Replication of Medi-Sense Box: Development of Sensor-Integrated Medicine Boxto Address Medication Adherence (2025)

Authors: Renzo H. Ocampo, Althea Mae M. Abenojar, Rhico S. Ascaño, Mart Reden R. Blanco, Rhian B. Cablaida, Julianna Claire M. Caramto, Cathleen D. Hermosura, Maria Louisa A. Lim, Rianne Rafi M. Muesco, Ashey H. Vargas, John Bill V. Villasfer

School Year 2025-2026

Research Adviser: Virginia V. Papas

ABSTRACT

In today's fast-paced world, medication adherence is essential for achieving better health outcomes, and the improved Medi-Sense Box addresses this need by enhancing the effectiveness and efficiency of a sensor-integrated medicine reminder system. Building on previous research, the device uses an Arduino, ultrasonic sensor, servo motor, LCD, rechargeable battery, and durable casing to ensure accurate timing, reliable alarms, and continuous operation. Compared to the earlier version, the improved model showed significant advancements in enclosure design, system efficiency, button layout, usability, accessibility, and cost-efficiency, along with better user understanding through the inclusion of a user manual. Testing confirmed rapid battery charging with long operating time, faster sensor response, audible alarms under varying noise conditions, and 100% time accuracy. Overall, the upgraded Medi-Sense Box demonstrated superior functionality, reliability, portability, and user convenience, making it a more effective tool for supporting proper medication adherence.

KEYWORDS: *Medi-Sense box, ultrasonic sensor, enhanced medication adherence, accuracy rate, assistive technology*

ACKNOWLEDGMENT

The completion of this research was made possible through the guidance, support, and encouragement of many individuals and institutions. First, we thank the **Almighty God** for His constant guidance and strength throughout this journey. We extend our sincere gratitude to **Mrs. Virginia V. Papas** and **Ms. Mydel B. Campehios** for their invaluable guidance, constructive feedback, and encouragement, which greatly strengthened this study. We also thank the panelists for their insightful comments and professional expertise that improved the quality of this research.

Our deepest appreciation goes to **Mr. Kemuel Gabriel L. Barrameda**, external consultant and electronics engineering expert, and **Mr. Lowrence Tobias**, internal consultant specializing in industrial education–information technology, for their technical knowledge and support. We are likewise grateful to **Mrs. Rose Gajesan** for her assistance in soldering and for her invaluable guidance in developing the Medi-Sense prototype.

We also acknowledge **Camp Vicente Lim Integrated School** for providing the necessary resources and a supportive academic environment. To the **12 STEM Einstein Family**, our thanks for their encouragement and camaraderie. Finally, we thank **our families and loved ones** for their unwavering support and **the previous authors and researchers** whose works served as the foundation and inspiration for this study.

I. Introduction

Medication adherence, defined as the extent to which patients take medications as prescribed, is essential for achieving positive health outcomes. Poor adherence, particularly among the elderly, individuals with memory impairments, and those with physical limitations, can lead to complications, worsening conditions, and increased healthcare costs. Studies such as Horvat et al. (2024) and Schwartz (2017) noted that many patients struggle to take medications correctly and consistently and that pillboxes can help support adherence.

Sensor-integrated medication boxes have been developed to address these challenges by providing organized compartments, reminders, and improved medication management. However, earlier prototypes, including the original Medi-Sense Box developed by Gamiao et al. (2025), had limitations related to usability and material quality. Building on previous systems such as the one proposed by Zeidan et al. (2018), the current study aims to enhance the device by improving its physical design, portability, and user interface, including the addition of a larger and easy-to-press button to assist elderly users and those with limited hand strength.

The improved Sensor-Integrated Medicine Box incorporated pill-monitoring sensors, programmable alerts, and a microcontroller to support timely intake, track consumption, and generate usage histories. This study evaluated the effectiveness of these enhancements to determine their potential in reducing missed doses and improving overall treatment outcomes.

Statement of the Problem

This study aimed to replicate and improve the functionality of the Sensor-Integrated Medicine Box (Medi-Sense) to guarantee the needs of its target users and enhance medication adherence.

Specifically, the study sought to address the following questions:

1. What are the specific improvements that can affect the following aspects of the Medi-Sense Box compared to the previous material:
    1.1. Physical interface improvement: use of thicker acrylic sheets for a lighter, more durable, and cost-efficient design,
    1.2. Button design enhancement: replacement of small tactile switches with larger, easy-press buttons,
    1.3. Power supply upgrade: integration of rechargeable or replaceable battery system, and
    1.4. User support material: inclusion of a clear and simple user manual for guidance?
2. How do the applied improvements affect the following:
    2.1. Comparison of overall performance,
    2.2. Accessibility,

2.3. Cost-efficiency, and

2.4. Usability of the Medi-Sense Box compared to the initial prototype in terms of:

2.4.1 Sensor Response Time,

2.4.2 Alarm Audibility, and

2.4.3 Time Alarm Accuracy?

3. Based on the results, what conclusions can be made?

Scope and Limitation

The study centers on the development of a physical interface and evaluation of the Medi-Sense Box's features and its ability to remind individuals to take their medication on time with ease of use. The study was limited to assessing the effectiveness of the Medi-Sense Box for pill-based medication, excluding different types of medicine. It focused on how well the device reminded users to take their medication at the correct time. The testing was conducted within Camp Vicente Lim.

II. METHODOLOGY

This section describes the methodology used in the study, including the conceptual framework, research methodology flowchart, system diagrams, materials costing, and Arduino IDE codes. These elements explain how the system was designed, assembled, and implemented to achieve the objectives of the study.

Conceptual Framework of the Study

The conceptual framework for this replicated study is based on the Input–Process–Output (IPO) model, which provides a structured approach for understanding the development of the Medi-Sense Box. This model organizes the project into three key stages: defined inputs, systematic processes, and the resulting functional output.

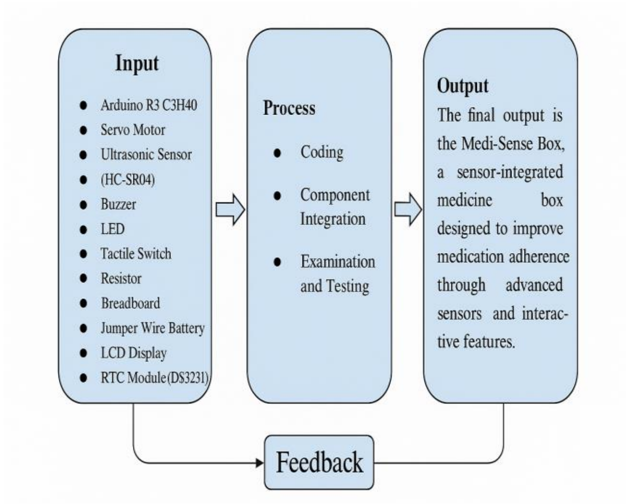

Figure 1. Input-Process-Output Method (IPO Method)

The product is the Medi-Sense Box, a sensor-enabled medicine box. Figure 1. depicts the thought process, beginning with input materials like the Arduino, servo motors, ultrasonic sensors, rechargeable battery, and other electrical components from their assembly, coding, and testing to the product of a working Medi-Sense Box that will encourage medication compliance through increased readability, better structure, and interactive user-friendly functions. This flowchart clearly shows the systematic approach used in constructing the device, emphasizing the stages of systematic planning, integration, and testing necessary to come up with a good and efficient product.

Research Methodology Flowchart

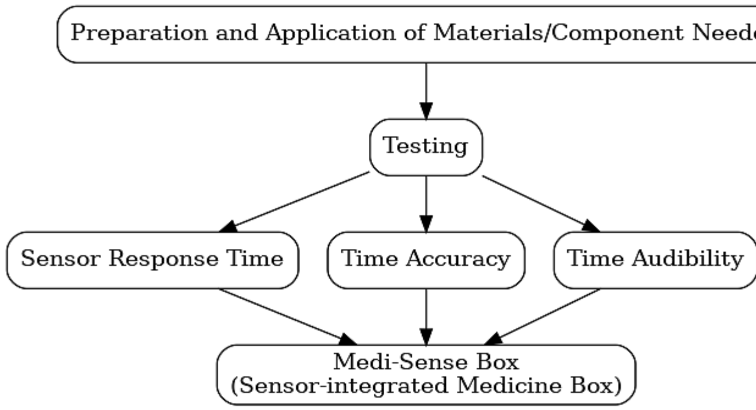

Figure 2. Research Methodology Flowchart

Figure 2 presents the Sensor-Integrated Medicine Box, named Medi-Sense, which was subjected to testing with respect to (1) Sensor Response Time, (2) Time Accuracy, and (3) Time Audibility during its application. This blueprint contributes to the product by clearly outlining the placement and interaction of Medi-Sense's components, enabling consistent assembly and accurate testing. It ensures that the device's sensor response time, time accuracy, and time audibility can be evaluated reliably, thereby supporting the overall effectiveness and reliability of the system.

Wiring Diagram of the System

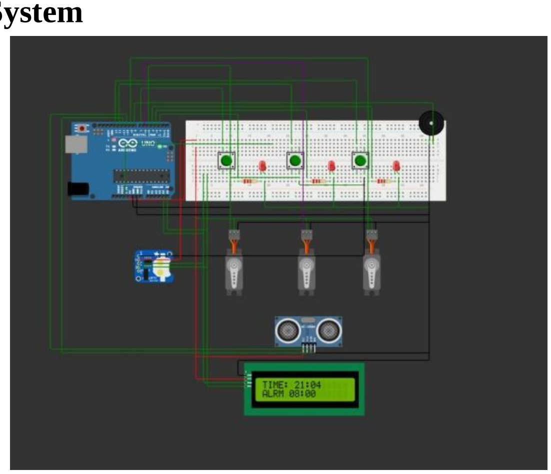

Figure 3. Wiring Diagram of the System

Figure 3 illustrates the complete Arduino-based alarm and automation system, with the Arduino UNO serving as the main controller that supplies power and manages all components. The RTC module and 16×2 LCD share I2C lines to display accurate time and alarm status, while LEDs indicate system states. Push buttons enable time setting, system control, and alert acknowledgment, and a buzzer provides audible alarms. Servos connected to PWM pins perform mechanical actions, while the HC-SR04 ultrasonic sensor detects distance or motion. All components share a common ground, ensuring reliable and coordinated system operation.

Pictorial System Diagram

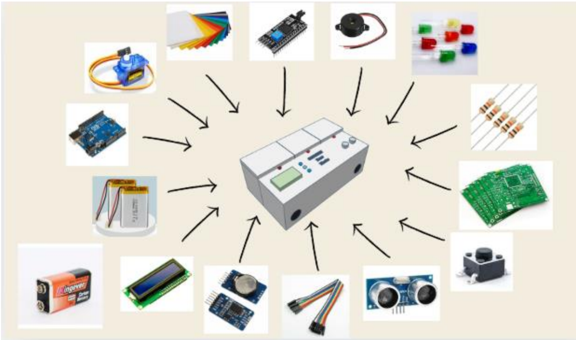

Figure 4. Pictorial System Diagram

Figure 4 presents the various electronic and structural components assembled to create the sensor-integrated medicine box. These include the Arduino Uno, servo motor, HC-SR04 ultrasonic sensor, buzzer, LEDs, tactile switch, resistors, breadboard, jumper wires, power source, LCD display, DS3231 RTC module, battery, and acrylic sheets. Together, these materials enable the device to incorporate technological functions into a conventional medicine box, thereby enhancing patient medication adherence.

III. RESULTS

The findings, analysis, and interpretation of the information acquired from the device's numerous tests, experiments, and assessments are presented in this part. A description of the results from several aspects of the study's goals is also included in this section.

Table 1. Comparison of Enclosure Materials for the Medi-Sense Box

Criteria	Previous Acrylic Sheets	Quality Acrylic Sheets	Observation
Acrylic Sheet Size	2x2 mm	3x3 mm	Better structural support
Weight	Light	Moderate	Improved stability

Thickness	Thin	Thick	Increases rigidity
Durability	Moderate	High	Better durability and impact resistance
Portability	Poor	Good	Easier to carry
Overall Design Efficiency	Low	High	Improved design

Table 1 highlights the improved enclosure design of the Medi-Sense Box through the use of high-quality acrylic sheets. Increasing the sheet size and thickness enhanced structural support, impact resistance, and overall durability, while improving portability from poor to good despite a slight increase in weight that contributed to better stability. As a result, overall design efficiency improved from low to high, effectively addressing previous design limitations. These enhancements are supported by Han et al. (2024), who emphasized acrylic's durability and cost-efficiency, and Seo et al. (2023), who underscored its safety, design flexibility, and user-friendly qualities in medical applications.

Table 2. Comparison and Test Results of Button Designs

Criteria	Previous small tactile switches used in the Medi-Sense Box	Current easy-press, slightly larger-sized buttons of the Medi-Sense Box	Observation
Button Size	6x6x4.3 mm	6x6x6 mm	Larger button easier to locate
Required Press Force	Medium	Low	Less force needed
Ease of Pressing	Moderate	Easy	Improved usability
Comfort	Poor	Good	Less finger strain
Overall Usability	Poor	Excellent	Enhanced Design

Table 2 indicates the comparison and test results of button design. The researchers found that the original small buttons (6×6×4.3 mm) were hard to use. They were difficult to find and required too much pressure to press, which made the device uncomfortable for the user. To fix this, we switched to slightly taller, easier-to-press buttons (6×6×6 mm). Although the size change was small, it made a huge difference. The device is now much more pleasant and user-friendly. By increasing the button height to 6 mm, the design addressed both dimensions of the Liao et al. (2020) study: the taller profile provided a clearer visual cue for the user to find the controls, while the reduced pressure requirement improved the tactile interaction. Because of this change, the usability rating improved from "Poor" to "Excellent."

Table 3. Rechargeable Battery Test

Battery	Battery Life	Charging Duration	Observation
Lithium Polymer Battery	11 hrs and 25 mins	2 hrs and 34 mins	Efficient charging speed with stable endurance
	12 hrs	2 hrs and 35 mins	Consistent performance and charging reliability
	3 days (Power Saving Mode)	2 hrs and 35 mins	Significantly extended battery life with rapid recharging

Table 3 outlines test results for a lithium polymer battery as part of a power supply upgrade plan focused on integrating rechargeable or replaceable battery systems. The first set of measurements demonstrates strong performance, with the battery delivering a total runtime of 11 hours and 25 minutes when fully charged and requiring only 2 hours and 34 minutes to reach full capacity from an empty state. This observation of "rapid charging endurance" indicates that the battery not only supports fast charging but also maintains reliable functionality and longevity under such conditions. These results are consistent with the findings of Liang et al. (2019), who emphasized that rechargeable batteries serve as the primary energy source of portable electronic devices and play a critical role in sustaining performance stability, particularly in applications where continuous operation and minimal downtime are essential.

Table 4. Comparison of User Support Materials for the Medi-Sense Box

Criteria	Previous Version (No Manual)	Current Version (With User Manual)	Observation
Availability of Manual	None	Printed Manual Included	User guidance is now provided
Ease of Understanding	Difficult	Easy	Instructions are clear and simple
Setup Time	Long	Short	Users can set up the device faster
Error Rate During Use	High	Low	Fewer mistakes occur with guidance
Learning Time	Long	Short	Manual shortens the time it takes to learn

Overall Usability	Poor	Good	Usability significantly improved

Table 4 shows the limitations of the previous device by providing a structured and easy-to-use manual. The manual was designed using simple language and visual cues to guide users in device setup and medication reminders. This helps to improve and make the device easier to understand, reduce user errors, and shorten the setup and learning time, particularly for elderly people who have difficulty interpreting medical instructions without the guidance of others. This is supported by the study of Berthenet et al. (2016). According to their study among elderly outpatients, 50 of 76 tested pharmaceutical pictograms reached over 67% comprehension, validating that adding a guidance manual and pictogram could increase medication adherence and reduce errors.

Table 5. Comparison of Overall Performance of the Medi-Sense Box

Performance Indicator	Initial Prototype	Improved Medi-Sense Box	Observation
Sensor Response Time	Moderate	Fast	Improved responsiveness
Alert Accuracy	Moderate	High	More reliable alerts
System Reliability	Moderate	High	Fewer system errors
Power Stability	Low	High	Consistent operation
Overall Performance	Fair	Excellent	Performance significantly improved

Table 5 shows that the new Medi-Sense prototype is much better than the original one. The sensors now respond faster, and the alerts are much more accurate with fewer errors. Power stability moved from "Low" to “High,” which keeps the device running without stopping. Because of this major improvement, the overall performance jumped from "fair" to “excellent,” proving that the new Medi-Sense is more durable, dependable, and stronger. According to Saraswathi et al. (2023), a smart medicine box with sensors could significantly improve medication compliance; this proves that the Medi-Sense can really bring changes in the users.

Table 6. Accessibility Comparison of the Medi-Sense Box

Accessibility Factor	Initial Prototype	Improved Medi-Sense Box	Observation
Button Size	Small	Medium	Easier to press

Ease of Handling	Difficult	Easy	Improved portability
User Guidance	None	With manual	Better user understanding
Time of Learning	Slow	Fast	Faster adaptation
Accessibility Level	Low	High	Accessibility enhanced

Table 6 shows that the improved Medi-Sense Box enhanced usability and accessibility by upgrading from small to medium-sized buttons, making the device easier to press and handle. The addition of a user manual significantly reduced learning time and improved user understanding, while improvements in design increased portability and overall accessibility from low to high. Designed for users with limited motor skills and minimal technical knowledge, its lightweight acrylic casing supports ease of handling and independent use, particularly among elderly users. These design features are supported by Horvat et al. (2024), who emphasized minimizing physical and cognitive barriers, and Saraswathi et al. (2023), who highlighted the role of sensor-based automation and clear guidance in improving accessibility and medication adherence.

Table 7. Cost-Efficiency Comparison of the Medi-Sense Box

Cost Factor	Initial Prototype	Improved Medi-Sense Box	Observation
Enclosure Material	Lower	High	Improved stability
Battery Replacement	Not rechargeable	Rechargeable	Reduced recurring cost
Overall Cost-Efficiency	Low	Moderate	More economical over time

Table 7 compares the cost-efficiency of the initial prototype and the improved Medi-Sense Box. Although the improved version used higher-quality materials and required a higher initial cost, its enhanced durability and use of a rechargeable battery significantly reduced long-term expenses. In contrast, the initial prototype relied on a non-rechargeable battery, resulting in frequent replacements and higher recurring costs. Overall, the improved Medi-Sense Box demonstrated high cost-efficiency, consistent with Schwartz (2017), who emphasized that durable assistive medication devices reduce costly medication errors and support long-term savings.

Table 8. **First Sensor Response Time Test**

Sensor	Trial	Expected	Actual	Difference	Observation

	No.	Response Time	Response Time		
Ultrasonic Sensor (HC-SR04)	1	1 second	0.42 seconds	0.58	Faster than expected response
	2	1 second	0.46 seconds	0.54	Faster than expected response
	3	1 second	0.29 seconds	0.71	Faster than expected response

Table 8 shows that in the first sensor response time test, Trial 1 recorded an actual response time of 0.42 seconds, followed by 0.46 seconds in Trial 2 and 0.29 seconds in Trial 3. Each actual response time responded faster than the expected response time of one second in all trials. This shows that the ultrasonic sensor (HC-SR04) was able to detect user interaction and support timely system actions.

Table 9. Second Sensor Response Time Test

Sensor	Trial No.	Expected Response Time	Actual Response Time	Difference	Observation
Ultrasonic Sensor (HC-SR04)	1	1 second	1 second	0	Matched expectation
	2	1 second	0.44 seconds	0.56	Faster than expected response
	3	1 second	0.67 seconds	0.33	Fast than expected response

Table 9, which is the second sensor response time test, trial 1 met the expected response time of one second, while trial 2 and trial 3 responded faster at 0.44 and 0.67 seconds, respectively. The results indicate consistent sensor performance under repeated testing conditions.

Table 10. First Alarm Audibility Test (Lower Environmental Noise)

Trial No.	Distance (Meter)	Environmental Noise (Decibel)	Alarm Sound Level	Observation

			(Decibel)	
1	1 m	35dB	67 dB	The alarm was loud and distinctly heard.
2	3 m	36 dB	58 dB	The alarm was audible, but marginally decreased as a distance grew farther away.
3	5 m	43 dB	52 dB	The alarm was weak but still audible.

Table 10 presents the results of the alarm audibility test conducted in a low-noise home environment. At 1 meter, the alarm sound was clearly distinguishable from environmental noise, while at 3 meters it remained audible despite a slight decrease in clarity. At 5 meters, although the alarm intensity further decreased and background noise increased, the alarm was still audible. Overall, the findings indicate that alarm audibility decreases as distance increases, even under low environmental noise conditions.

Table 11. Second Alarm Audibility Test (Higher Environmental Noise)

Trial No.	Distance (Meter)	Environmental Noise (Decibel)	Alarm Sound Level (Decibel)	Observation
1	1 m	44 dB	55 dB	The alarm was sounded a little louder.
2	3 m	33 dB	53 dB	The alarm was audible, but weaker as a result of the elevated environmental sound.
3	5 m	42 dB	51 dB	The alarm was audible, but less clear because of elevated distance.

Table 11 presents the results of the alarm audibility test conducted under higher environmental noise conditions. At 1 meter, the alarm remained loud and clearly distinguishable from background noise, while at 3 meters it was still audible but perceived as weaker due to increased distance. At 5 meters, although the alarm sound level further decreased and environmental noise increased, the alarm remained audible but less clear. Overall, the results demonstrate that alarm audibility decreases as the distance from the device increases, regardless of variations in environmental noise levels.

Table 12. Time Accuracy Test

Trial No.	Schedules Time	Actual Activation Time	Time Difference	Classification	Remarks
1	6:00 AM	6:00 AM	0	TP (True Positive)	Accurate
2	10:00 AM	10:00 AM	0	TP (True Positive)	Accurate
3	2:00 PM	2:00 PM	0	TP (True Positive)	Accurate
4	No Reminder	No Alarm	N/A	TN (True Negative)	Correctly Silent
Accuracy	100%				

Table 12 shows the Time Accuracy Test. The sample span is around 4 hours, and the scheduled times are 6:00 AM, 10:00 AM, and 2:00 PM. All of the tests accurately activated at the scheduled times with no time difference, which concluded as True Positive (TP) classifications. For the last test, there was no scheduled reminder; therefore, no alarm rang, and no time difference was available. This resulted in a True Negative (TN) classification, indicating that the system was correctly silent. Overall, all tests accurately depicted time accuracy with no allowances, which resulted in a 100% Time Accuracy Test.

IV. DISCUSSION

The Medi-sense Box was successfully developed to support proper medication management, particularly for elderly users and individuals with chronic illnesses. It is integrated with an Arduino-based sensor system and an LCD display. Similar to the previous studies, the device incorporates an HC-SR04 ultrasonic sensor to detect user presence, an accurate alarm schedule using RTC (Real-Time Clock), and audible alarms under various environmental conditions.

Building upon the recommendation of the previous researchers, this study introduced several key improvements, including the addition of a structured, easy-to-use manual and the use of rechargeable batteries and an acrylic sheet for the base material. These enhancements improved usability, portability, and durability while also making the device cost-efficient.

For instance, the Medi-sense box is intended to help patients adhere to their medication regimens and improve their healthy lifestyle. This is especially important for elderly patients and patients who have trouble taking their medications on time. This ensures and prioritizes the patient's well-being. It is a user-friendly medication box that will help patients with an understandable manual and an accessible interface that consists of sensors and an audible sound to help prevent missed doses. Additionally, many people will have access to a portable medicine box that they can bring with them wherever they go, especially while they're not at home. Particularly for elderly patients and others who have trouble hearing sounds, the unique medicine box has increased sound audibility.

Recommendations

To further enhance the functionality and usability of the Medi-Sense Box, several improvements are recommended based on the study’s results and findings. The use of 3D printing may be explored to improve the durability and overall design of the device casing. Enhancing the system’s mobility and automation is also suggested to promote easier and more efficient operation. Additionally, extending the buzzer alarm duration may improve alert effectiveness and ensure timely user response. Redesigning the physical interface into a more organized and visually appealing layout could further enhance usability and user experience. Lastly, testing the device with actual participants is highly recommended to evaluate its performance, reliability, and overall effectiveness.

References

Abusuwaleh, S. (2025, January 23). Arduino in sleep mode to save power. Regent Electronics. https://regentelectronics.com/microcontrollers/arduino-in-sleep-mode-to-save-power

Berthenet, M., Vaillancourt, R., & Pouliot, A. (2016). Evaluation, modification, and validation of pictograms depicting medication instructions in the elderly. *Journal of Health Communication, 21*(6), 648–657

Bridges, D., Pitiot, A., MacAskill, M. R., & Peirce, J. W. (2020). The timing mega-study: comparing a range of experiment generators, both lab-based and online. PeerJ, 8, e9414. https://doi.org/10.7717/peerj.9414

Gamiao, A. D., Alcantara, V. S., Alipio, Z. L. S., Dimapilis, A., Garzon, D. K. F., Landicho, J., Lorenzo, K., Mamalayan, M. H., Micosa, S. M. P., Sabas, A. B., & Sumagui, H. P. (2025). *Medi-Sense Box: Development of a sensor-integrated medicine box to address medication adherence* [Unpublished research project]. Camp Vicente Lim Integrated School, Laguna, Philippines.

Godha Krishna, M., Joshikka Sri, E., Keerthanna, R., & Nithya, K. (2023). An IoT-based smart pill dispenser with health monitoring. International Research Journal of Engineering and Technology (IRJET), 10(10), 1054–1058. https://www.irjet.net/archives/V10/i10/IRJET-V10I10130.pdf

Han, B., Liu, X., Yen, C. C., & Zheng, C. (2024). E-acrylic: Electronic-acrylic composites for making interactive artifacts. *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*, 1–15.https://doi.org/10.1145/3613904.3642010

Hekkert, P. (2025, May 20). Acrylic thickness vs strength: How thickness impacts acrylic strength and durability. MaterialDif. https://materialdif.com/acrylic/acrylic-thickness-vs-strength

Horvat, M., Eržen, I., & Vrbnjak, D. (2024). Barriers and facilitators to medication adherence among the vulnerable elderly: A focus group study. *Healthcare, 12*(17), Article 1723.https://doi.org/10.3390/healthcare12171723

Jha, P. R., Chen, X., & Wang, X. (2023). Preliminary usability evaluation of personal medical devices towards better home healthcare. In Proceedings of the International Symposium on Human Factors and Ergonomics in Health Care (Vol. 12, No. 1, pp. 125–129). SAGE Publications.

Laroche, C., Giguère, C., Vaillancourt, V., Roy, K., Pageot, L.-P., Nélisse, H., &Nassrallah, F. (2018). Detection and reaction thresholds for reverse alarms in noise with and without passive hearing protection. International Journal of Audiology, 57(sup1), S51–S60. https://doi.org/10.1080/14992027.2018.1453748

Liang, Y., Zhao, C., Yuan, H., Chen, Y., Zhang, W., Huang, J., Yu, D., Liu, Y., Titirici, M., Chueh, Y., Yu, H., & Zhang, Q. (2019). A review of rechargeable batteries for portable electronic devices. *InfoMat, 1*(1), 6–32.https://doi.org/10.1002/inf2.12000

Liao, Y. C., Kim, S., Lee, B., &Oulasvirta, A. (2020). Button simulation and design via FDVV models. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1–14).https://arxiv.org/abs/2001.04352v2

Li, J., Wang, J., & Huang, Y. (2024). Effect of mechanical keyboard switch and backlight status on typing performance and user experience. Electronics, 13(21), 4205. https://doi.org/10.3390/electronics13214205

Nasir, Z., Asif, A., Nawaz, M., & Ali, M. (2023). Design of a smart medical box for automatic pill dispensing and health monitoring. Engineering Proceedings, 32(1), 7. https://doi.org/10.3390/engproc2023032007

New advances in wireless rechargeable battery research target reduction of surgical risks. (2023, June 15).*AmericanHHM*.https://www.americanhhm.com/technotrends/new-advances-in-wireless-rechargeable-battery

Paganin, G., Margheritti, S., Farhane-Medina, N. Z., Simbula, S., & Mazzetti, G. (2023). Health, stress and technologies: Integrating technology acceptance and health belief models for smartphone-based stress intervention. *Healthcare, 11*(23), Article 3030.https://doi.org/10.3390/healthcare11233030

Saraswathi, S., Sangeetha, R., & Sangeetha, S. (2023). IoT-based patient health monitoring and smart medicine box. *International Journal of Creative Research Thoughts*, *11*(3), 255–259.https://ijcrt.org/papers/IJCRT2303317.pdf

Schwartz, J. K. (2017). Pillbox use, satisfaction, and effectiveness among persons with chronic health conditions. *Assistive Technology*, *29*(4), 181–187. https://doi.org/10.1080/10400435.2016.1219884

Seo, R., & Seo, R. (2023, November 24). Acrylic sheet used in medical and science equipment. *Content Optimization*.https://contentoptimization.com.au/acrylic-sheet-uses-in-medical-and-science-equipment/

Srigiri, D., Sushilendra, Shirwal, S., Palled, V., Sreenivas, A. G., &Pampanna, Y. (2025). Performance of ultrasonic and infrared sensors for detection of the target for development of sensor based orchard sprayer. Journal of Scientific Research and Reports, 31(2), 74–81. https://doi.org/10.9734/jsrr/2025/v31i22826

Staff. (2016, November 16). Visual instructions improve drug adherence, safety for older patients. *U.S. Pharmacist*.https://www.uspharmacist.com/article/visual-instructions-improve-drug-adherence-safety-for-older-patients

Yeh, P. (2025). Exploring touchscreen interface design for home health management products: Effects of button size and position on elderly users. *Perceptual and Motor Skills*. Advance online publication.https://doi.org/10.1177/00315125251345594

Zeidan, H., Karam, K., Abi, R., Hayek, A., & Boercsoek, J. (2018). Smart medicine box system.https://doi.org/10.1109/imcet.2018.8603031