TRADITIONAL CHINESE MEDICINE IDENTIFICATION WITH ARTIFICIAL INTELLIGENCE IN TEACHING AND LEARNING

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Chinese medicine practitioners (CMP) have a long historical standing. Nowadays, they become important in treating diseases apart from General Practitioner. Unlike western medicine, CMP uses Traditional Chinese Medicine (TCM), which are herbal products from the nature. The herbal products can be roots, stems, barks, leaves, flowers, fruits, seeds and whole herbs. The functions of a plant with roots and stems can be different. In addition, there are many easily confused TCM, for instant, there are leaves from two different plants and their shapes are similar. However, their functions can be completely opposed. It may cause poison to the patients and lethal if wrong TCM was used.

Many universities in China and Hong Kong wants to make TCM in scientific management. To identify a TCM, there are few steps. Firstly, it is an original identification by naked eye or touching them. In the second step, macroscopic authentication can be used and further by microscopic identification. Finally, physical & chemical authentication by operating HPLC and LCMS. Lastly, molecular biology identification can be used, such as polymerase chain reaction (PRC). Ultimately, a large scientific bases are built for the identification of TCM which can be used in the future. Nevertheless, it is difficult to identify by layman or public in the first step.

Artificial Intelligence, machine learning and deep learning has emerged in our daily life, such as the analysis of consumer behaviours or using crime prevention by police force. AI identification of TCM can offer an innovative solution to identify the similar TCM. In our institute, students have to learn modules about TCM, like, Principles of Chinese Medicine, Medicinal Botany, Authentication in Chinese Materia Medica. However, the methods they learnt are traditional, as mentioned above, chemical analysis, microscopic observation. Our institute try to introduce and apply Chinese Herbs Identification App which is a protype for students and teachers, in order to enhance the teaching and learning effectiveness. The App can help users identify Chinese herbs with deep learning technology and analyzes images of Chinese herbs. This can accurately determine the type and information.

Keywords: *Deep learning, Chinese Medicine, identification App, Chinese Herbs*

Introduction

Traditional Chinese medicine (TCM) refers to a holistic medical system for the pathophysiology, diagnosis, treatment, and prevention of diseases. (Liu et al., 2021; Xu et al., 2013). As one of the oldest traditional medicine systems in the world, TCM was formed more than 2000 years ago and developed with the accumulation of knowledge and practice in the following centuries (Lu et al., 2021; Raja et al., 2015; Tang et al., 2008; Lu et al., 2004; Wang et al., 2018). Nowadays, the evolution of technologies is exponentially growing. Deeping learning, artificial intelligence (AI), augmented reality (AR), virtual reality (VR) and mixed reality (MR) are merged in our daily life. For example, they can be used in computer games or home video game consoles for entertainment. In addition, they also can be used for learning and teaching purpose. For instance, medical students can use it to learn human anatomy and perform virtual surgery which can be beneficial to patients. ChatGPT and Deepseek turn over a new leaf in this century, which start to change our life. Many App related to the above technologies can be downloaded and used easily with user-friendly Graphical user interface (GUI). Back to TCM, although it can be used to treat disease, the principle is different from western medicine. Herbal products from the nature are used. The herbal products can be roots, stems, barks, leaves, flowers, fruits, seeds and whole herbs. For example, *Periostracum Cicadae* (蟬蛻) is an expensive TCM while *Periostracum Cicadae Flammatae*is (金蟬蛻) is a common TCM, which is cheaper (Figure 1). Moreover, *Campsis Flos* (凌霄花) is a non-posion TCM, while *Daturae Flos* (洋金花) is poison TCM, which contains tropane alkaloid. (Figure 2). In order to help our students to identify similar TCM, a Chinese Herbs Identification App is still under developing which serves internally only. Leveraging advanced Deep Learning technology, the App analyzes images of Chinese herbs to accurately determine their type and provides detailed information such as the herb's name and characteristics.

Figure 1. *Periostracum Cicadae* (left) and *Periostracum Cicadae Flammataeis* (right)

Figure 2. *Campsis Flos* (upper) and *Daturae Flos* (lower)

Number	Name of Chinese Medicine (English)	Name of Chinese Medicine (Chinese)
1	*Eupolyphaga sinensis*	土鱉蟲
	Opisthoplatia orientalis Burm.	金邊土鱉
2	*Cordyceps sinensis (Berk.) Sacc.*	冬蟲夏草
	Cordyceps hawkesii Gray	亞香棒蟲草
3	*Ficus hirta Vahl*	五指毛桃
	Gelsemium elegans (Gardn. Et Champ.) Benth.	斷腸草
4	*Lygodium japonicum* (Thunb.) Sw.	海金沙
	Pinus massoniana Lamb.	松花粉
5	*Amomum kravanh Pirre ex Gagnep.*	豆蔻
	Alpinia katsumadai Hayata	草豆蔻
6*	*Periostracum Cicadae*	蟬蛻
	Periostracum Cicadae Flammataeis	金蟬蛻
7*	*Campsis Flos*	凌霄花
	Daturae Flos	洋金花
8	*Curcuma wenyujin*	鬱金
	Curcuma phaeocaulis	莪朮
9	*Dryopteris crassirhizoma*	綿馬貫眾
	Brainea insignis	蘇鐵蕨貫眾
10	*Acanthopanax gracilistylus*	五加皮
	Hedyotis hedyotidea	牛白藤
11	*Pseudolarix kaempferi*	土荊皮
	Cleistocalyx operculatus	土槿皮
12	*Apocynum venetum* L.	羅布麻葉
	Apocynum pictum	白麻葉
13	*Lonicera japonica Thunb.*	金銀花
	Lonicera macranthoides	山銀花
14	*Buddleja officinalis*	密蒙花
	Edgeworthia chrysantha	結香花
15	*Coixlacryma-jobi*	製薏苡仁
	Sorghum bicolor	製高粱
16	*Malva verticillate* L.	冬葵果
	Abutilon theophrastii Medic.	苘麻子
17	*Cynanchum atratum Bge.*	白薇
	Gerbera piloselloides (L.) Cass.	白眉草
18	*Artemisia anomala* S. Moore	劉寄奴
	Artemisia lactiflora Wall.ex DC.	鴨腳艾
19	*Hedyotis diffusa Willd.*	白花蛇舌草
	Hedyotis corymbosa (L.) Lam.	水綫草
20	*Ephedra sinica*	草麻黃
	Cinnamomum cassia Presl	桂枝

Table 1. Chinese Medicine proposed in our cloud library (some of them are under development)
*Chinese Medicine mentioned in this paper.

Methodology

Our App is designed to recognize 20 types of similar Chinese medicines (Table 1). In this paper, 4 types of them are taken as examples, which have been tested and gave the best performance. They are *Periostracum Cicadae*, *Periostracum Cicadae Flammataeis*, *Campsis Flos* and *Daturae Flos* which were mentioned in the introduction. The solution architecture of the App is shown in Figure 3. These TCM images dataset (100 images for each TCM) are partitioned into three distinct subsets: training, validation, and testing. After undergoing data pre-processing. A process that entails the refinement of data through format adjustments, value modifications, and structural alterations in the training and validation datasets are harnessed to build and train the classification model. This model leverages a deep learning technique known as MobileNetV3Large.

Upon the completion of the classification model's construction, the testing dataset was utilized to evaluate its performance. The images contained within the testing dataset were unique and separate from those found in the training and validation datasets, and they did not contribute to the model's training process. This arrangement enabled the model to be exposed to completely new images, thereby simulating real-world situations that users might encounter.

Model deployment constitutes the integration of a deep learning model into an established production environment, thereby enabling data-informed business decisions. This pivotal final phase, frequently characterized by its intricacy and time-consuming nature, essentially involved the incorporation of the model's outcomes into the application. For hosting the trained model, Microsoft Azure was utilized as cloud server. The open-source tools were used to develop the App, which were Python, Keras, Kotlin and Microsoft Azure respectively.

After deploying the model, a mobile application had been developed for real-world users to interact with the deployed model. This app allows users to capture photos of TCMs they encounter in their daily lives and upload them to the cloud server for analysis. Subsequently, the application provides information about the herb depicted in the image, enriching users' understanding of the herb.

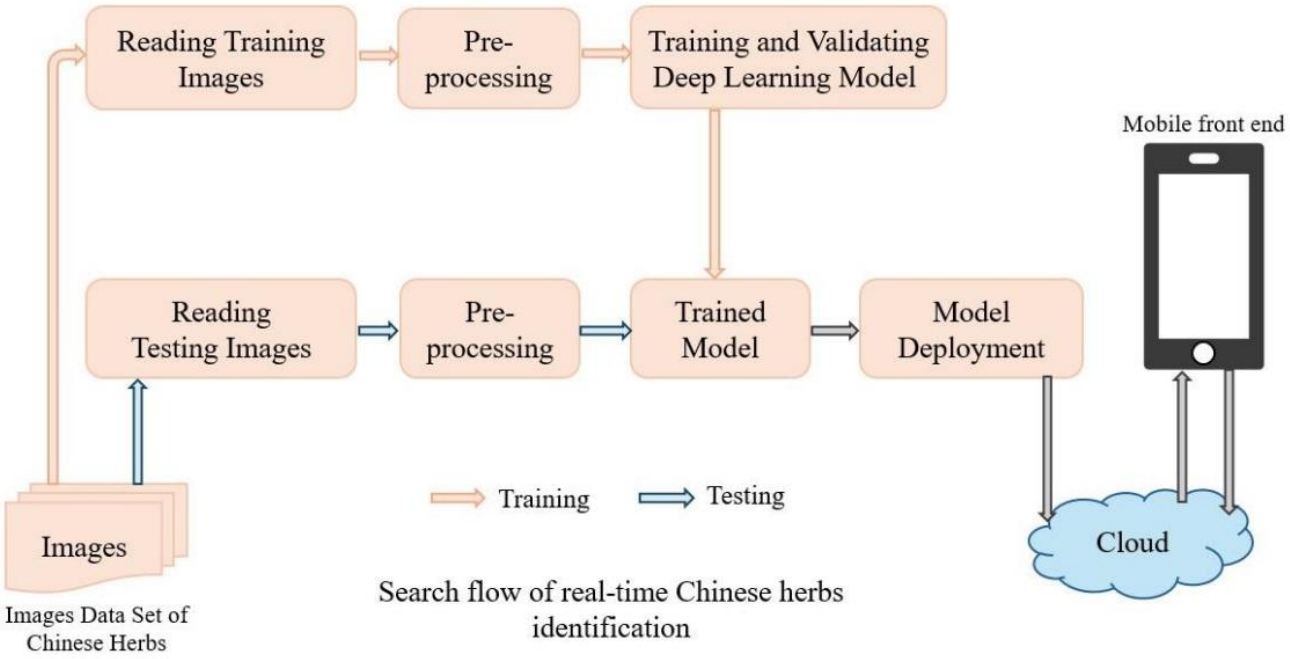

Figure 3. The solution architecture of App

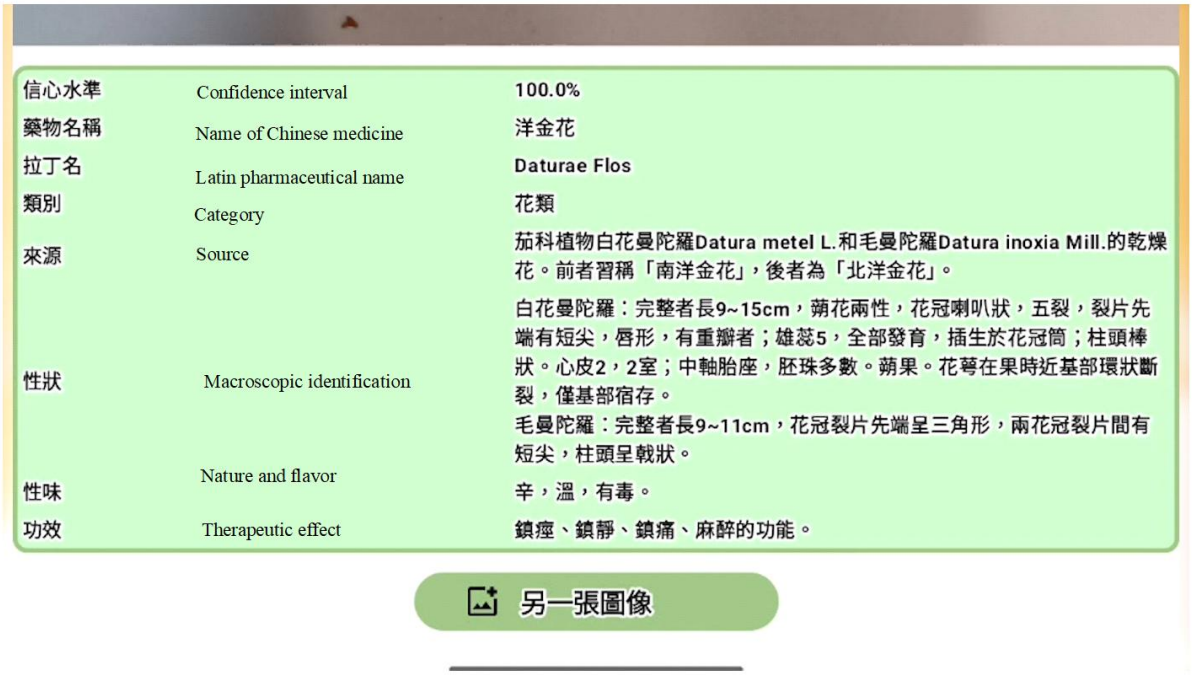

Figure 4. The detail information of Chinese medicine, *Daturae Flos* (洋金花)

Results and Discussion

Our App can show the detail information after scanning the Chinese Medicine, they are confidence interval, name of Chinese medicine, Latin pharmaceutical name, category, source, macroscopic identification, nature and flavor, therapeutic effect respectively. Taking *Daturae Flos* (洋金花) as an example, after scanning, the detailed information are shown in the App (figure 4) while the user can read the information easily. For confidence interval, it showed how the scanned picture matched our photos in our cloud library. Secondary, it also showed name of Chinese medicine (**洋金花**) with its Latin pharmaceutical name (*Daturae Flos)*. In addition, the category, such as, flower, seed, stem were also listed. Here, *Daturae Flos* was flower. Besides, the sources which *Daturae Flos* came from a flower named *Datura metel* L. and *Datura inoxia* Mill. Importantly, the information of macroscopic identification was given to the users. Finally, the nature and flavour and therapeutic effect were also shown to the users.

Miao et al., 2023 mentioned that deep learning technology is used to complete the recognition of traditional Chinese medicine, which not only effectively solves the problems of misjudgment and low efficiency caused by human factors, but also has high detection and recognition rate, convenient operation, and greatly saves time and labor costs. The is the objective of our App. However, the performance of our App can be further enhanced. The reasons are lack of publicly available datasets for traditional Chinese medicine, and the relatively high requirement for dataset size in deep learning classification tasks (Miao et al., 2023; Krizhevsky et al., 2012). In deep learning, image quality affects recognition accuracy, and the number of images affects network generalization performance (Miao et al., 2023). Furthermore, the angles and degree of distance of taking photos can also affect the accuracy to identify TCMs. During processing of the TCMs images, it is inevitable that they will be affected by various intensity signals, which will affect the quality of the image and disrupt the correlation between the content structure and pixels in the image, which is not conducive to further analysis of the image (Han et al., 2022).

Conclusions

In conclusion, our Chinese Herbs Identification App improve the the teaching and learning experience of both students and teachers. It offers valuable insights into the potential benefits and challenges of identifying similar TCMs.

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