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Research Note

# Facial Expression Recognition in Food Studies

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**Abstract:** The integration of technology in various sectors, including food studies, continues to increase exponentially. Computer vision, a research topic which initially started with object detection, facial detection, followed by facial recognition (FR), is currently focused on the more complex facial expression recognition (FER). The present research explores FER and its relevance in food studies. In addition to examining some of the current FER methods, such as Convolutional Neutral Network and Haar Cascade, the research is also developing a pre-processing method to increase the accuracy of FER results. FER methods are generally designed to study customer feedback and reactions towards meals served in the F&B industry. Typically, cameras are set up at different corners of a restaurant to capture facial expressions for analyses. Although one can never truly identify a person's feelings just by expression recognition alone, together with survey and feedback forms, researchers are able to get more reliable and accurate data with regard to a customer's preferences and taste.

**Keywords:** Computer vision, facial expression recognition, visual image noise optimisation, VINO, food studies

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## Introduction

One of the most critical features of human recognition is facial expression (Lopes, de Aguiar, De Souza, & Oliveira-Santos, 2017) whereby facial expression is a form of non-verbal communication between individuals (Mehdi, 2011). Individuals with

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other social coordination use this skill to enhance their daily communication (Batty & Taylor, 2003). A person can also share their thoughts and opinions with just their facial expressions alone, even before verbalising them.

The facial expressions of different individuals can be recognised easily; in other words, even though each person might look different from another, the facial expression portrayed is still recognisable (Mehdi, 2011). Similarly, we can identify a person even with multiple facial expressions. However, computers find it challenging to recognise a person's facial expressions even though it is the same person (Mehdi, 2011).

Non-verbal communication consists of six basic emotions or facial expressions, which are anger, happiness, fear, surprise, disgust and sadness (Ekman & Friesen, 1971). Eventually, the neutral face was also included in the list of basic emotions (Tarnowski, Kołodziej, Majkowski, & Rak, 2017).

According to Li and Jain, facial expression can be defined as "the facial change in response to a person's internal emotional state, intentions, or social communication" (Lopes et al., 2017). Even though facial expressions take place effortlessly on a daily basis and is a crucial feature, its recognition is still at its infancy stage (Lopes et al., 2017). Efficient facial expression recognition remains a difficult feat, hindered by a number of challenges.

While research on facial expression recognition has expanded over the past decades, it remains a challenge due to the many varied facial expressions in various situations (Shubhada & Manasi, 2016). Thus, new algorithms are always needed for facial expression recognition.

## Motivation

Facial expression recognition (FER) helps individual and machines to better understand a person's emotional state by studying their facial expressions. However, a number of methods used in other recognitions (facial detection and facial recognition) remain unexplored for FER. Understanding a person's expression will benefit specific industries as they can improve services based on feedback. As such, facial expression recognition is increasingly used for various purposes such as to conduct digital marketing, to study user experience, to analyse political speech and to investigate crimes.

In the F&B industry, FER plays a vital role in food studies to increase product feedback accuracy, study customer behaviour (likes and dislikes), and also for security. At Taylor's University's forthcoming Food Studies lab, FER will be a significant feature in getting a more accurate and comprehensive customer response and feedback.

## Problem Statement

In food studies, diners' thoughts and opinions influence feedback and survey results. Thus, there is a need to increase the accuracy of feedback so that the quality of products and services can be improved. In this regard, the integration of technology in food studies can help fulfil this need. Although the Computer Vision technology has been advancing over the years, the performance of FER models are still far from perfect. The current highest accuracy for a FER model is only 78% (Ko, 2018).

## Objective

The primary goal of this research is to develop an improved AI-based model for FER in a different pose which encompasses these objectives:

i. To investigate AI-based models for FER systems in food studies
ii. To propose an improved AI-based model for FER in food studies
iii. To improve computational time for FER
iv. To evaluate the FER models in the real-world environment (such as restaurant) and determine their success rate.

## Accuracy & Speed

FER consists of a few essential requirements: image pre-processing, face detection, extraction and recognition. Figure 1 provides an overview of the FER process.

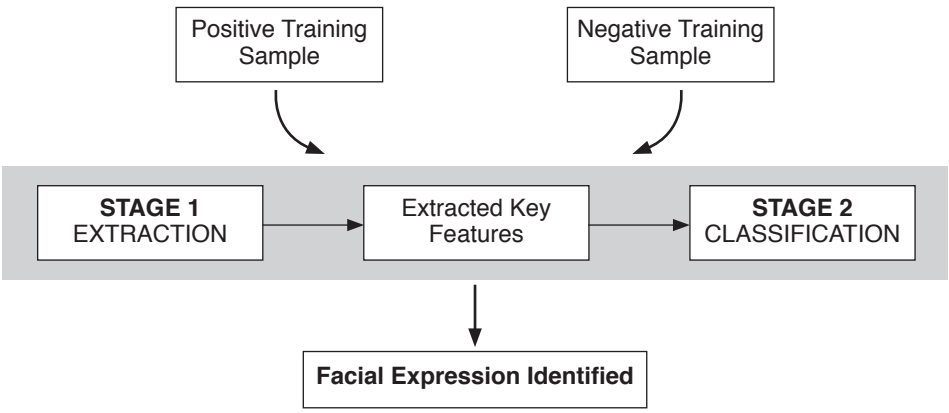


**Figure 1.** The FER process

For this research, we selected a case study from the F&B industry — Taylor's University's Experimental Restaurant which was designed to study customer feedback and reactions to meals served.

Cameras were placed at the four corners of the Experimental Restaurant. Customer's first expressions in response to meals were captured using these cameras. The analyses of the customers' facial expressions will help give better feedback and improve the quality of food and service. The research focuses on food, wines, ingredients and ready-made products in particular. The findings of this research can then be implemented in other settings and scenarios such as aeroplane cabin, cafeteria, fine dining restaurant, canteen, traditional restaurant and even hospital.

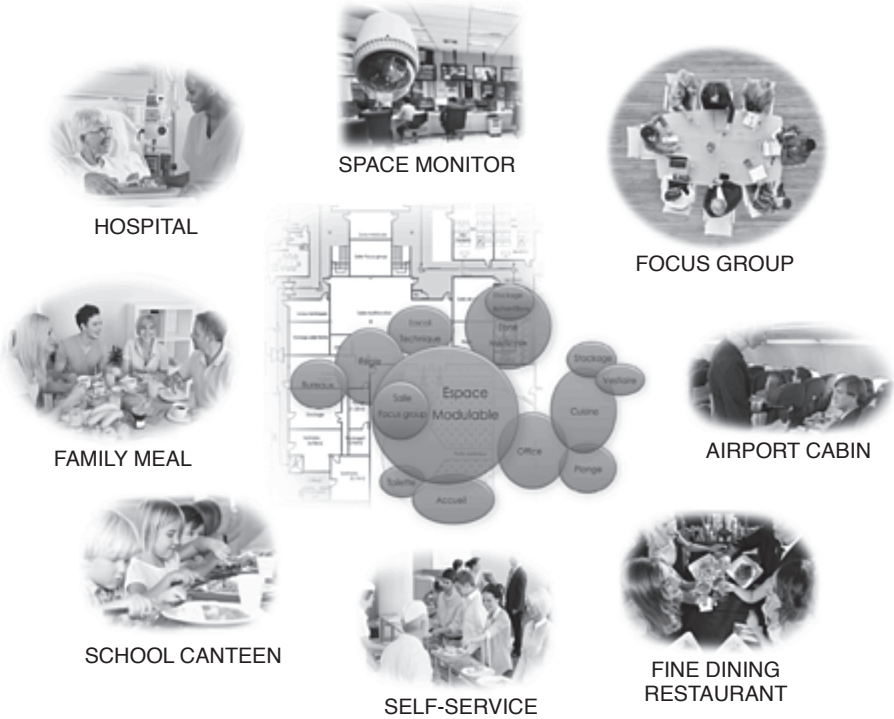


**Figure 2.** Overview of project

FER plays an essential role in inferring a person's mood. A catalogue of expressions can be compiled to correlate with a person's emotions or mood. This will then increase a survey's accuracy and feedback on food studies, producing higher quality results.

In other to achieve this, we have been working on improving the accuracy and speed of FER. A number of methodologies have been proposed, and one of them has shown impressive results.

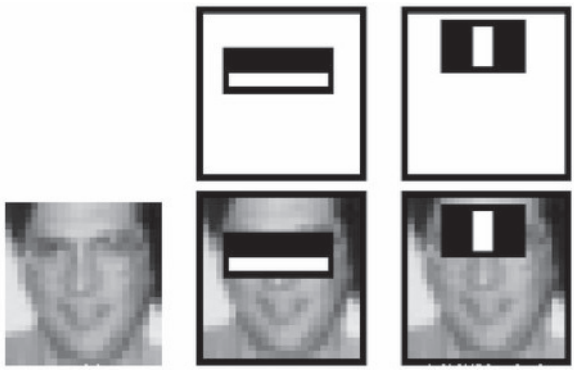

**Figure 3.** Key features of extraction

We have developed a pre-processing method that can help increase the accuracy rate closer to the industry standard of FER currently dominated by Microsoft Azure. The pre-processing image method enhances facial expression recognition accuracy, especially for prominent facial expressions. The method called Visual Image Noise Optimisation (VINO) reduces the surface area and background noise of an image while focusing on the key facial areas, which contribute to different facial expressions.

**Figure 4.** VINO, pre-processing method

VINO identifies key features such as the brow, eyes, nose and mouth, isolates them and runs them through the Convolutional Neural Network (CNN). In this

way, VINO not only eliminates distractions but produces more accurate results and reduces the time taken for analysis due to smaller image areas that needs to be classified by CNN.

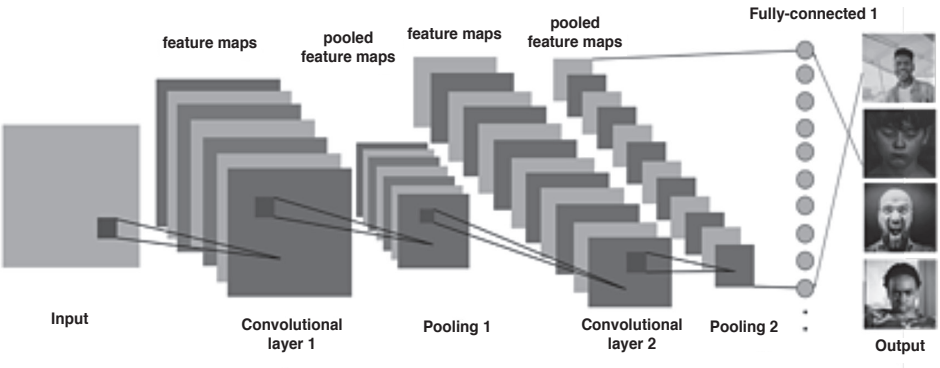


**Figure 5.** Convolutional Neutral Network (CNN)

After the pre-processing method, the facial images are then sorted and classified by CNN which help to finally identify the facial expression of an individual. A catalogue of facial expressions is also in the works to map out facial expressions for various moods. Our preliminary tests show a 37.1% increase in accuracy rate from 53.8 % to 90.9%.

## Conclusion

The study combines conventional methods and deep learning methods with the new pre-processing method to improve the accuracy of feedback for food studies. Further studies on the intrinsic and distortion parameters of images are needed to enhance the algorithm. Apart from that, we are working on strengthening the algorithm for images that are partially sealed or covered. Finally, the implementation of these methods on video needs to be further studied as it is crucial to retrieve real-time FER, especially in fast-paced environments.

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