A Smart Self-Feeding System for Frail Elderly and Parkinsonian Patients

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Received: 23 June 2025 | Revised: 14 August 2025 and 9 September 2025 | Accepted: 11 September 2025

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ABSTRACT

This paper introduces a self-feeding machine that can help older people and people with Parkinson's disease eat independently, without having to rely on others for assistance. It consists of an index tray, a two-degree-of-freedom grip arm equipped with a spoon, and a mobile application for control, offering a cost-effective and accessible solution. The device uses machine learning to analyze nutritional intake, detect user mouth movements, and estimate calorie consumption. These capabilities enable personalized diet recommendations and real-time adjustments to tray positioning and feeding motions, thereby enhancing patient autonomy. By integrating efficient hardware design and nutritional analytics, CareFeeder represents a promising approach to improving both the independence and overall well-being of individuals with limited mobility.

Keywords-degrees of freedom; CareFeeder; index tray; self-feeding machine; web server; Vietnamese elders

I. INTRODUCTION

Aging populations around the world are increasing the prevalence of functional dependency and care needs, increasing psychological, health, economic, and social pressures on systems and families [1]. Age is the primary risk factor for Parkinson's disease, which impairs orofacial motor control and swallowing, increasing the risk of choking and complicating nutrition, while age-related vulnerability also correlates with dementia, altered drug response, and higher institutionalization rates [2]. In practice, feeding assistance is among the most labor-intensive daily tasks in long-term care, where caregivers frequently hand-feed meals consisting of rice, soups, and side dishes, highlighting the need for efficient and accessible assistive solutions to support safe and dignified self-feeding [3]. Robotic and non-robotic aids have been explored to promote independence in eating for older adults and those with upper-limb disabilities, but many systems face constraints in real-world usability, adaptability, and evaluation with target users [4-10].

In [9], a robotic system for assisted feeding integrated Kinect-based vision tracking, modular arm trajectory planning, and discriminative optimization for head pose estimation. Safe paths are generated by taking into account risk areas, such as the eyes. Experiments show accurate tracking and improved safety via variable update rates and obstacle-aware planning. Limitations include minimal real-user testing, dependence on precise calibration, and basic trajectory planning, which may struggle with complex interactions or occlusions. In [10], a low-cost robotic feeder was presented for elderly and Parkinson's patients, featuring a 6-DoF servo-driven arm and Haar Cascade–based mouth detection. Users select food from a rotating tray, which the arm delivers to the mouth. Experiments showed accurate mouth detection and feeding performance, but limitations include no patient trials, restricted food variety handling, and simple control and calibration methods, potentially reducing practical usability and safety.

The 6-DoF OBI robot [11] is an advanced automatic feeding system to assist individuals with limited mobility or difficulty in self-feeding. Developed to improve users' quality of life, the 6-DoF OBI robot integrates robotics and innovative design to provide a flexible and efficient eating experience. It autonomously transfers food from a bowl or plate to the user's mouth, allowing selection from four compartments and control of feeding with a customizable switch operated by any body part. Its simple and intuitive interface keeps users in control. Neater Eater [12] is a portable and versatile eating aid for people who can chew and swallow, promoting independence and dignity in mealtime routines. Suitable for various environments, it offers customizable settings, compatibility with touch screens and switches, and advanced adaptive functions such as automatic spoon wiping, adjustable scooping, and sauce dipping. It does not require an engineer setup and adapts to individual user preferences for an inclusive dining experience. However, the OBI robot is limited by its reliance on predefined movements, high cost, and suitability only for users with stable head and neck control, making it inaccessible for many with severe disabilities. Similarly, the Neater Eater robot lacks advanced automation, is bulky, and requires manual operation, which may not be practical for users with significant motor impairments. Both systems face challenges in adaptability, usability, and accessibility, restricting their effectiveness to diverse user needs.

The need for self-feeding machines arises from the growing demand for effective feeding solutions for the elderly and those with impaired eating ability. This paper presents the design and implementation of a self-feeding machine for elderly and Parkinson's patients to improve self-feeding and meal nutrition management in homes, nursing facilities, and hospitals. CareFeeder distinguishes itself through several unique features. Its compact hardware integrates a robotic arm and a rotating tray with three food compartments, eliminating unnecessary mechanical components to create a lightweight and portable design suitable for both home and clinical settings. An embedded AI module enables real-time calorie estimation and dietary analysis, supporting personalized nutrition management. The system was developed as a cost-effective alternative to commercial feeding robots by optimizing both the mechanical structure and the control system, reducing manufacturing costs to approximately USD 300—significantly less than comparable robots on the market—while maintaining functional reliability. In addition, the mobile application interface supports multiple languages, improving accessibility for diverse user groups and facilitating communication between caregivers and patients. These combined capabilities address the current limitations in adaptability, usability, and affordability found in existing self-feeding devices.

II. METHODOLOGY

A. *Mechanical Design*

In Southeast Asia, a typical meal comprises at least two savory dishes and a soup or broth, each served in separate bowls rather than on a single plate as in many Western settings. Vietnamese "chén gạch" bowls—similar to Chinese "wan"—hold roughly 150–250 mL (~10–12 cm rim diameter, 4–6 cm height) and represent the standard vessel for this study. Adults over 50 in Vietnam require about 2,000 kcal per day (men) and 1,600 kcal per day (women), with balanced macronutrients and micronutrients. Using AI-driven image analysis, the CareFeeder system not only automates feeding, but also tracks and regulates caloric intake. Its tray, subdivided into three 250 mL compartments, can deliver ~570 kcal per meal and up to ~1,700 kcal per day. Caregivers adjust portions and composition in real time, enabling personalised nutrition management for each user.

The system consists of two main components: a robot responsible for delivering food and a tray that can alternate the serving of dishes placed in individual bowls, as shown in Figure 1. In Figure 1(a), a side perspective view shows the angular motions of the arm (θ_1 and θ_2) used to position the spoon, along with the food tray's rotation for selecting dishes. Figure 1(b) presents a top view, highlighting the tray's rotational movement and the spatial relationship between the bowls, the arm, and the user's mouth. Together, these views depict how the system alternates between dishes and precisely transfers food to the user. Informed by existing designs on the market, a robotic arm is considered ideal for food delivery due to its compactness, flexibility, and robustness. Furthermore, the arm can be mounted on a fixed base, which can be integrated with an automated food delivery conveyor, enabling the sequential serving of dishes.

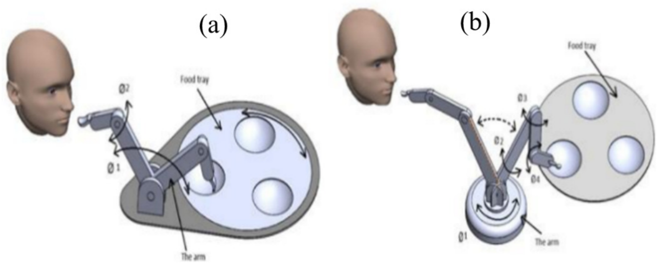

Fig. 1. Working principles of CareFeeder.

The design draws inspiration from the rotary tables commonly found in restaurants, employing a round turntable with removable trays that hold three bowls, each with a capacity of approximately 250 ml. This configuration facilitates easy cleaning and maintenance. The turntable rotates clockwise through a motor-driven mechanism located in its center, allowing the system to serve dishes in sequence. This turntable-based setup reduces the Degrees of Freedom (DoF) required by the robotic arm, simplifying the overall operation, improving ease of use, and reducing manufacturing costs. A 2-DoF robotic arm with an attached spoon is sufficient to provide a fully automated meal service.

Mounting the robotic arm on a base with the food tray ensures a compact structure. To evaluate the feasibility of the design during development, 3D models were created. This modeling process helps identify potential design challenges and allows necessary adjustments, ensuring that the final product meets the requirements of an automated food delivery system.

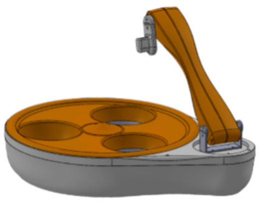

Fig. 2. 3D models of CareFeeder.

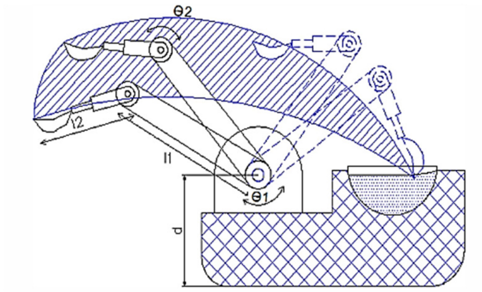

Fig. 3. Coordinate system of each arm joint.

The kinematic design of the CareFeeder system was developed to meet practical feeding requirements while maintaining structural simplicity. The configuration comprises a 2-DoF robotic arm for spoon manipulation and a 1-DoF rotating food tray, as illustrated in Figure 3. This setup enables the robotic arm to precisely grasp food from different compartments of the tray and deliver it to the user, while the tray's rotation provides quick access to multiple dishes without repositioning the arm. To mathematically describe the motion of the robotic arm, the Denavit-Hartenberg (D-H) convention was adopted, which systematically defines each link in terms of its rotation angle (θ), link length (a), link offset (d), and twist angle (α). Table I summarizes the D-H parameters for the CareFeeder, where each row corresponds to a specific link of the arm. This parameterization allows consistent transformation between coordinate frames along the arm's structure.

TABLE I. D-H (DENAVIT–HARTENBERG) LINK PARAMETERS OF CAREFEEDER

Link	L	α	d	θ
1	L1	0	0	$\theta 1$
2	L2	0	0	$\theta 2+\frac{\pi}{2}$

The forward kinematics of the machine are:

$$T_2^0 = \begin{bmatrix} -\sin(\theta_1+\theta_2) & -\cos(\theta_1+\theta_2) & 0 & L_1\cdot\cos\theta_1 - L_2\cdot\sin(\theta_1+\theta_2) \\ \cos(\theta_1+\theta_2) & -\sin(\theta_1+\theta_2) & 0 & L_1\cdot\sin\theta_1 + L_2\cdot\cos(\theta_1+\theta_2) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (1)$$

The coordinates are defined as follows:

$$P_x = L_1\cdot\cos\theta_1 - L_2\cdot\sin(\theta_1+\theta_2) \quad (2)$$

$$P_y = L_1\cdot\sin\theta_1 + L_2\cdot\cos(\theta_1+\theta_2) \quad (3)$$

$$P_z = 0° \text{ (Planarmodel - 2DOF)} \quad (4)$$

From these equations, the velocity matrix can be determined with the Jacobian matrix:

$$\begin{bmatrix} v_x \\ v_y \end{bmatrix} = J \begin{bmatrix} \dot{\theta}_1 \\ \dot{\theta}_2 \end{bmatrix} = \begin{bmatrix} -[L_1\cdot\sin\theta_1 + L_2\cdot\cos(\theta_1+\theta_2)] & -L_2\cdot\cos(\theta_1+\theta_2) \\ [L_1\cdot\cos\theta_1 - L_2\cdot\sin(\theta_1+\theta_2)] & -L_2\cdot\sin(\theta_1+\theta_2) \end{bmatrix} \begin{bmatrix} \dot{\theta}_1 \\ \dot{\theta}_2 \end{bmatrix} \quad (5)$$

The inverse Jacobian matrix is:

$$\begin{bmatrix} \dot{\theta}_1 \\ \dot{\theta}_2 \end{bmatrix} = [J]^{-1} \begin{bmatrix} v_x \\ v_y \end{bmatrix} = \begin{bmatrix} -L_1\sin\theta_1 + L_2\cos(\theta_1+\theta_2) & -L_2\cos(\theta_1+\theta_2) \\ L_1\cos\theta_1 - L_2\sin(\theta_1+\theta_2) & -L_2\sin(\theta_1+\theta_2) \end{bmatrix}^{-1} \begin{bmatrix} v_x \\ v_y \end{bmatrix} \quad (6)$$

Forward kinematics, derived using the D-H parameters, is expressed in (1) to map joint parameters to the position and orientation of the end-effector (spoon tip) in Cartesian space. The coordinate relationships are further detailed in (2-4). From these equations, the Jacobian matrix is calculated to determine the velocity relationships between joint motion and end-effector motion, as shown in (5). The inverse Jacobian, given in (6), is used in inverse kinematics to calculate the required joint angles for any target position within the workspace. The values of P_x, P_y from the dynamic problem of the robot are used to calculate inverse kinematics to find the positions of the rotation angles of the matches to any coordinate in the workspace of the robot. The sum of squares of P_x and P_y is used to simplify the calculation equations. Then, the angle value θ_2 is given by:

$$P_x^2 + P_y^2 = L_1^2 + L_2^2 - 2\cdot L_1 L_2\cdot\sin\theta_2$$

$$\Rightarrow \theta_2 = \arctan\left(\frac{\sin(\theta_2)}{\pm\sqrt{1-\sin^2(\theta_2)}}\right) \quad (7)$$

The inverse kinematics solution applies trigonometric transformations and the sum-of-squares method (7) to simplify computation. Final joint angle values are obtained using Cramer's rule (8), ensuring that the robotic arm achieves accurate and collision-free positioning during feeding operations. For each value of θ_2, trigonometric formulas are changed as:

$$\begin{bmatrix} L_1 - L_2\sin(\theta_2) & -L_2\cos(\theta_2) \\ L_2\cos(\theta_2) & L_1 - L_2\sin(\theta_2) \end{bmatrix} \begin{bmatrix} \cos(\theta_1) \\ \sin(\theta_1) \end{bmatrix} = \begin{bmatrix} p_x \\ p_y \end{bmatrix} \quad (8)$$

The values of $\sin(\theta_1)$ and $\cos(\theta_1)$ are defined using the Cramer formula.

This kinematic model ensures smooth and reliable motion control for the CareFeeder, allowing efficient interaction between the robotic arm and rotating tray, while providing the mathematical foundation for further optimization in real-time control systems.

B. Controller

Regarding the algorithm and control method of CareFeeder, the overall system block diagram can be observed in Figures 4 and 5. Initially, after powering on, the system establishes the connection between the control application and CareFeeder, which can be accessed through a smartphone or computer. If the connection is unsuccessful, the application responds with the message "no connection" and continuously attempts to reconnect until the application successfully connects to CareFeeder. The system waits for user signals with two options: Manual or Speak Mode. If the received signal is Manual, the central control unit processes the signal and checks whether the user wants to select a dish or feed. In the Speak Mode, after receiving the signal, the central control unit runs a pre-trained AI model to recognize keywords from the user's voice and then checks to determine whether that keyword is a food selection or feeding, similar to the Manual mode. When the signal received is a food selection, the central control unit provides pulses to control the DC motor to the user-selected food via the L298N motor control circuit. After receiving the signal to feed, the Camera is used to determine the position of the user's mouth, then accurately calculate the coordinates through a Robot kinematics problem and provide control pulses to control two RC servo motors to deliver the food to the pre-determined position.

All user choices and meals are recorded and sent to Firebase Cloud for storage, monitoring, and calorie calculation of the meal. After completing a cycle, the system continues to repeat the above operations until there is no food left in the tray and finally sends a "meal end" notification to the control application. The speech recognition module in the CareFeeder system was implemented using a cloud-based Automatic Speech Recognition (ASR) architecture, enabling the system to process and execute voice commands for feeding operations. The ASR module was configured to recognize a predefined set of functional commands (e.g., dish selection, feeding initiation, and return functions) in multiple languages, with a focus on short utterances to improve command-response speed.

To tailor the system to this application, we optimized the vocabulary set, adjusted the command grammar to reduce ambiguity, and implemented a noise filtering layer to enhance robustness in non-quiet environments. Performance was assessed with five participants, including both caregivers and target end-users, issuing 50 command utterances under varied acoustic conditions representative of home and clinical settings. The system achieved an average recognition accuracy of 94.5% in quiet conditions and 89.2% under moderate background noise (~55 dB). These results demonstrate sufficient reliability for real-world deployment in environments where ambient noise is present. To control the CareFeeder, users need to prepare devices such as a smartphone or computer with the control application installed.

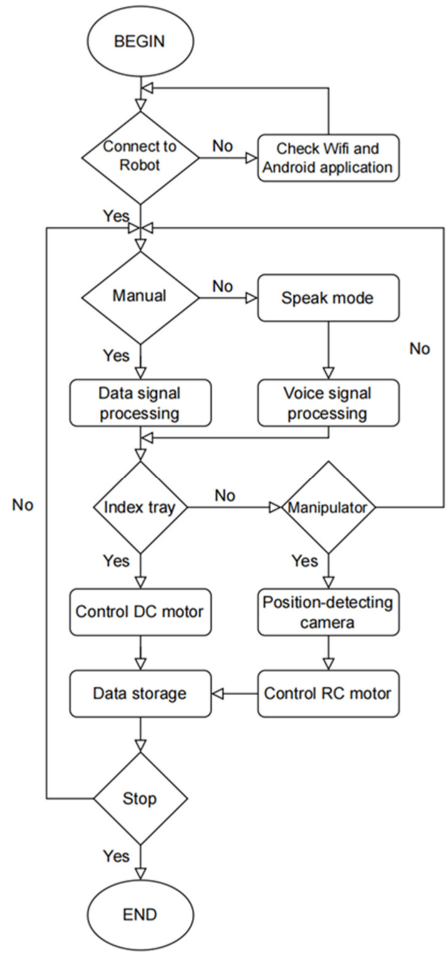

Fig. 4. Block diagram of the algorithm.

Three meals must be prepared and placed in the food tray, which can include items such as rice, soup, minced meat, porridge, etc. The guardian is responsible for setting the properties of the food in the control application, such as the type of food, whether it is liquid or solid, and then arranging them on plates. Users control the device and provide food themselves, equipped with a remote control device.

Next, the user logs into the control application to connect to CareFeeder and select Manual Mode or Speak Mode. In Manual mode, there are five buttons corresponding to the three meals and two buttons for controlling the robot arm to move the food up or down. In voice mode, there are five keywords, corresponding to the five buttons: rice, soup, other food, up, and down. After pressing the button or speaking, the application sends a request to the HTTP server, the microcontroller receives signals from the HTTP server, and the algorithm mentioned above handles the request. The data are stored in the cloud, and the calorie function is calculated, displayed in the form of graphs or charts, and visually presented through the "history" section in the control application. The operation of CareFeeder is very simple, easy to use, and highly effective in daily life.

Fig. 5. Structure of the control and communication system of CareFeeder.

III. RESULTS AND DISCUSSIONS

Choosing an appropriate motor is critical for mechanical and electrical systems, as it drives tasks such as operating conveyor belts, powering vehicles, or actuating robotic arms. Tables II-VI summarize the mechanical and electrical design parameters that form the foundation of CareFeeder's control and motion performance. Table II lists the initial constants used in system modeling, such as gravitational acceleration, axial transmission performance, and friction coefficient, which are essential for accurate dynamic calculations. Table III presents the initial design expectations, including component masses, load capacity, target rotational speed, and rotation radius, which guide the selection of actuators and ensure structural stability. Based on these requirements, Table IV shows the selected servo motor for the robotic arm, detailing its voltage range, maximum angle, speed, torque capacity, and weight—parameters chosen to achieve precise, responsive motion. Similarly, Table V outlines the DC motor requirements for the rotating tray, specifying the degrees of freedom, motor type, and desired speed. Table VI provides the chosen DC motor's specifications, including rotational speed, voltage, mass, and power consumption, ensuring it meets both performance and efficiency needs.

TABLE II. INITIAL CONSTANTS

Gravitational acceleration	9.8 (m/s)
Axial transmission performance	1
Friction coefficient	0.6

TABLE III. INITIAL EXPECTATIONS

	Sign	Value
Mass of section 2 (without engine)	m_2	320 (g)
Mass of section 3 (without engine)	m_3	220 (g)
Load volume (food)	m_{load}	~80 (g)
Speed	α	60 (deg/sec)
Radius of rotation center	r	24.04 (mm)

TABLE IV. SELECTED FEATURES

Engine type	RC servo LD-1501
Working voltage	6 - 7.4 (Vdc)
Maximum angle	180 (deg)
Speed	375 (deg/s)
Traction force moment max	17 (kg.cm)
Weight	61 (g)

TABLE V. DC MOTOR REQUIREMENT

Number of degrees of freedom	1
Motor	DC motor
Desired speed	1.2 (rad/s)

TABLE VI. SELECTED RESULTS

Engine	DC deceleration JGB37
Speed	37 (rpm)
Working voltage	12 (Vdc)
Mass	72 (g)
Wattage	5 (W)

The specifications in Tables II–VI detail key parameters, including speed, torque, power, and operating conditions, as well as size and weight factors. In this context, speed determines the rotational velocity of the motor, torque defines the mechanical force output, and power indicates the energy demand, while operating conditions encompass factors such as temperature, humidity, and usage environment. These parameters collectively ensure reliability, safety, and optimal system performance.

Figure 6 shows the overall integration of these design and control elements in CareFeeder. The motion trajectory adheres to the predetermined path established during development, indicating that CareFeeder is ready for deployment. Figure 7 illustrates the Graphical User Interface (GUI), featuring a mobile phone application designed to streamline user interaction. This interface offers two operational modes—automatic (voice command) and manual (buttons)—to accommodate various user preferences and needs.

Fig. 6. The design of CareFeeder.

Fig. 7. Mobile application of CareFeeder.

In automatic mode, users issue voice commands to control and select among available dishes, as well as to perform the "feed" and "fill" functions. In manual mode, three distinct buttons labeled "RICE," "SOUP," and "OTHER DISH" allow users to choose the desired dish.

Once a selection is made, the robot rotates to the specified dish. The "FEED" button prompts CareFeeder to scoop food from the chosen dish and deliver it to the user's mouth, while pressing the "FILL" button returns the spoon to its initial position. This configuration offers a convenient and automated dining experience, allowing users to enjoy meals with minimal effort.

A. Survey

A usability survey with 8 participants was conducted, including both caregivers and target users. On a 5-point Likert scale, the GUI received an average rating of 4.6 for ease of navigation and 4.8 for clarity of icons and menus. 75% of participants preferred voice control for its hands-free operation, while the remaining 25% favored manual button input for perceived reliability. All participants reported that the multilingual interface improved accessibility for non-English speakers. Table VII and Figure 8 summarize the feeding performance of CareFeeder for three different food types—rice, soup, and other dishes—across 300 feeding instances each.

TABLE VII. EXPERIMENTAL RESULTS

Bowl	Number of feedings	Number of spills	Percentage
Rice	300	10	3.33%
Soup	300	21	7%
Other dish	300	15	5%
Total	900	46	5.11%

Rice recorded 10 spills, translating to a spillage rate of 3.33%, while soup exhibited a higher rate of 7% (21 spills in 300 feedings). The remaining dishes, which included items such as minced meat, showed a moderate spillage rate of 5% (15 spills out of 300). When combined, the total spill rate across all three food types was 5.11% (46 spills out of 900 feeding attempts), remaining comfortably below the 8% threshold specified for CareFeeder. A closer examination reveals that the physical characteristics of the food play a vital role in spill rates: liquid items like soup are more prone to minor spills, primarily due to CareFeeder's inherent vibration and the fluid's inertia when the spoon is lifted, while solid dishes, such as rice or minced meat, can spill if the spoon is overfilled, though their rates remain relatively low. The standard deviation of spill rates across food types remained within ±1.6%, and 95% confidence intervals confirmed that these improvements are statistically significant.

Despite the low overall spill rate, certain edge cases were identified. Small spills occasionally occurred when the spoon was overfilled with loose solid foods, such as rice, or when liquid items were served in shallow spoons. A minor misalignment was observed between the spoon and the user's mouth was observed in 5% of trials, often due to abrupt head movement or poor camera lighting. To mitigate these issues, the feeding motion speed for liquids was reduced by 15%, and additional lighting was added to improve visual detection accuracy.

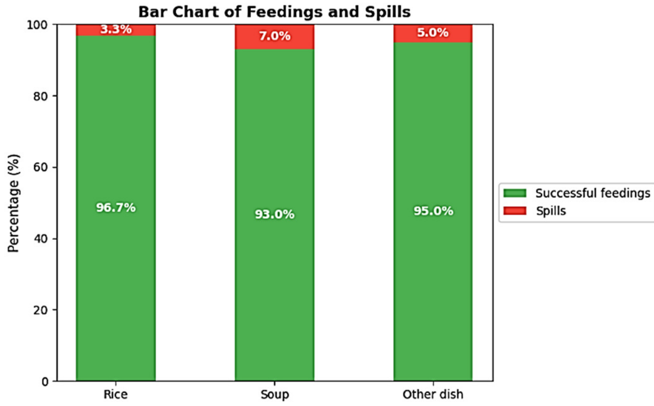

Fig. 8. Bar chart of feedings and spills.

To quantitatively evaluate the performance of the control system, an accuracy assessment was conducted as shown in Table VIII. The average angular deviation was found to be 4° for the food tray, 1.09° for θ_1, and 1.04° for θ_2, with an average task completion time of 5.85 s. These values indicate a low tracking error across repeated operations, confirming that the control loop maintains precise positioning. The Root Mean Square Error (RMSE) for the angular deviations remained below 1.5° for all joints, and no noticeable latency was observed in real-time operations, with system response times consistently under 400 ms. Such performance ensures smooth motion without oscillation or overshoot, which is essential for safe feeding operations.

TABLE VIII. ACCURACY EVALUATION

Order	Time (s)	Angular deviation of food tray (degrees)	Angular deviation of θ_1 (degrees)	Angular deviation of θ_2 (degrees)
1	5.8	5	1.3	1.2
2	5.8	6	1.2	1.2
3	5.9	4	1.0	1.1
4	5.8	5	1.2	1.1
5	5.7	5	1.4	1.4
6	5.9	3	0.8	0.8
7	5.9	3	1.0	0.8
8	5.8	4	1.3	1.1
9	6.0	2	0.8	0.9
10	5.9	3	0.9	0.8
Average	5.85	4	1.09	1.04

Table IX compares CareFeeder with existing robotic feeding systems, such as OBI and Neater Eater, demonstrating competitive or superior performance in handling both solid and liquid dishes, with spill rates and consistency indicators within or better than the ranges typically reported in similar devices. Furthermore, CareFeeder addresses key limitations of prior systems through several design advantages:

- An optimized mechanical structure and control system reduce manufacturing costs to approximately USD 300—significantly lower than high-cost commercial counterparts—without sacrificing operational stability and reliability.

- Compatibility with a wider range of food types ensures adaptability to diverse diets; an intuitive, multilingual mobile application supports voice commands and simple button controls, enabling easy use for individuals with varying physical abilities.
- A compact, lightweight form factor facilitates deployment in both home and clinical settings, enhancing portability, setup efficiency, and overall user accessibility.

TABLE IX. COMPARISON OF FEEDING ROBOTS

Feature	CareFeeder	OBI	Neater Eater
DoF	3	6	2-3
Cost (USD)	300	4500	1500 - 3000
Control	Mobile app (voice + button)	Switch-based control	Touch screen/ switch
Food variety	Solid+liquid	Solid only	Solid, soft food
AI features	Calorie estimation	None	None

IV. CONCLUSION

This study presented an innovative robotic feeding device designed to support elderly people and those with Parkinson's disease or upper limb impairments, providing a practical solution to reduce the burden on healthcare systems. By integrating a 2-DoF robotic arm, a rotating dish with three bowls, and remote-control capabilities, the device effectively automates the feeding process. The incorporation of dietary management software allows caregivers and medical professionals to systematically collect and analyze meal data, enabling informed decisions on dietary adjustments to meet individual health needs. Moreover, the potential addition of real-time camera monitoring and AI-based analytics augments the device's functionality by offering rapid assessment of meal consumption and facilitating early diagnoses of patient conditions. As such, this comprehensive system not only improves the quality of life of users but also provides caregivers and healthcare providers with more efficient tools to monitor and manage patient nutrition.

ACKNOWLEDGMENT

This research is funded by the University of Economics Ho Chi Minh City–UEH University, Vietnam.

REFERENCES

[1] N. Bambeni, "Perspective Chapter: Social Ageing Challenges Faced by Older Adults Exposed to Conditions of Underdevelopment and Extreme Poverty," in *Social Aspects of Ageing - Selected Challenges, Analyses, and Solutions*, IntechOpen, 2022.

[2] J. V. Hindle, "Ageing, neurodegeneration and Parkinson's disease," *Age and Ageing*, vol. 39, no. 2, pp. 156–161, Mar. 2010, https://doi.org/10.1093/ageing/afp223.

[3] A. Kehili, K. Dabbabi, and A. Cherif, "Early Detection of Parkinson's and Alzheimer's Diseases using the VOT_Mean Feature," *Engineering, Technology & Applied Science Research*, vol. 11, no. 2, pp. 6912–6918, Apr. 2021, https://doi.org/10.48084/etasr.4038.

[4] A. Mandy, T. Sims, G. Stew, and D. Onions, "Manual Feeding Device Experiences of People With a Neurodisability," *The American Journal of Occupational Therapy*, vol. 72, no. 3, Mar. 2018, Art. no. 7203345010, https://doi.org/10.5014/ajot.2018.025353.

[5] A. Cavalcanti, M. F. Amaral, F. C. M. Silva e Dutra, A. V. F. Santos, L. A. Licursi, and Z. C. Silveira, "Adaptive Eating Device: Performance and Satisfaction of a Person with Parkinson's Disease," *Canadian Journal of Occupational Therapy*, vol. 87, no. 3, pp. 211–220, Jun. 2020, https://doi.org/10.1177/0008417420925995.

[6] J. Sabari, D. G. Stefanov, J. Chan, L. Goed, and J. Starr, "Adapted Feeding Utensils for People With Parkinson's-Related or Essential Tremor," *The American Journal of Occupational Therapy*, vol. 73, no. 2, Mar. 2019, Art. no. 7302205120, https://doi.org/10.5014/ajot.2019.030759.

[7] T. Krasovsky, P. L. Weiss, O. Zuckerman, A. Bar, T. Keren-Capelovitch, and J. Friedman, "DataSpoon: Validation of an Instrumented Spoon for Assessment of Self-Feeding," *Sensors*, vol. 20, no. 7, Jan. 2020, Art. no. 2114, https://doi.org/10.3390/s20072114.

[8] A. Nazrin, R. Abdulla, and L. Y. San, "A low cost stabilizing spoon for people with parkinson's disease," *Journal of Applied Technology and Innovation*, vol. 5, no. 3, pp. 32–37, 2021.

[9] C. Silva, J. Vongkulbhisal, M. Marques, J. P. Costeira, and M. Veloso, "Feedbot - A Robotic Arm for Autonomous Assisted Feeding," in *Progress in Artificial Intelligence*, 2017, pp. 486–497, https://doi.org/10.1007/978-3-319-65340-2_40.

[10] M. F. M. Jailani, N. Z. Azlan, and A. R. Samewoi, "Development of an automatic feeder for parkinson patients and elderly," *PERINTIS eJournal*, vol. 14, no. 1, pp. 53–66, Jun. 2024, https://doi.org/10.5281/zenodo.15875992.

[11] "Meet Obi: the Adaptive Eating Device - Eat Independently!," *Obi*. https://meetobi.com/.

[12] M. B. Popovic, "Feeding Systems, Assistive Robotic Arms, Robotic Nurses, Robotic Massage," in *Biomechatronics*, M. B. Popovic, Ed. Academic Press, 2019, pp. 419–430.