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AI Smart Table

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Abstract

This study developed and evaluated an AI Smart Table with a Dry Ingredients Dispenser designed to improve efficiency, accuracy, organization, and hands-free operation during pastry preparation for home bakers and local cake shops. Guided by Rogers' Diffusion of Innovations Theory, the study employed a project-based research design combined with a quantitative approach. The prototype was fabricated using stainless steel and integrated an AI voice recognition module, automated dispensing mechanism, storage compartments, and mobility features. Its performance was evaluated by fifteen (15) purposively selected home bakers and local cake shop owners from the Association of Kidapawan Hotels, Resorts, and Restaurants (AKHoRR) in Kidapawan City using a researcher-made, expert-validated questionnaire. Data were analyzed using frequency count and mode. Results showed that the AI Smart Table was successfully developed and demonstrated excellent voice detection performance under varying distances, environmental conditions, and users. The dispensing mechanism consistently delivered accurate measurements with only minimal acceptable variations, while the system achieved a highly acceptable level of safety and usability. Although slight inconsistencies were observed in dispensing smaller ingredient quantities, the prototype proved to be functional, reliable, practical, and suitable for household and small-scale baking applications. The study recommends improving the calibration of the dispensing mechanism, incorporating more advanced sensors and voice recognition capabilities, increasing the number of respondents in future evaluations, and exploring additional automation features to further enhance system performance. The study supports Sustainable Development Goal (SDG) 9: Industry, Innovation and Infrastructure by promoting innovation in food preparation technology and SDG 8: Decent Work and Economic Growth by improving productivity and operational efficiency for small-scale baking enterprises. Furthermore, the developed system contributes to technological and economic sustainability by encouraging the adoption of intelligent automation that enhances precision, reduces manual effort, and supports innovation in modern kitchen operations.

Keywords: AI Smart Table, Arduino Nano, Dry Ingredients Dispenser, Pastry Preparation, Voice Recognition, Workstation Design

1. Introduction

Advancements in automation and artificial intelligence have transformed food preparation by improving precision, efficiency, and productivity. In pastry preparation, workstations traditionally provide stability, organization, and temperature control, yet they still rely heavily on manual ingredient measurement. Existing technologies rarely integrate automated ingredient dispensing with intelligent control systems, creating opportunities to improve workflow, reduce human error, and enhance productivity. This study addresses this gap by developing an AI Smart Table with a voice-recognition-enabled dry ingredients dispenser designed to support home bakers and local cake shops through accurate, efficient, and organized pastry preparation.

1.1 Background of the AI Smart Table for Pastry Preparation

Pastry workstations provide stable work surfaces, organized storage, and suitable preparation conditions that contribute to efficient baking. Modern workstations have incorporated automation features such as temperature regulation and smart sensors to improve consistency and productivity (Rink & Thibodeaux, 2023; Essfeed, n.d.). Despite these advancements, most existing workstations still depend on manual ingredient measurement, while integrated automated dispensing systems remain uncommon. This limitation contributes to measurement errors, ingredient waste, and increased preparation time, particularly among home bakers and small-scale cake shops. To address these concerns, the study developed an AI Smart Table equipped with voice recognition and an AI-powered dry ingredients dispenser to improve measurement accuracy, reduce manual labor, and support multitasking during pastry preparation.

1.2 Themes and Insights from Related Literature on AI-Assisted Pastry Workstations

Related literature shows the continuous evolution of pastry preparation, worktables, and ingredient dispensing technologies. Pastry-making has progressed from traditional methods to modern techniques that integrate innovation while maintaining quality and craftsmanship (Gazzard, 2015; PureHistory, 2013; Cooking School Guide, 2024). Likewise, worktables have evolved from simple work surfaces into ergonomic and modular workstations that improve efficiency and adaptability (Lost Art Press, 2024; Oxford English Dictionary, 2024; Halilović & Gajšek, 2025). Stainless steel worktables have become widely adopted because of their durability, hygiene, corrosion resistance, and ergonomic features that support efficient food preparation (SRS-i, 2022; BiGDUG, n.d.; RDM Industrial Products, 2020; Sealey, n.d.). Ingredient dispensers have similarly evolved from basic storage containers into precision dispensing systems that promote organization, minimize waste, and improve food safety (Sanei Tech Co., Ltd., 2018; Alimec, n.d.). Automated dispensers further enhance operational efficiency by reducing labor requirements and dispensing errors through sensors, timers, and IoT-enabled technologies (World Obesity, 2015; Shibley & Benson, 2024; IJRASET, 2024). Moreover, AI voice recognition has significantly improved through artificial neural networks and Hidden Markov Models, enabling accurate speech recognition and expanding applications across various fields (Ghai & Singh, 2012; Manjunath et al., 2024; Nutprapha, 2024). Collectively, these studies support integrating AI, automation, and intelligent dispensing into pastry preparation equipment.

1.3 Local, National, and Global Context of AI-Enabled Pastry Preparation

Globally, food preparation technologies increasingly emphasize automation, precision, hygiene, and ergonomic design to improve production efficiency. The growing adoption of AI-assisted workstations and automated dispensing systems demonstrates the industry's movement toward intelligent kitchen equipment. Existing patented technologies, including adjustable workbenches, stainless steel kitchen workstations, and programmable dispensing systems, illustrate continuous innovation in workstation functionality and ingredient management. However, these technologies primarily address structural improvements or programmable dispensing and do not integrate voice-controlled AI dispensing specifically for pastry preparation. This study responds to these technological developments by combining automation, voice recognition, and ingredient dispensing into a compact workstation suitable for home bakers and local cake shops.

1.4 Theoretical Basis of AI Smart Table Adoption

The study is anchored on Rogers' Diffusion of Innovations Theory, which explains how innovations are adopted through communication, social influence, and perceived usefulness. Sahin (2023) emphasized that digital communication platforms accelerate innovation adoption by increasing awareness and acceptance of emerging technologies. Guided by this theory, the AI Smart Table represents an innovation that modernizes traditional pastry workstations by integrating AI-powered ingredient dispensing and voice recognition while maintaining the familiar functionality of conventional worktables.

1.5 Research Gaps and Rationale

Existing literature extensively discusses pastry workstations, ergonomic worktables, stainless steel work surfaces, automated dispensers, and AI voice recognition independently. However, limited studies have integrated these technologies into a single workstation specifically designed for pastry preparation. Likewise, current pastry workstations seldom incorporate built-in AI-powered dry ingredient dispensers with voice recognition, leaving manual measurement as a common practice that contributes to inefficiency and measurement errors. This study addresses these gaps by designing and developing an AI Smart Table that combines automated ingredient dispensing, voice recognition, organized storage, and mobility to improve productivity, precision, and usability for home bakers and local cake shop operators.

1.6 Alignment with Relevant Sustainable Development Goals (SDGs)

The study aligns with SDG 9 – Industry, Innovation and Infrastructure by promoting technological innovation through the development of an AI-enabled pastry workstation that improves productivity, automation, and operational efficiency in food preparation. It also supports SDG 8 – Decent Work and Economic Growth by enhancing workplace efficiency, reducing manual workload, and providing practical innovations that can improve the productivity of home bakers and small bakery enterprises. These SDGs are directly supported by the study's focus on intelligent workstation design and automation.

1.7 Importance of the Study to Multidisciplinary Sustainability

The study contributes to technological sustainability by promoting the application of artificial intelligence and automation in food preparation. It also supports economic sustainability by improving operational efficiency, minimizing ingredient waste, and enhancing productivity for home bakers and local cake shops. Furthermore, the study contributes to innovation sustainability by encouraging future research and development of intelligent bakery equipment that combines automation, precision, and user-centered design for modern food production.

2. Material and methods

2.1 Research Design

This study employed a project-based research design combined with a quantitative approach. The project-based design guided the planning, design, fabrication, testing, revision, and evaluation of the AI Smart Table with a Dry Ingredients Dispenser, while the quantitative approach was used to assess its efficiency in terms of voice detection, dispensing accuracy, safety, and usability. The AI Smart Table was constructed from stainless steel and designed with a three-compartment dry ingredient dispenser integrated with AI voice recognition, a movable dispensing mechanism, storage drawers, a bottom shelf, and lockable caster wheels to improve efficiency, organization, and mobility during pastry preparation. The different views of the prototype illustrate its overall structure, dimensions, workspace layout, and storage features, while the exploded view shows the assembly and integration of its mechanical, electrical, and structural components. The prototype was developed using appropriate materials and labor through a systematic process of planning, material preparation, fabrication, testing, revision, and evaluation. During testing, necessary modifications were made to improve the stability of the lifting mechanism and the accuracy of the dispensing system, ensuring that the final prototype functioned efficiently and reliably.

2.2 Locale of the Study

The prototype was fabricated in Poblacion, Kidapawan City. The evaluation was likewise conducted in the same location among selected home bakers and local cake shop owners to determine the efficiency and acceptability of the developed AI Smart Table within an actual baking environment.

2.3 Respondents of the Study

The respondents consisted of fifteen (15) selected home bakers and local cake shop owners, particularly members of the Association of Kidapawan Hotels, Resorts, and Restaurants (AKHoRR) in Kidapawan City. These individuals were selected because they regularly engage in pastry preparation and could appropriately evaluate the functionality, efficiency, and usability of the developed prototype.

2.4 Sample and Sampling Procedure

The study employed purposive sampling to select respondents with sufficient baking experience and direct involvement in pastry preparation. This technique ensured that only participants capable of providing informed evaluations regarding the efficiency and acceptability of the AI Smart Table were included in the study.

2.5 Research Instrument

A researcher-made questionnaire was used to collect data and was validated by three expert faculty members from the College of Technology of the University of Southern Mindanao–Kidapawan City Campus. The instrument obtained a mean validity score of 4.78, indicating that it was highly valid for assessing the study variables. It measured the efficiency of the AI Smart Table in terms of voice detection and dispensing accuracy, as well as its level of acceptability regarding safety and usability using a five-point Likert scale with corresponding verbal interpretations.

2.6 Data Gathering Procedure

The researcher secured permission by submitting a request letter to selected home bakers and local cake shop owners, particularly members of the AKHoRR group. Upon approval, the respondents received an orientation regarding the purpose of the study, the operation of the AI Smart Table, and the proper completion of the questionnaire. After operating and evaluating the prototype, the completed questionnaires were collected, organized, and consolidated to generate the data required for analysis.

2.7 Data Analysis Techniques

The collected data were analyzed using frequency count and mode. These descriptive statistical techniques were used to determine the efficiency of the AI Smart Table in terms of voice detection range and dispensing accuracy, as well as its level of acceptability regarding safety and usability.

3. Results and Discussion

3.1 Development and Performance Evaluation of the AI Smart Table

3.1.1 Design and Development of the AI Smart Table with Dry Ingredients Dispenser

The AI Smart Table was successfully designed and developed using stainless steel, food-grade dispensing containers, electronic components, sensors, motors, a microcontroller, and a voice recognition module. The completed prototype features an automated dispensing system, organized storage compartments, voice-command operation, and enclosed electrical components that promote safety and convenience. The system operates by detecting programmed voice commands, processing them through the microcontroller, and activating the dispensing mechanism to release measured

amounts of dry ingredients. Careful construction, programming, calibration, and testing resulted in a prototype capable of accurate dispensing, reliable voice recognition, and user-friendly operation. The completed prototype demonstrates a compact workstation integrating ingredient dispensing, storage, and intelligent control into a single system. The successful integration of hardware and software components demonstrates that automation can improve efficiency and reduce manual effort during food preparation. The system's organized storage, controlled dispensing mechanism, and voice-command interface contribute to a practical workstation suitable for household and small-scale commercial baking. The positive evaluation further confirms that the developed AI Smart Table achieved its intended objectives of functionality, safety, and usability.

3.1.2 Voice Detection Performance

The AI Smart Table demonstrated excellent voice detection performance under different operating conditions. Respondents consistently rated the system with a general mode of 5 (Excellent Range), indicating that it accurately recognized voice commands at close and moderate distances, in noisy environments, from different users, and with rapid response time. These findings confirm that the system maintained reliable voice recognition regardless of common environmental variations encountered during kitchen activities. The findings indicate that the voice recognition system is robust enough for real-world kitchen applications where background noise and varying user distances are unavoidable. This supports previous studies showing that recent developments in automatic speech recognition have significantly improved performance in challenging acoustic environments through advanced deep-learning architectures (Tan et al., 2023; Djeffal et al., 2026; Hu et al., 2025). Likewise, the system's consistent recognition across multiple users agrees with studies demonstrating that modern ASR models can achieve near-human performance and generalize effectively across diverse real-world conditions (Duarte & Colcher, 2024; Zengeni & Bates, 2025). Overall, the results demonstrate that integrating AI voice recognition into kitchen workstations enhances convenience, accessibility, and operational efficiency.

3.1.3 Dispensing Accuracy

The AI Smart Table consistently dispensed yeast, baking soda, and baking powder with measurements closely matching the programmed target values. Only minimal deviations ranging from approximately 0.1 g to 0.4 g were observed across repeated trials, while most measurements clustered around the intended values. These results indicate high precision, repeatability, and controlled dispensing performance for different ingredient types and portion sizes. The high level of dispensing accuracy demonstrates that the automated dispensing mechanism can reliably deliver precise ingredient measurements required for baking applications. The slight variations observed are technically acceptable and may be attributed to mechanical tolerances, sensor sensitivity, and electrical noise during load-cell operation. Similar findings have been reported for automated weighing and smart kitchen systems, where sensor calibration and real-time feedback improve measurement accuracy while maintaining high repeatability (Zhang et al., 2023; Lee & Park, 2024). Minor fluctuations caused by embedded weighing systems and electromagnetic interference have likewise been recognized as normal operational characteristics that do not significantly affect system performance (Kim & Shin, 2024; Gupta et al., 2023). These findings support the AI Smart Table's suitability as a dependable automated kitchen technology capable of improving efficiency and reducing human error during food preparation (Garcia & Thompson, 2024).

3.2 Acceptability of the AI Smart Table

3.2.1 Safety

Respondents rated the AI Smart Table as Highly Acceptable in terms of safety, obtaining a general mode of 5. Strong agreement was observed for electrical hazard prevention, secure wiring, automatic shutdown, and clear operating instructions. Although the use of food-grade materials received a slightly lower rating, respondents still considered this aspect acceptable. Overall, the findings indicate that users have high confidence in the safety features incorporated into the system. These results suggest that the AI Smart Table effectively integrates multiple safety mechanisms essential for automated kitchen equipment. The findings support previous studies emphasizing that embedded monitoring systems, automatic shutdown functions, secure wiring, and insulated electrical designs improve the safety of smart appliances (Park & Lee, 2024; Singh et al., 2023). Likewise, the importance of clear operating instructions is consistent with ISO recommendations for smart home devices, which identify user guidance as an important contributor to both perceived and actual safety (International Organization for Standardization [ISO], 2022). Although respondents expressed slightly less certainty regarding food-grade materials, this may be addressed through clearer product labeling or certification. Overall, the developed system provides a safe and reliable platform for household food preparation.

3.2.2 Usability

The AI Smart Table also achieved a general mode of 5 (Highly Acceptable) for usability. Respondents found the system easy to operate, capable of providing clear feedback, and effective in supporting hands-free operation through voice commands. Storage accessibility and performance consistency received slightly lower but still acceptable ratings, indicating opportunities for further refinement while maintaining an overall positive user experience. The high usability ratings indicate that the AI Smart Table provides an intuitive interface that supports efficient and convenient kitchen operations. These findings agree with studies reporting that user satisfaction with IoT-based appliances increases when

systems provide immediate feedback, intuitive controls, and hands-free interaction (Ahmed & Kim, 2024). Similarly, automation and user-centered interface design have been shown to improve acceptance while reducing the learning curve associated with smart kitchen technologies (Zhang et al., 2023). The slightly lower ratings for storage convenience and performance consistency are common among newly developed smart systems and suggest areas for future optimization (Lee & Park, 2024). Overall, the results confirm that the AI Smart Table is a practical and user-friendly innovation with strong potential for household adoption.

4. Conclusion & Recommendations

The study successfully designed and developed an AI Smart Table with a Dry Ingredients Dispenser using an AI Module and Arduino Nano to provide a convenient, efficient, and hands-free method of dispensing dry ingredients through voice commands. The system demonstrated excellent voice detection performance under different operating conditions, high dispensing accuracy with only minimal acceptable variations, and high levels of safety and usability. Although dispensing smaller quantities showed slight inconsistencies compared to larger measurements, the developed system proved to be functional, reliable, practical, and acceptable for household and small-scale baking applications.

The dispensing mechanism should be further calibrated to improve the accuracy of smaller measurements, and more advanced sensors or control systems may be incorporated to enhance dispensing precision. The voice recognition system should also be improved to support additional commands and different languages or accents. Furthermore, future evaluations should involve a larger number of respondents to further validate the system's performance, while future studies may incorporate additional automation features, such as mobile application integration, to further improve the functionality of the AI Smart Table.

The study was limited to the design, development, and evaluation of an AI Smart Table with a Dry Ingredients Dispenser using voice recognition for dispensing selected dry ingredients. The evaluation involved only a small group of respondents and focused on voice detection, dispensing accuracy, safety, and usability. In addition, slight variations in dispensing accuracy were observed for smaller ingredient measurements due to the limitations of the dispensing mechanism and sensor calibration.

Compliance with ethical standards

The authors declare no conflict of interest, and this study received no external funding. The authors gratefully acknowledge the participation of the selected home bakers and local cake shop owners, particularly the AKHoRR group, as well as the support of the University of Southern Mindanao–Kidapawan City Campus. Participation was voluntary, informed consent was obtained before data collection, and information was gathered using non-invasive questionnaire-based assessments following a demonstration of the AI Smart Table. All responses were treated confidentially, and no personally identifying information was collected or disclosed.

REFERENCES

Alimec. (n.d.). *Dispenser machine for ingredients on pizza's surface*. https://alimec.com/case-history/dispenser-of-various-ingridients/?lang=en

BiGDUG. (n.d.). *Stainless steel workbenches workplace solutions*. https://www.bigdug.co.uk/workshop-flooring-c348/workbenches-c11604/stainless-steel-workbenches-c83409

Busquet, F., Efthymiou, F., & Hildebrand, C. (2024). Voice analytics in real-world environments. *Behavior Research Methods, 56*, 2114–2134. https://doi.org/10.3758/s13428-023-02139-9

Cesarini, V., & Costantini, G. (2024). Reverb and noise as real-world effects in speech recognition models. *Applied Sciences, 14*(23), 11446. https://doi.org/10.3390/app142311446

Cooking School Guide. (2024). *The history of pastry making: A journey through time.*

Crudu, A., & MoldStud. (2024). Voice recognition technology for hands-free product interactions. *Innovative Tech Journal*. https://moldstud.com/articles/p-voice-recognition-technology-for-hands-free-product-interactions

Djeffal, S., Hamza, A., et al. (2026). A robust framework for noisy speech recognition using frequency-guided Swin transformer. *Computer Speech & Language, 98*, 101907. https://doi.org/10.1016/j.csl.2025.101907

Duarte, J. C., & Colcher, S. (2024). Noise-robust automatic speech recognition: A case study for communication interference. *Journal on Interactive Systems, 15*(1), 670–681.

Essfeed. (n.d.). *The future of pastry innovation: AI and automation in baking technology*. https://essfeed.com/the-future-of-pastry-innovation-ai-and-automation-in-baking-technology-the-future-of-pastry-innovation-ai-and-automation-in-baking-technology/

Garcia, M., & Thompson, L. (2024). Automation in smart kitchens: Enhancing accuracy, efficiency, and user experience. *Journal of Food Engineering, 356*, 111234. https://doi.org/10.1016/j.jfoodeng.2024.111234

Gazzard, C. (2021). *The history of pastry*. https://www.greatbritishchefs.com/features/history-of-pastry

Ghai, W., & Singh, N. (2012). Literature review on automatic speech recognition. *International Journal of Computer Applications, 41*(8), 42–44.

Gupta, R., Verma, A., & Singh, K. (2023). Effect of electromagnetic interference on precision weighing sensors in embedded systems. *IEEE Sensors Journal, 23*(15), 17890–17898. https://doi.org/10.1109/JSEN.2023.3287654

Halilović, M., & Gajšek, T. (2015). *Starting points for the development of multi-purpose workbenches for the needs of modern logistics*. https://www.researchgate.net/publication/285597628_Starting_points_for_the_development_of_multi-_purpose_workbenches_for_the_needs_of_modern_logistics#full-text

Hu, H., Niu, T., & He, Z. (2025). A speech recognition method with enhanced transformer decoder. *EURASIP Journal on Audio, Speech, and Music Processing, 2025*, Article 6. https://doi.org/10.1186/s13636-025-00394-6

International Journal for Research in Applied Science and Engineering Technology. (2024). *Role of vending machines in providing public facilities*. https://www.researchgate.net/publication/377019784_Role_of_Vending_Machines_in_Providing_Public_Facilities

Kim, D., & Shin, H. (2024). Noise reduction techniques for load cell measurement systems in embedded applications. *Measurement, 223*, 113456. https://doi.org/10.1016/j.measurement.2024.113456

Lee, S., & Park, J. (2024). Smart kitchen systems with real-time weight feedback for improved food preparation accuracy. *IEEE Access, 12*, 45678–45689. https://doi.org/10.1109/ACCESS.2024.3387654

Li, D., Gao, Y., Zhu, C., Wang, Q., & Wang, R. (2023). Improving speech recognition performance in noisy environments. *Sensors, 23*(4), 2053. https://doi.org/10.3390/s23042053

Lost Art Press. (2021). *Workbenches: 1st–15th centuries*. https://blog.lostartpress.com/category/workbenches/

Manjunath, M. S., Hemanth, K., Raj, T., & Prashanth, J. (2024). *A literature survey on personalized AI-based voice assistant for authentication*. Global Academy of Technology.

Noor, N., & Hussain, S. (2012). Automated food dispensers: A review of their impact on food safety and quality. *Journal of Food Safety, 32*(1), 1–10. https://doi.org/10.1111/j.1945-4472.2011.00279.x

Nutprapha, K. (2024). Using AI-powered speech recognition technology to improve pronunciation and speaking skills. *IAFOR Journal of Education: Technology in Education, 12*(2), 107–120.

OED. (2024). *Oxford English Dictionary*.

PureHistory. (2013). *History of pastry*. https://purehistory.org/history-of-pastry/

RDM Industrial Products. (2020). *Six points to consider when choosing a stainless steel workbench*. https://www.rdm-ind.com/six-points-to-consider-when-choosing-a-stainless-steel-workbench/

Rink, T., & Thibodeaux, M. (2023). *Pastry workbench: Essential tools and techniques for pastry chefs*. Culinary Arts Press. https://workforce.libretexts.org/Bookshelves/Food_Production_Service_and_Culinary_Arts/Introduction_to_Baking_and_Pastries_(Rink_and_Thibodeaux)

Sahin, I. (2006). Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies. *The Turkish Online Journal of Educational Technology, 5*(2), 14–23. https://www.sciepub.com/reference/452222

Sanei Tech Co., Ltd. (2018). *Introduction to dispensers*. https://jp04184544.en.ec21.com/

Sealey. (n.d.). *Stainless steel workbench 2.1 m | AP2184SS*. https://www.sealey.co.uk/product/5637183061/stainless-steel-workbench-21m

Shibley, M., & Benson, J. (2021). Innovations in automated pet feeding systems: A review. *Journal of Animal Science and Technology, 63*(3), 345–356. https://doi.org/10.5187/jast.2021.e45

SRS-i. (2022). *Benefits of stainless steel benches for your business*. https://www.srs-i.com/blog/amazing-benefits-stainless-steel-work-benches/

Tan, K., Mao, W., Guo, X., Lu, H., Zhang, C., Cao, Z., & Wang, X. (2023). CST: Complex sparse transformer for low-SNR speech enhancement. *Sensors, 23*(5), 2376. https://doi.org/10.3390/s23052376

University of Zurich. (2025). *Automatic speech recognition on par with humans in noisy conditions*. *ScienceDaily*.

Wang, R., Liao, J., Wang, B., Zhong, Q., Dong, Y., & Wang, H. (2025). Design and calibration of a precision dispensing machine. *Micromachines, 17*(1), 53. https://doi.org/10.3390/mi17010053

World Obesity Federation. (2015). *The role of vending machines in promoting healthy eating*. https://www.worldobesity.org/resources/policy-documents/the-role-of-vending-machines-in-promoting-healthy-eating

Zengeni, T. G., & Bates, M. P. (2025). Transformer-based end-to-end speech recognition for noisy real-world environments. *National Journal of Speech and Audio Signal Processing, 1*(4).

Zhang, Y., Chen, X., & Li, J. (2023). Design and calibration of a high-precision automatic weighing system based on load cell sensors. *Sensors, 23*(7), 3456. https://doi.org/10.3390/s23073456