Mouse	: - PS/2 2Button, USB	
Keyboard	: - Enhanced 104 Standard	
Display Type	: - SVGA Color Monitor	
Hard Disk	: - 40 GB	
Processor RAM	: - Dual Core or more. : - 1GB	





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Front End	: Python
Database/Back End	: MySQL
Framework	: Flask

#### **Development Model**

The development of the project "Recipe Generation from Food Image Using Machine Learning" follows a structured Software Development Life Cycle (SDLC) model to ensure systematic planning, implementation, testing, and deployment. For this project, the Iterative Development Model was adopted due to its flexibility and suitability for machine learning-based applications that require repeated model training, testing, and improvement.

#### Phases of the SDLC Applied:

#### 1. Requirement Analysis

- Identified the need for a system that can generate recipes from food images.
- Defined functional and non-functional requirements, including input (image), output (recipe), performance expectations, and user preferences.

#### 2. System Design

- Designed the architecture comprising frontend (user interface), backend (Flask server), database (MySQL), and ML components (CNN + NLP).
- Planned integration of modules such as image preprocessing, classification, and recipe generation.

#### 3. Implementation

- Developed frontend in Python (HTML templates with Flask).
- Implemented machine learning models using frameworks like TensorFlow/Keras.
- Built backend logic to handle image input, model predictions, and database interaction.

#### 4. Testing

- Conducted unit testing on individual modules (image preprocessing, classification, NLP).
- Performed integration testing to ensure the entire pipeline functions correctly.
- Accuracy testing with real food images to evaluate model performance.

#### 5. Deployment

- Hosted the system on a local server using Flask.
- Created a simple user interface for uploading images and viewing recipes.
- 6. Evaluation & Iteration
  - Collected feedback on recipe accuracy and user experience.
  - Refined model performance through additional training and data augmentation.
  - Planned future improvements based on limitations encountered.

#### V. IMPLEMENTATION

#### Tools, Platforms, and Programming Languages Used

The development of the Recipe Generation from Food Image Using Machine Learning system required a combination of software tools, frameworks, and platforms to ensure efficient image processing, model training, and user interaction. The primary tools and technologies used are:

- 1. Programming Language: Python used for implementing machine learning models, backend logic, and image processing.
- 2. Framework: Flask a lightweight web framework used for building the server-side application.
- 3. IDE: PyCharm for Python code development and debugging.
- 4. Database: MySQL to store recipe data and user preferences.

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- 5. Web Server: Nginx to handle HTTP requests and serve the application.
- 6. Operating System: Windows 7 and above.
- 7. Web Browsers Supported: Google Chrome, Mozilla Firefox, and IE6 or higher.

#### Algorithms or Techniques Implemented

- 1. Convolutional Neural Networks (CNNs): Used for image classification and feature extraction. Models such as ResNet or Inception were employed due to their high accuracy in visual recognition tasks.
- 2. Natural Language Processing (NLP): Techniques using LSTM or Transformer models to generate recipe instructions based on the identified food item.
- 3. Image Preprocessing: Standardization techniques like resizing, normalization, and noise filtering were applied to prepare the input for classification.

#### **Step-by-Step Development Process**

- 1. User Interface Development: A web-based interface was created to allow users to upload food images and specify dietary preferences.
- 2. Image Preprocessing: Uploaded images were resized and normalized to eliminate distortions caused by lighting or angle.
- 3. Feature Extraction Using CNN: The preprocessed image was passed through a CNN model that extracted essential visual features.
- 4. Food Classification: The system classified the dish based on extracted features and assigned a confidence score to the prediction.
- 5. Recipe Generation Using NLP: Based on the identified dish, the system either retrieved a predefined recipe from the database or generated a new one using NLP models.
- 6. Result Presentation: The generated recipe, including ingredients and step-by-step instructions, was displayed to the user with options for customization and feedback.
- 7. Backend Integration: A backend service handled data flow, user preferences, and database operations to ensure a seamless experience.

#### VI. RESULT/SCREENSHOTS

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#### VII.TESTING & EVALUATION

#### **Testing and Evaluation**

#### **Testing Methods**

#### Unit Testing:

Each individual module, including image preprocessing, CNN-based food classification, and the NLP-based recipe generator, was tested independently. This helped isolate and resolve issues within specific components before system-wide integration.

#### Integration Testing:

After validating individual modules, the complete workflow—from image upload to recipe display—was tested to ensure seamless data flow and functional interaction between components. This included verifying user inputs, model predictions, and backend integration.

#### Accuracy Testing:

Real food images across various categories (snacks, meals, desserts, etc.) were used to evaluate model performance. The goal was to assess how accurately the system could classify dishes and generate relevant recipes, even with varying image quality, angles, and lighting.

#### **Test Cases**

- Upload an image of a single known dish (e.g., "Pav Bhaji") and verify if the system correctly identifies it.
- Test classification accuracy with low-light and high-glare images.
- Validate ingredient extraction by comparing generated ingredients with ground-truth recipes.
- Measure the similarity between generated and actual preparation steps.
- Attempt recognition of visually similar dishes (e.g., "Butter Paneer" vs. "Paneer Tikka") to assess the model's sensitivity.

#### **Performance Evaluation**

• Classification Accuracy:

The CNN-based image recognition module achieved over **85% accuracy**, which was measured by comparing predicted dish labels against the ground truth in a labeled test dataset.

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#### • Recipe Relevance:

The generated recipes were found to have a **high similarity with original recipes** in terms of ingredient list, sequence of steps, and overall structure. Evaluation was done using cosine similarity and expert validation.

• System Responsiveness:] Average response time from image upload to recipe display was kept within a few seconds, providing a smooth user experience.

#### **Challenges Encountered**

- **Complex Dishes**: Dishes with multiple components or garnishes (e.g., thali plates or combo meals) caused difficulty in identifying individual items, often leading to misclassification or partial recipe generation.
- Lighting and Image Quality: Variations in lighting, shadow effects, and blurry or poorly framed images impacted feature extraction, reducing classification accuracy.
- Ingredient Ambiguity: The NLP model occasionally generated ingredients with vague or generic names (e.g., "spices" instead of listing specific ones), highlighting the need for further training on detailed datasets.

#### **Conclusion of Testing**

The system passed all functional tests and demonstrated high reliability in real-world conditions. Despite minor limitations in image quality handling and fine-grained classification, the results indicate that the model is well-suited for practical deployment in cooking-related applications.

#### VIII. CONCLUSION AND FUTURE WORK

The project "Recipe Generation from Food Image Using Machine Learning" represents a significant advancement in AI-driven culinary technology. Traditional recipe discovery methods rely heavily on manual searches, predefined tags, and text-based inputs, limiting their efficiency and personalization. Our system bridges this gap by enabling users to generate detailed recipes simply by uploading an image of their desired dish. This process not only simplifies meal planning but also introduces a new level of accessibility for cooking enthusiasts, individuals with dietary restrictions, and businesses in the food industry.

By leveraging **Convolutional Neural Networks (CNNs)** for food classification and **Natural Language Processing** (NLP) for recipe synthesis, our system exhibits **high accuracy** in identifying dishes and constructing relevant cooking instructions. The integration of deep learning allows for a dynamic, scalable solution that adapts to different cuisines, image qualities, and user preferences. Beyond its technical capabilities, this project showcases the broader potential of AI in transforming the culinary landscape—from enhancing mobile cooking applications and assisting food bloggers to automating restaurant menu creation and nutritional guidance.

Throughout development, we encountered challenges such as **image quality variations, ingredient ambiguity, and fine-tuning deep learning models for optimal performance.** However, extensive testing and evaluation refined the system's ability to accurately recognize dishes and generate structured recipes. Performance metrics, including food classification accuracy, recipe relevance, and efficiency, indicate a promising future for AI-powered cooking assistants.

#### **Future Improvements:**

- Integrate voice assistants for interactive recipe narration.
- Expand dataset for more diverse food recognition.
- Implement AR-based cooking guides for users.





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