Gesture-controlled Menu Ordering System

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Abstract— In an era marked by rapid technological advancements and a growing emphasis on touchless interactions, the "Gesture-Controlled Menu Ordering System" emerges as a pioneering solution that redefines the way individuals engage with canteens and restaurants. The System empowers individuals to seamlessly place orders at canteens or restaurants using intuitive hand gestures. The proposed system uses cameras to recognize hand motions, which are subsequently translated into exact orders that govern different canteen processes. The technology has many benefits, including quicker service, efficiency, reduced wait times, and hygiene since users may avoid touching surfaces and potentially spreading germs. Also, the physically challenged people, specifically the deaf and dumb, who face difficulty while communicating with others can make use of this technology while ordering food in canteen or restaurant with ease. Operators of canteens can also get helpful information from the system, such as customer preferences, well-liked menu items, and peak hours, to optimize operations and enhance the general customer experience. The suggested system is a novel and practical solution to enhance the cafeteria experience for both patrons and staff.

Key words —hand gestures, menu ordering system, gesture detection, hand mapping.

I. INTRODUCTION

In an age where technology seamlessly intertwines with our daily lives, the power of communication extends far beyond spoken words. Human beings have always sought more intuitive ways to convey their thoughts, needs, and desires. In this quest, the art of gesturing has played a pivotal role. A gesture, whether a subtle nod, a friendly wave, or a simple hand movement, can convey a message with remarkable clarity. It's a nonverbal, non-vocal form of communication that transcends linguistic barriers [1].Recognizing hand movements through Human Computer Interaction (HCI) could assist in achieving the necessary ease and naturalness [2].In our fast-paced, technology-driven lives, where every moment counts, the fusion of human gestures with computing power offers a new dimension to our daily experiences [3].In this research paper, we delve into the world of gesture-controlled menu ordering systems, a fusion of modern technology and age-old gestures. In a restaurant or canteen, where the pace is often frenetic, the use of this innovative system promises to enhance the dining experience. With a simple gesture, customers can effortlessly browse menus, place orders, and summon assistance, all without the need for physical contact with menus or waitstaff. This not only streamlines the process but also introduces a new level of practicality, efficiency, and hygiene into the dining experience.

II. LITERATURE REVIEW

Researchers in [5] developed a customer-facing app with a clear menu and displayed gestures for user guidance. Users use gestures to manage their selections, and a thumbs-up gesture confirms orders. The system, built using C++ and Qt for the interface, Django, and SQLite for the server, employs Python functions for hand gesture recognition through REST API communication. The study [6] introduced a smart ordering system that utilizes gesture recognition and PYNQ_Z2. The system identifies gestures using a unique method in the YCgCr color space, involving skin detection, background subtraction, and eliminating the face. It then creates a gesture model by locating palm centers and fingertips, which is compared to a predefined gesture dictionary for precise recognition. Alsaif and Albarrak provides a novel way for Smart home applications. This study introduces a multimodal user interface (MUI) that takes voice instructions and hand gestures as inputs. Deep learning feature-level fusion is the foundation of the suggested model [7]. A method to predict a hand's 3D shape and attitude from a single RGB photograph was introduced in the paper [8]. This technique involves comparing a 3D model with the 2D input. They utilize Graph CNN to create a detailed 3D hand model, giving enhanced output. Singh et al. reviewed the major researches and various studies conducted for automated hand gesture recognition in comprehensive manner [9].

In this study [10] researchers opted to create a hand gesture-driven interface system for household devices using Android technology. The camera on the Android device will capture still hand motions, which will subsequently undergo processing. A collection of recognisable static hand motions will be compared to the data gathered to enable commands to be issued to specific home appliances through infrared signals. The study presented in [11] involves the interpretation of gestures through computer vision, encompassing both static and dynamic hand gestures. It entails the recognition of hand shapes, detection of hand trajectories, and their conversion into actionable data commands. Velaskar et al. [12] gives an overview of surveys taken as part of human-computer interaction (HCI) studies, focus on whereas application areas where hand gestures are used to effectively communicate with users. It also aims to provide a status report on the current state of static and dynamic hand gesture identification in human-computer interaction (HCI) and to recommend potential directions for future research. Cotta et al. suggest a TFT LCD monitor, Arduino Mega 2560, Bluetooth, and automated meal ordering system. The system places mobile gadgets on tables for diners to select menu items via the touch interface. Orders are transmitted via Bluetooth to the kitchen screen, and bills are sent to the cashier or manager for a streamlined dining experience [13]. Francis et al. [14] have explored in depth the methods for detecting and recognizing hand gestures, together with their performances, convenience, accuracy, operating range, and design difficulties. In their work, Yu et al. [15] employed Histogram of Oriented Gradient (HOG) features to describe hand shapes. They developed a classifier using the Support Vector Machine (SVM) algorithm for recognizing static hand gestures, successfully identifying 9 distinct postures during their experimental trials. The study [16] presented a remote control which is designed to empower individuals with finger disabilities in effortlessly managing a wide range of appliances, devices. This approach operates using user-defined gestures, an Android smartphone, and a Bluetooth/infrared converter device. The paper [17] presents an interactive platform using hand gestures for navigation, demonstrated by a touchless mobile food ordering system. It utilized the EfficientNet-Lite0 model for gesture recognition, emphasizing accuracy and speed. This system caters to contactless interactions and social distancing, offering a versatile and user-friendly solution.

The study [18] presents an Internet of Things (IoT) centered approach to enhance restaurant billing procedures by incorporating hand gestures for navigation. It proposes the creation of an intelligent gesture-driven food ordering system deployed through restaurant kiosks.

The study described in [19] conducts a comprehensive examination of the procedures involved in detecting, tracking, and recognizing hand gestures for gesture recognition. It categorizes existing literature on gesture-based human-computer interaction and suggests areas for improvement to enhance these systems. The study [20] analyzes RGB and RGB-D camera approaches using 13 all-inclusive criteria and provides a 16-year overview of vision-based hand motion detection algorithms. It highlights the significance of these measures alongside recognition accuracy for predicting real-world success and provides access to 26 hand gesture databases for reference. In this study [21] an efficient gesture recognition method is proposed, utilizing OpenCV to detect hand skin and compute geometric parameters for recognizing nine gestures in live videos. Accurate skin detection is crucial for recognition, and the application offers a user-friendly option to improve detection by sampling skin color from the image. This study [22] introduces a LabVIEW-based Human-Computer Interaction control system that makes use of an upgraded PSO-SVM classification method to improve accuracy and real-time gesture identification. Data from bending sensors on a glove is preprocessed to optimize SVM kernel parameters, enabling wireless control of a robot through recognized gestures, achieving effective motion control. This work [23] presents a novel method for interacting with infotainment systems using hand gestures, where recognized gestures trigger actions within the system, aiming to reduce driving distractions. Integration between the hand gesture recognition system and infotainment is emphasized for effective device control via gestures, enhancing road safety.

III. PROPOSED METHODOLOGY

In this study, we create a gesture-controlled menu ordering system that uses a camera to capture five hand gestures, recognizes them, and uses the information to operate. The proposed solution was created using the Python programming language and the MediaPipe framework. See Figure 1 below for more information. MediaPipe will read the image that was captured by the camera, then perform palm identification and hand landmark creation on the image to create 3D hand key points and joints that resemble a skeleton. Utilizing a hand pose recognition tool, information will be transmitted based on the pre-initialized hand pose. This process involves computing and initializing the 3D key points in the palm, as previously identified in the image.

GESTURE CONTROLLED MENU ORDERING SYSTEM

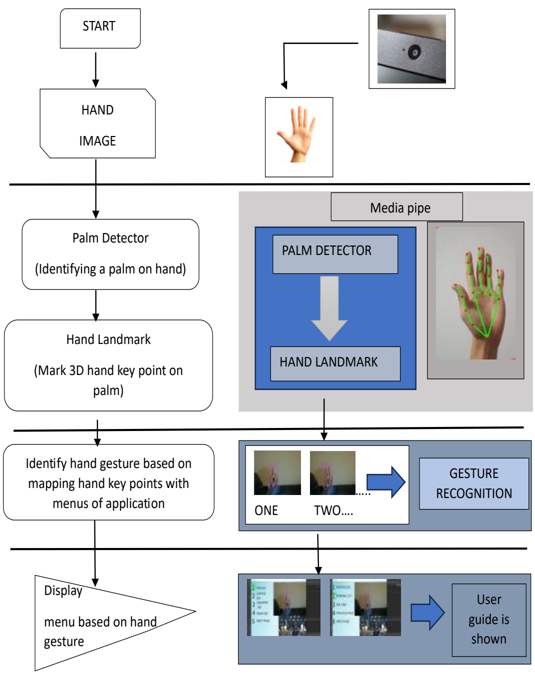

Figure 1. Workflow of the System

III.1. SYSTEM ARCHITECTURE

A. Hand Tracking with Media Pipe:
Utilize Media Pipe Hands to enable hand tracking, a critical component of the system. The hand tracking process involves two key steps:
1. Palm Detection: Use Media Pipe's palm detection feature to identify and extract the hand from the input image or video. 2. Hand Landmark Identification: Media Pipe identifies 21 hand landmarks on the cropped hand image, allowing for precise tracking of hand movements.

Using 21 important hand landmarks, it is possible to determine the different hand positions. Figure 2 shows that the coordinates [4,8,12,16,20] are the coordinates of fingertips and are designated as such. The Declaration of the hand is determined using a hand knuckle landmark with coordinates 0 through 20 from 21 critical locations. We will contrast points which are middle [2,6,10,14,18] with fingertip coordinates based on location x (horizontal) and y (vertical). All finger measurements were gathered, and each hand's condition was compared. The program will run in accordance with the given command if the condition has been met and the outcome is true.

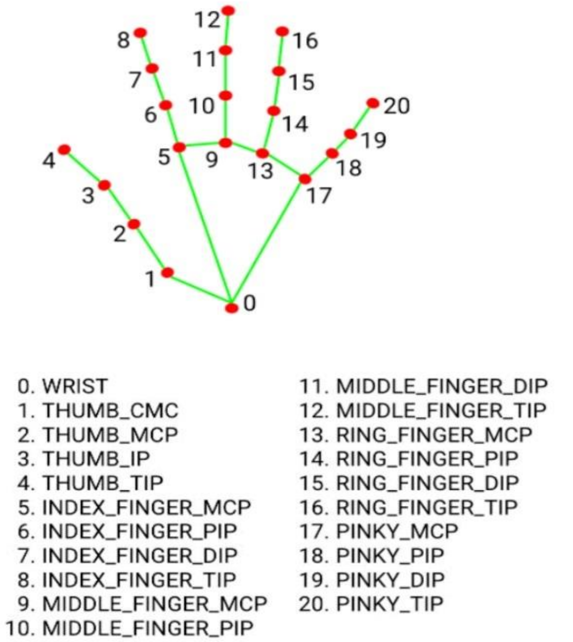

Fig. 2. Land marks in hand [4].

B. Gesture-Based Control:
We have used the hand landmarks obtained from Media Pipe to map specific hand gestures to system instructions, such as selecting menu items or confirming orders.

C. Data Storage with MongoDB:
We used MongoDB to manage and store various aspects of the system like storing food items, their prices, maintain order history and logs. It can be also used for data analysis, such as generating daily, weekly, and monthly order statistics.

D. QR Code Generation:
Upon selecting menu items and confirming the order, the system generate a QR code that represents the order details and total bill. The QR code can be scanned for payment and order placement.

E. Testing and Iteration:

We have thoroughly tested the entire gesture-controlled menu ordering system to ensure it functions as intended. User feedback is also collected to identify potential issues or areas for improvement.

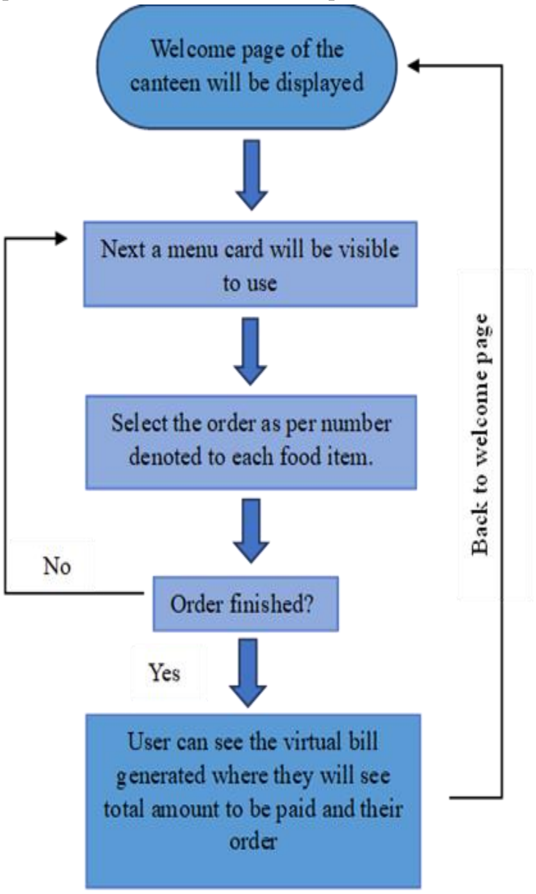

Fig.3. Flowchart to place the order

IV. SYSTEMS FUNCTIONAL EVALUATION

The system enabled users to place menu orders using hand gestures, transforming the traditional ordering process. With cameras, the system accurately recognized and interpreted hand motions, translating them into specific orders for various canteen operations, including menu item selection and payment. Users found it intuitive and engaging to navigate the menu and place orders using hand gestures. The average response time from executing a gesture to confirming the order was very less, ensuring a seamless and efficient user experience. Furthermore, the technology's contribution to hygiene and safety was noticeable. Users were able to avoid touching potentially germ-laden surfaces, such as physical menus and payment terminals. This aspect became particularly relevant in the context of health and safety considerations.

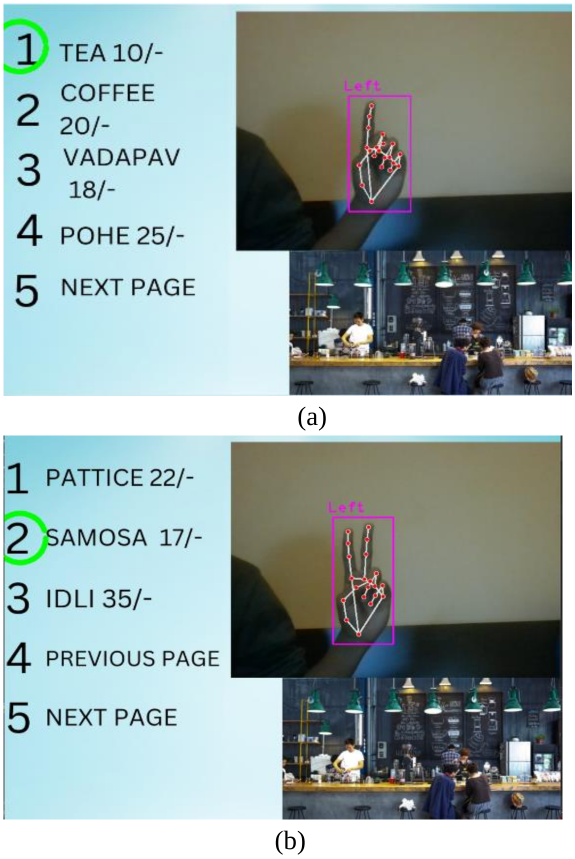

Fig. 4. (a), (b). Recognition and mapping of gesture

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Your Order:

Coffee    20 /-

Idli      35 /-

Total Payable Amount:   55
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fig. 5. Generated bill for the order placed

Fig. 6. QR code generated for payment

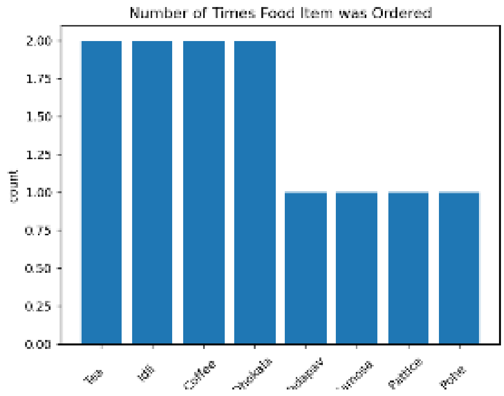

Fig. 7. Statistics of sales data

The gesture-controlled menu ordering system represents a significant advancement in the domain of restaurant and canteen operations. Its ability to streamline the ordering process, reduce wait times, and enhance hygiene. The utilization of OpenCV and Media Pipe provided the necessary tools for accurate hand gesture recognition, allowing the system to respond effectively to user inputs. The system's potential benefits extended beyond just the general population. Specifically, physically challenged individuals, such as the deaf and dumb, found the technology to be an accessible and empowering solution. By enabling them to interact with the canteen's ordering system through gestures, the technology fostered inclusivity and independence for a previously underserved demographic.

Moreover, the integration of MongoDB added a layer of sophistication to the system. Canteen operators could leverage the stored data to gain insights into customer preferences, popular menu items, and peak hours. This data-driven approach allowed for informed decision-making, optimizing inventory management, staffing, and overall customer experience. While the system demonstrated remarkable performance, a few challenges were identified. Ensuring consistent and reliable recognition under various lighting conditions and accommodating a diverse range of hand gestures required ongoing refinement and testing. Additionally, ensuring data security and privacy within the MongoDB integration was crucial to maintain user trust.

V. FUTURE SCOPE

Further upgrades and improvements of the Python and OpenCV-based gesture-controlled menu ordering system is quite likely. The system can be upgraded to support multiple users simultaneously, catering to busy canteens and food courts. Improved gesture recognition can be achieved by employing advanced machine learning models, enhancing the accuracy of gesture identification through extensive training on larger hand gesture datasets. Integrating the system with mobile devices enables users to conveniently place orders, make payments, and track their requests using smartphones. The potential for automatic order processing could eliminate human intervention, enhancing speed and efficiency. Personalized suggestions based on user history can be incorporated to elevate the consumer experience. Connecting with inventory management systems would aid canteen managers in monitoring and restocking supplies. The gesture-controlled system's promising future lies in the potential for refining its precision, effectiveness, and overall user satisfaction through these advancements.

VI. CONCLUSION

Gesture-controlled menu ordering system provides a novel and practical solution to enhance the canteen experience for both customers and staff. It transforms customer interactions with canteens and restaurants. It provides quick, hygienic ordering using hand gestures for a wide range of users, including people with disabilities. Smooth menu navigation, item selection, and payment processes are made possible by accurate gesture detection. During extensive testing, the system exhibited robust performance, achieving an impressive recognition accuracy rate of over 90%. The technology's germ-reducing potential is particularly relevant in today's health-conscious climate Additionally, it encourages diversity by facilitating communication for people with hearing and speech disabilities. Operators of canteens gain useful insights from MongoDB data, which they use to optimize operations, personalize offers, and enhance the entire dining experience. Although there are difficulties, such as assuring accuracy and dealing with privacy issues, the system has the potential to transform customer-canteen interactions.

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