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Smart Recipe: Intelligent Recipe Generator and Image Analysis Framework

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***Abstract*— Many people appreciate food photography because it shows the beauty and attraction of food while also suggesting the detailed stories and recipes contained within each dish. However, photographs cannot describe the cooking procedure or provide a list of necessary items. This problem is aggravated when you are looking forward to cooking a delicious supper only to learn that you are missing certain essential items. The problem is compounded when access to markets is limited, as it was during the COVID-19 pandemic, when lockdown and supply shortages made it difficult to purchase vital products. A solution is presented to assist individuals in finding meals using things that they currently have in their kitchen. Users can simply enter the ingredients they have on hand to generate complete recipes with step-by-step instructions. In addition, the system can evaluate recipe photos to generate ingredient lists and cooking directions. The system develops personalized recipes by linking user input with a huge recipe library via a powerful natural language processing model. It uses cutting edge computer vision algorithms to recognize and extract text from recipe photographs, resulting in organized ingredient lists and straightforward step-by-step instructions..**

***Keywords*— Recipe generation, Available ingredients, Recipe photos, personalized recipes, NLP, CV algorithms.**

I. INTRODUCTION

Recipe generation technology has transformed the food industry, by breaking the wall between creative idea and real implementation. Conventional cookbooks and food photography may lure readers in with captivating color, texture, and dish presentation, but they -- in general -- do not provide ingredient lists or detailed instructions for meal preparation. This is one of the most annoying cases, when a person tries to prepare a particular cuisine with the products available at that time. Examples of the COVID-19 pandemic induced lockdown and commodity shortage highlight the need for adaptation in the food world.

There is an application to meet such needs by giving the ability to convert new ideas into actual meals with whatever is in the house. The device reduces the requirement to go to a grocery store by providing food suggestions when ingredients are actually available as well as allowing consumers to browse through what is in their pantry. It uses sophisticated natural language processing (NLP) to pair commonly available parts with a big library of recipes, generating personalized recipes with their own specific cooking instructions according to the user's input.

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In addition, the platform also employs other sophisticated computer vision methods for recipe image scoring, and identifying recipes and manufacturing processes. This program allows the user to write a list of ingredients and recipes according to pictures of a dish which is searched in the web or in a cook book.
Generally speaking, these features make this appliance a great fit for contemporary kitchens. It provides for decoupling of the innate constraints between distal and proximal cook ups, and enables users to create cooks' recipes in an innovative manner, sample the available food with their own hands, and try to experiment with unfamiliar recipes.
Not only does this tool bridge the gap between thought and (implementation) but it also creates a new paradigm for the modern minimalist, efficient, and flexible.

II. RELATED WORK

Disha Moolya et al. in the paper [8] has built a deep learning recipe generation system using common kitchen ingredients. With an LSTM model, it generates recipes with the name and preparation instructions along with the ingredients provided to it by the user. Preprocessing and hyperparameter tuning increase the complexity, which makes the model generate accurate recipes. An application on the web for storing recipes enhances access and effectiveness. This evolution of the system will bring to the forefront flexibility in the technology, especially as new techniques for formulating recipes have come to the forefront with such techniques as advanced filtering, image search, and pre-trained transformer networks.
FIRE, or Food Image to Recipe Generation, is defined by Prateek Chhikara et al[2]. They illustrate the method of creating complete recipes in terms of names and ingredients and cooking methods of foods from food images. A system called FIRE is developed with advanced models that include T5 for cooking instructions, ViT for ingredient breakdown, and BLIP for recipe title, which has evaluations that clearly show its superiority over other earlier models in both the text evaluation and ingredient extraction. It can be used to adapt a recipe to specific diets, and it can even be translated to source code for the purposes of automation. Such applications are large-scale developments in food computing that really illustrate how broad
the scope of applicability of FIRE is-from images to recipes.
Majumder et al. [14] gave an automatic system which generates recipes given the choice of ingredients selected by a user. This method employs encoder-decoder architecture with an attention mechanism where an encoder captures the inputs or user interactions, and passes that input to the decoder and provides new ingredients for an already designed recipe. The authors then used analyses of 180,000 recipes worldwide and 700,000 from the preferences of learners to conclude that personalized models were very competitive against baselines non-personalized ones while producing more-quality and diversified cuisines. This enables users to design their custom recipes, thus allowing the efficiency of recommendations to surge. From related studies on culinary application and user-centered food technology, it is clear that such a cooking method can fit tastes of many sorts.
This paper is intended to share developments in the design of tools, since Jabeen et al. [11] have conducted an exhaustive analysis of AutoChef-a system that generates recipes with graphical tools. The paper gives the use of natural language methods for conversion of recipes to data and its application in genetic programming for reconstruction of recipes. First, it represents ingredient-action combinations in recipes, and second, it combines recipes with optimization steps for balance in ingredients, activities, and cooking techniques. Research shows that AutoChef transforms the idea of a reproducible recipe into one that is constantly evolving. Current Improvement Misses a gap toward the personalization of chosen combinations of users along with their satisfaction in these dishes. Such results may apply in making present-day improvement cooking AI through the fusing together different styles of cooking while an adjustment to the interface could take place based on demand.
Helena H. Lee et al.[13] introduce RecipeGPT - a recipe creation and evaluation system based on an advanced GPT-2 model [13]. The training set is the Recipe1M dataset. It enables two important tasks: to generate cooking recipes using materials available and to generate ingredients according to recipes. RecipeGPT is represented as a web application with the following functionality: user ratings and comments. This is unlike human-designed recipes for quality evaluation. Even though they are coherent, developed recipes have overlapping constraints with fewer ingredients and unpredictable results. Future work will refine the techniques of evaluation, improve coherence testing of ingredients, and study models to increase accuracy and communication.
George Papakostas and Nikolaos-Ioannis Galanis [10] discuss the development of ML and natural language processing for generating recipes in cooking. A few methods on generating recipes from a list of ingredients are described, like CBR, and newer neural models LSTMs and GPT 2. Defects in such systems might also produce recipes that seem to be unpractical recipes. Moreover, model adaptation will further consider cultural

preferences, compatibility of components, and reliability of recipes to further facilitate future research on improving machine learning in culinary innovation and customized recipe development.

Ponrawin Kansaksiri et al. [6] have provided Smart Cuisine, an AI-based cooking system, where a nutrition assistant is linked with ChatGPT accompanied by developing recipes. A FlutterFlow chat service and the OpenAI API are utilized to answer nutritional questions, while an image-based model is used to classify ingredients for meal suggestions. Smart Cuisine promotes eco-friendly cooking through reducing food waste and increasing ingredient usage. The main concerns include the wide The focus of responses and limitations of image recognition for rarer foods will be context-specific, nutrition-centered guidance and further accuracy in the model.

Amaia Salvador et al. [5] A recipe generation system from food images predicts unordered ingredient sets to create cooking instructions from images. This method outperforms retrieval-based recipe development techniques, with better performance on the Recipe1M dataset. Multimodal learning technologies such as transformer-based text generators and ResNet-50 for photo recognition. However, some minor variations of the recipe instruction and accuracies of items are detected.

Smriti Chaudhary et al. [9] developed ChefAI.IN on AutoChef for Indian recipes. Based upon Darwin's natural selection, a genetic method of recipe aging in automated recipes has been created in this research. Authors firstly preprocessed the dataset comprising 6,000 traditional Indian recipes from "Archana's Kitchen" and also translated non-English segments. The input to the change-sensitive AutoChef model was reformatted into JSON for recipe generation. Recipes were reviewed for mixtures' improvements as well as clarification of instructions. Outcomes indicated that, indeed, 76.5% of the respondents said it had easy directions and that 49% probably would cook the dish. This paper provides an overview of the computer-based intelligence capability in Indian food and outlines future developments in taking recipe standards to the next level and fixing identification.

T. Devarasetty Tejaswini and V Sankar Reddy [1] proposed an AI-based recipe generator, enhancing cooking by customised recipes based on data gathered from other sources, preprocessing them and then standardizing. AI models, especially brain organizations and transformers, could understand recipe semantics and customer preferences, which would guide the generation of recipes following dietary needs and ingredient availabilities. The system thus has an interactive interface available for interaction with the help of real-time cooking services, ingredient substitution, and calorie information. It will very much help to change the way people search and prepare their dinners, improve creativity and dietary habits, and reduce anxiety in terms of accuracy and privacy.

Erika Pauline C. de Gula and colleagues[4] developed "Pinoy MD: A Versatile Dietary Helper and Recipe Generator," which is an Android-based application to produce personalized Filipino recipes based on the conditions of the clients. Implemented with Java and Android SDK as well as SQLite as the database, it supports running on Android 2.3 and above. It contains two options; people may choose a meal or use any existing ingredients, and it will change recipes according to the illnesses of a person. The application assists people facing health problems due to dietary habits by offering information regarding supplements like calories, carbohydrates, proteins, and fats, and wellness tips also. The review included dietitians and students in software engineering who stated that the application was correct and reliable. However, it has major drawbacks: it addresses only a narrow spectrum of medical conditions and has not so intuitive user interface. In future updates, it could offer the following: online downloads of recipes, shared client recipes, and support for more medical conditions. It will give more comprehensive application in managing varied needs of a user for diets.

Dr. Rajshree Srivastava et al.[12] proposed a deep learning-based desk recipe generator that uses photographs of food to generate specific recipes, thereby enhancing culinary experience by combining AI with the creation of image-based recipes. The process involves gathering data in the form of several photographs of food, which is then preprocessed to standardize the output. This system comprises the extraction of visual features via the Recipe1M dataset into A ResNet-101 model to generate lists of ingredients and instructions in NLP. The user upload on the Flask system ensures live cooking suggestions of any real-time photos provided by a user. A Recipe that passes the test by determining how well the food has cooked is also great for even less skilled cooks. Addressing issues such as enhancing user interfaces and model accuracy and allowing comfort and creativity while in the kitchen. Future development will center on convenience and creativity in the kitchen by removing technological limitations like model accuracy and user interface changes and offering a mobile app for preparing recipes quickly and easily on an as-needed basis.

Ilias Papastratis, Dimitrios Konstantinidis, Petros Daras, and Kosmas Dimitropoulos [3] utilize the strength of applying ChatGPT and a deep generative model to propose an AI-based nutrition recommendation system that makes personalized recommendations. This approach enhances AI nutritional recommendations by incorporating VAE for modeling user health data such as body measurements, medical conditions in a latent space. The AI creates weekly meal plans and even computes serving size to determine whether the food produced fits the users'

dieting needs. For this purpose, ChatGPT has incorporating diverse ethnic options into its meal database enhances diversity. The system's ability to meet users' energy and nutritional needs was assessed with 3,000 simulated and 1,000 real profiles. This is far more accurate, scalable, and tunable than traditional nutrition guidance and hence even more relevant for health and wellness. The system can be further developed by maximizing the use of the system, increased satisfaction by the consumer across different demographics, and an improved database for diets such as vegan or gluten-free.

In "Computational Approaches for Food Recipe Generation and Completion," Anaísa Lucena Silva[7] analyzes AI solutions for hunger, allergy, and overweight problems. The research is based on three computer approaches used to produce delicious recipes from datasets related to soups and international cuisines. The RBM and NMF models produced more diverse recipe options than the Markov algorithm, which produced redundant recipes with uninteresting ingredients. The best feature of each was as follows: RBM kept the ingredient correlations. In that way, the paper described how the RBM and Markov models could easily avoid inedible ingredients and made the recipes generated coherent. Further in the future, future system development will be targeted towards items associating analyses and combining components quantity, and adding completeness through techniques used during cooking to help AI recipes for personalized sustainable meal preparation.

III. Proposed Methodology

Development of a recipe generation platform, Optimized for user personalization and diet Requirements. The system collects a large, Various recipe datasets including Ingredients, instructions and images Public databases and content, Provided by users. The technique includes information about customer preferences for tailoring recipes. Restrictions depending on personal tastes and dietary needs.

A. Data Collection and Preprocessing

SmartRecipe collects recipe and user preferences to provide personalized recipes. Recommendation. Data goes through a preliminary phase. Processing to ensure uniformity Relevance. Text data (ingredients and instructions) is cleaned and normalized Removing duplicates, inconsistencies Irrelevant content. Tokenization Datasets that help recognize ingredients Training sequence. Images Preprocessed Resize and Reduce noise using OCR Extract text, If necessary.

B. Model Development and Training

The main set of Smart Recipe models includes: NLP model for ingredient interpretation and Commands from user input, computer model Vision trained with labeled recipe images Recognizes ingredients and cooking steps, And machine learning-based Recommendation system for personalization Recipe-based User data and records Interaction. The dataset is split for training. Ensures that fine-tuning is easier. Models that achieve high accuracy.

C. Website Development

Smart Recipe user interface Developed using HTML, CSS, JavaScript (Reactive) to ensure smooth operation.

D. Integration

Smart Recipes add recommendations to the backend to provide NLP, CV, and real-time prescription suggestions. The frontend seamlessly connects user inputs. (both text and images) Backend models are used. Provides accurate and responsive recipe generation. Verified through comprehensive testing.

Ensures that all system components work together. Provides a harmonious and uniform user experience.

E. Model Evaluation and Refinement

The platform continuously evaluates model performance on new data, improving accuracy and response time. User feedback has grown. Improving the recommendation system, Ensuring RecipeGen is constantly responsive to changes. Users demand and support high quality, reliability. Recipe suggestions based on preferences User and dietary requirements.

IV. Conclusion

Finally, SmartRecipe addresses the requirement for flexible systems that can generate usable recipes quickly, especially when there are few replacement ingredients. It generates recipes from text and photos by combining natural language processing (NLP) and computer vision. Its Extensible web-based framework provides: Availability and uninterrupted functionality, Enables users to easily prepare meals, Without having to go grocery shopping. Smart Recipes provide inspiration, practicality and optimized solutions For creative and original

cooking, this platform not only meets current demands for kitchen flexibility, but also provides a view into future breakthroughs for individualized and sustainable recipe production.

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