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MARTIBO: SMART TISSUE DISPENSER WITH MONITORING DASHBOARD

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Abstract— Martibo is a smart tissue dispenser leveraging IoT technology to enhance hygiene and optimize facial tissue usage. It features a proximity sensor for touchless dispensing, a load cell sensor for monitoring tissue stock, and a voltage sensor for battery tracking. Data processed by an ESP32 microcontroller is displayed on an LCD screen and transmitted via a smartphone application, enabling real-time notifications. With an average tissue stock detection error of 0.11%, an average voltage measurement error of 1.2% and a notification response time of 1.2s. Martibo ensures hygiene, prevents stock shortages, and improves convenience.

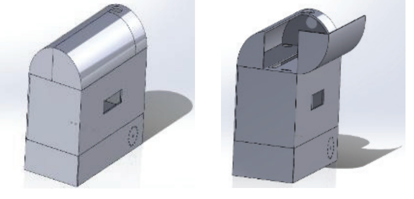
I. Introduction

The increasing demand for convenience and hygiene [1] has highlighted the need for efficient and automated solutions [2]. The advancement of Internet of Things (IoT) technology has significantly improved the development of automated systems for hygiene management [3-7]. Despite the growing use of tissues in shared environments, issues like tissue wastage, stock shortages, and contamination from exposed tissues remain prevalent [8-10]. The study by [8] demonstrates the utility of IoT in reducing contact and minimizing pathogen spread through touchless dispensing systems. Similarly, the Intelligent Tissue Dispenser System (iTDS) developed by [10] utilizes ultrasonic sensors and an IoT-enabled microcontroller to monitor tissue stock levels and notify users in real-time.

This study introduces Martibo, a novel smart tissue dispenser system designed to address the issues of conventional tissue dispenser. It combines touchless dispensing, real-time stock monitoring, and a user-friendly smartphone interface. By leveraging IoT technology and integrating sensors such as proximity and load cells, Martibo ensures efficient tissue usage, timely notifications, and improved hygiene.

II. Methodology

This study designed Martibo as an integrated solution for automated tissue dispensing and real-time monitoring. Figure 1 depicts the 3D model of Martibo featuring a sleek, rectangular body with a curved upper cover that facilitates tissue dispensing. It includes a compact display panel for user interaction or status indication and ventilation slots on the side, possibly for electronic components.



(a) (b)

Figure 1: 3D Design

The block diagram shown in Figure 2 represents the architecture of Martibo. The input consists of a load cell sensor to detect the weight of the tissue stack and a proximity sensor to identify user interaction. The ESP32 DevKit V1 processing unit receives sensor data and communicates with the cloud for remote monitoring. The outputs include a servo motor to automate tissue dispensing, an LCD (16 x 2) with I2C for displaying relevant information and integration with the Blynk platform for mobile app control. Figure 3 shows the electronic circuits of Martibo.

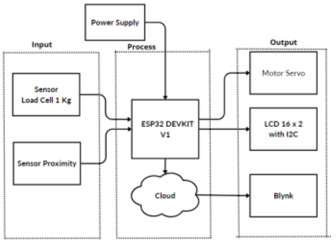


Figure 2: System Block Diagram

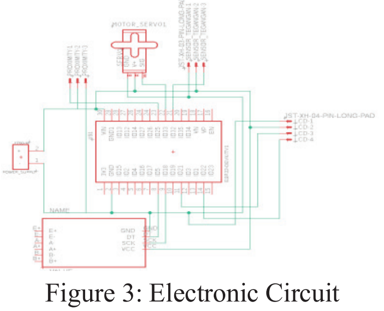
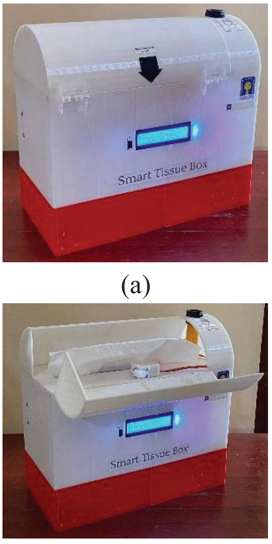


Figure 3: Electronic Circuit

The Martibo system operates seamlessly. The proximity sensor triggers touchless dispensing. The load cell sensor ensures accurate stock monitoring. The voltage sensor tracks the battery capacity. The ESP32 microcontroller processes and transmits this data to the LCD and smartphone application, delivering real-time feedback and notifications. This comprehensive design ensures Martibo meets user needs in various environments, including offices, schools, and public facilities.

III. Results and Discussion

Figure 4 presents the Martibo system, while Figure 5 shows the user interface. The system was evaluated based on its accuracy, reliability, and responsiveness. Key performance metrics included the precision of tissue stock measurement and battery voltage reading, the response time for notifications, and the effectiveness of the touchless dispensing mechanism.



(a)

(b)

Figure 4: Martibo Smart Tissue Box when closed (a) and open (b)

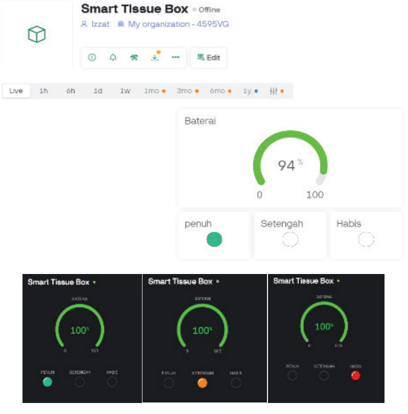


Figure 5: User Interface

Table 1 shows that the load cell sensor accurately measured tissue stock levels. The system recorded an average RMSE of 0.11%. This measurement ensures timely notifications for tissue refills, addressing the frequent issue of tissue shortages. Figure 6 shows an example of user notification. Notifications regarding tissue stock and battery levels were delivered within an average response time of 1.2s. This near-instant feedback ensures proactive maintenance, preventing operational downtime. The seamless synchronization between the microcontroller and the application highlights the effectiveness of the system's IoT integration.

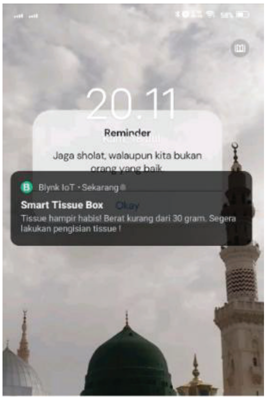


Figure 6: User Notification

Table 2 shows that the voltage sensor provided high-precision real-time battery status updates. The average RMSE is 1.2%. During tests simulating extended use, the system successfully triggered low-battery notifications when the battery capacity dropped below 20%. This feature ensures uninterrupted operation by allowing timely recharging, making the system suitable for high-demand environments like hospitals or offices.

Table 1: Tissue Stock Measurement

No	Actual weight (g)	Sensor reading (g)	Error (g)	RMSE (%)
1	65	64.86	0.14	0.11
		64.90	0.10	
2	190.3	190.36	0.06	0.1
		190.40	0.10	
3	124.3	123.84	0.46	0.21
		123.85	0.45	
4	179.9	179.99	0.09	0.08
		179.99	0.09	
		179.95	0.05	
5	71.6	71.69	0.09	0.08
		71.68	0.08	
6	108.3	108.18	0.12	0.12
		108.11	0.19	
		108.14	0.16	
			RMSE Average	0.11

Table 2: Battery Voltage Measurement

No	Actual Voltage (V)	Sensor reading (V)	Error (V)	RMSE (%)
1	7.41	7.46	0.05	1
		7.48	0.07	
2	7.36	7.40	0.04	0.8
		7.39	0.03	
3	7.0	7.05	0.05	1
		7.06	0.06	
4	6.44	6.50	0.06	1.2
		6.52	0.08	
5	5.99	6.05	0.06	1.2
		6.05	0.06	
6	5.63	5.72	0.09	2
		5.73	0.1	
			RMSE Average	1.2

Table 3 shows that the proximity sensor reliably detected hand movements. The dispenser lid opened consistently within 2.05s of detection, maintaining about 7s before automatic closure. This touchless mechanism enhances hygiene by minimizing physical contact and operates without misfires, even in rapid, successive hand movements. The smooth operation of the servo motor further demonstrated the system's ability to handle continuous use without mechanical failures.

The results demonstrate that Martibo is a reliable and efficient system for tissue management in shared environments. The high precision of the load cell sensor ensures accurate stock monitoring, addressing the common issue of tissue shortages in public facilities. The touchless dispensing mechanism, enabled by the proximity sensor, significantly reduces the risk of contamination, aligning with hygiene requirements.

Table 3: Proximity Sensor Responsiveness Measurement

No	Proximity Sensor Response (s)	Tissue Box Open Time (s)	Tissue Box Close Time (s)
1	2.09	7.22	0.68
2	1.5	7.93	0.16
3	2.5	7.01	0.10
4	1.91	6.68	0.11
5	2.67	7.02	0.17
6	2.81	6.84	0.27
7	1.21	7.54	0.18
8	1.45	7.15	0.16
9	2.10	7.88	0.22
10	2.26	7.02	0.10
Average	2.05	7.22	0.21

The integration of a voltage sensor and a smartphone application enhance user convenience by providing timely notifications for battery recharging and stock refilling. The low notification response time of 1.2s ensures real-time feedback, critical for environments where continuous operation is essential. These features collectively make Martibo a comprehensive solution for managing hygiene-sensitive products.

While the system performs well, certain limitations warrant consideration. For instance, the dependency on a stable Wi-Fi connection for notifications may pose challenges in areas with poor connectivity. Additionally, optimizing energy consumption to extend battery life further could enhance the system's portability.

IV. Conclusion

Martibo integrates IoT technology with automated tissue dispensing and real-time monitoring to deliver an efficient and hygienic tissue management solution. The system demonstrated high accuracy, ensuring timely notifications and preventing shortages. Its touchless dispensing mechanism enhances hygiene by minimizing physical contact, while the voltage sensor tracks battery status to ensure uninterrupted operation. The user interface offers real-time updates, ensuring seamless user interaction.

Future developments will focus on enhancing system robustness and multi-dispenser management under a unified dashboard. Features to minimize tissue wastage will align Martibo with environmental sustainability goals.

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