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Touch-free tissue dispensing device

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ABSTRACT

In this paper, an innovative solution for the everyday issue of tissue dispensing is presented. With billions of tissues distributed daily, the current dispensers often face challenges, as revealed in studies of frequently damaged units. The primary objective was to enhance this fundamental item, aiming to simplify users' lives. The key innovation lies in granting users control over the tissue dispenser's rolling mechanism. Introducing the Arduino UNO microcontroller-powered smart tissue dispenser. Operated by a stepper motor, the dispenser reacts to the user's needs. Activation occurs when the infrared sensor detects hands, prompting the motor to release the appropriate amount of tissue. It's like witnessing magic, yet it's simply the ingenuity of technology at play. The software for the Arduino UNO, serving as the project's controller, is compiled, and uploaded using the Arduino IDE. The performance of this automatic tissue dispenser indicates success in addressing common issues and facilitating effortless tissue retrieval.

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1. INTRODUCTION

The highlights the issue of the company's excessive spending on tissue purchases, which may indicate overspending because of ineffective inventory control and tissue utilization. The reference to the waste of extra or unneeded tissue also draws attention to the possibility of monetary losses as well as the effects on the environment. Improved management techniques are therefore desperately needed to maximize tissue acquisition, utilization, and inventory control with the goal of reducing waste and unnecessary costs. The automatic tissue dispenser presented in this study represents a forward-thinking solution to the challenges associated with traditional tissue dispensers. With thousands of tissues distributed daily, the need for an efficient and user-friendly system is paramount. This innovative project addresses the challenge of excessive toilet paper usage, aiming to limit production and reduce waste. The primary focus is on controlling individual consumption and promptly notifying cleaning staff when toilet paper is depleted. The significant financial investment the company made in purchasing toilet paper serves as the inspiration for this initiative. Without intervention, the company faces the prospect of increased expenses and heightened environmental impact due to the unnecessary disposal of unused tissue.

In contemporary society, there is a growing concern about the diminishing awareness regarding the environmental impact of toilet tissue waste. The indiscriminate use of these products not only contributes to environmental degradation but also poses a threat to the natural habitat of wild plants, as the demand for tissue production leads to deforestation. Some businesses are not aware of the problem, and they only become aware of excessive tissue use when maintenance staff replaces worn-out tissue rolls on a regular basis. The Arduino UNO is a popular microcontroller board that is widely used in various electronic projects and prototyping. The Arduino UNO is versatile and user-friendly, making it a great choice for hobbyists, students, and professionals working on a wide range of projects, from simple blinking light emitting diode (LED) experiments to complex automation systems. Numerous studies have harnessed the creative potential of the Arduino UNO microcontroller, seamlessly integrating its versatile features to breathe life into their systems and projects. The Arduino UNO microcontroller has found its place in numerous academic investigations, proving to be an invaluable asset in diverse systems and experiments. The systems in [1]‒[6] were using an Arduino UNO as their microcontroller. The Arduino serves as the mastermind, overseeing and harmonizing the actions of all other components for efficient coordination. In its role as the central coordinator, the Arduino ensures precise synchronization and communication across all integrated components [3]. This study aims to address these concerns by exploring how consumers can adopt more responsible practices in handling and using tissues. By discussing storage methods and promoting mindful consumption, the goal is to contribute to a more sustainable approach to this everyday necessity, mitigating the environmental impact associated with toilet paper waste.

In this paper, the previous and present methodologies investigated by researchers were reviewed from a variety of angles, including methodologies used in determining the automatic tissue device. The main objectives of this study are to get insight into how to innovate the tissue dispenser for consumers in most practical way. The remainder of this paper is structured as follows. The theoretical background for this study is discussed in section 2. The methodology is covered in sections 3, results and discussion are discussed in section 4 and finally, the conclusion of this study is covered in section 5.

2. THEORETICAL BACKGROUND

This project focuses on keeping the environment clean and encouraging the community to minimize tissue usage. There are several references from previous work that have been used to support this paper. A touch-less system of water, soap, and self-tissue dispensers was built using an ultrasonic sensor and an Arduino UNO microcontroller as the main components of the system. The Arduino UNO microcontroller oversees the entire system. A system of tissue dispensers was developed by Man *et al.* [7], named the intelligent tissue dispenser system (iTDS). The primary contribution of iTDS lies in its ability to monitor and track the need for toilet tissue refilling. Beyond the realm of tissue dispensers, dispensing technology finds diverse applications, promising a multitude of innovative solutions across various domains. Dispensers are commonly used for dispensing various consumables or products in a controlled manner. Soap dispensers, sanitizer dispensers, water dispensers, and medicine dispensers are a few innovations that show the versatility of dispenser technology. The system in [8]‒[13] create a smart medication dispenser with features like scheduled dispensing, dosage tracking, and automatic prescription refills. The system in [14]‒[17] focus on automatic pill dispenser system to assist people in more effectively controlling how much medication they take since it is critical to take prescription drugs at the recommended dosages and at the recommended times. internet of things (IoT) was implemented in the system in [18], [19] where the systems of medicine dispenser which based on IoT uses smart technologies and internet connectivity to promote prescription adherence and expedite medication management. This results in increased convenience, flexibility, and peace of mind for users and carers. Whereas the system in [20] implement smart features in water dispensers, such as touchless controls, temperature settings, and a notification system for maintenance or filter replacement. In the context of hygiene, an automatic hand sanitizer dispenser with smart features, such as contactless operation and real-time monitoring of sanitizer levels, could be explored, as developed by researchers in [21], [22]. Another dispenser system commonly create by researchers are automatic hand sanitizer dispenser as in [23]‒[26].

Only a few systems are specifically designed to address challenges in tissue dispenser management, making this a unique and underexplored area of innovation. With a scarcity of projects focusing on automatic tissue dispensers, there is a significant opportunity to seize and explore this specific field. This unique circumstance provides an excellent chance to not only delve into innovative projects related to automatic tissue dispensing but also to expand the existing knowledge and capabilities in this domain. It opens the door for pioneering efforts and advancements that can potentially reshape and elevate the landscape of automated tissue dispenser technology.

This study aims to provide a hygienic and convenient method for users to access tissue without physical contact. The device utilizes infrared (IR) sensors to detect the presence of hands. When hands are detected, the device initiates the dispensing mechanism, allowing users to obtain tissue without touching the dispenser. The stepper motor plays a crucial role in the hands-free tissue dispensing device, serving to efficiently roll out the tissue once the device detects the presence of hands. This automated mechanism ensures a seamless and contactless experience for users, enhancing hygiene and convenience in accessing tissue. Simultaneously, the inclusion of a buzzer in the device serves as an alert system. Its primary function is to activate when the device is running low on tissue. This alert system is designed to notify cleaning staff without requiring manual checks. When the buzzer sounds, it signals to the cleaning staff that the device needs a refill, eliminating the need for constant manual monitoring. This dual functionality, combining the stepper motor for tissue dispensing and the buzzer for low tissue alerts, significantly streamlines the workflow for cleaning staff. They are promptly notified when intervention is required, allowing for timely and efficient maintenance of the tissue dispenser. Overall, this integration of automated functions not only enhances the user experience but also optimizes the operational efficiency of the hands-free tissue dispensing device. According to previous work, there is not much work that represents the tissue dispensing system. Prior research has demonstrated the effectiveness of touch-free dispensing devices; however, their primary function-detecting human hands-could use some improvement. To initiate the dispensing process, these sensors must detect hand movements with accuracy and dependability. Selecting the appropriate sensor is essential, considering elements such as detection range, reaction time, interference resistance, and cost. Future touch-free dispensing devices can function even better by choosing the best sensor technology, enhancing the user experience and hygiene in public areas.

The main contribution of this study is to provide a device that uses a more accurate IR sensor compared to previous studies. The difference between this paper and previous work is that the tissue dispensing device used an IR sensor to detect human hands when approaching the device, while previous work utilized an ultrasonic sensor in their system. An IR sensor is a device that detects infrared radiation in its surrounding environment. It works on the principle that most objects emit some level of thermal radiation. An IR sensor is more beneficial for close-range motion detection than an ultrasonic sensor for measuring distances in a specific range. Thus, an IR sensor is a suitable choice for a tissue dispensing device for several reasons, particularly when the device requires close-range motion detection, such as detecting the presence of human hands.

3. METHOD

3.1. Block diagram of system

Figure 1 shows the block diagram of a touch-free tissue dispensing device. This device is a project that uses the Arduino UNO microcontroller. The touch-free tissue dispensing device operates by detecting the presence of hands using sensors, typically infrared sensors. When a user’s hands are detected, the device activates a mechanism, often a motor or similar component, to dispense the tissue without requiring any physical contact. This touch-free functionality enhances hygiene by minimizing the risk of germ transmission and providing a convenient and efficient way for users to access tissue without touching the dispenser.

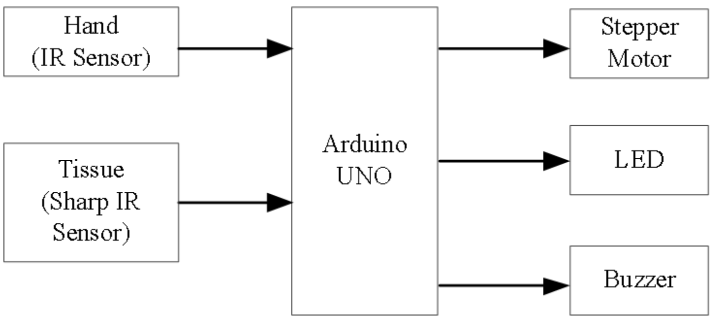


Figure 1. Block diagram of the system

The power supply for this project is facilitated through an adapter, which serves as the energy source to activate the entire system. When the project is powered on, the pivotal role of initiating operation is taken on by the infrared sensor. Positioned strategically, this sensor is designed to detect the presence of a user’s hand within its range. Upon sensing a hand, the infrared sensor translates this information into a digital input signal, sending it to the Arduino UNO. The Arduino UNO, acting as the central processing unit or “brain” of the project, receives this signal and swiftly processes the input. In response, the Arduino UNO generates an electrical signal, which is then directed to the stepper motor. The stepper motor, functioning as the muscle of the operation, responds to the electrical signal by initiating a controlled movement. In this case, the motor is responsible for rolling out the tissue from the dispenser. This entire process, from hand detection to tissue dispensing, is orchestrated seamlessly through the collaboration of the infrared sensor, Arduino UNO, and stepper motor, creating a touch-free and automated user experience. Proteus software was used in this system to provide a simulation process before the system was developed. The functions of every component are clearly outlined and presented in Table 1.

Table 1. Component of the project

No	Component	Function
1	Arduino UNO	Microcontroller to program the specific values for movement of human and distance thus run the system
2	IR sensor	To detect the movement of human
3	Sharp IR sensor	To detect the distance of object
4	Stepper motor	To roll out the tissue
5	LED	LED green ON when device still contain tissue LED red ON when the device running out of tissue
6	Buzzer	To alert staff cleaner to refill the tissue

3.2. Flowchart of touch-free tissue dispensing device

The flowchart of the system is shown in Figure 2. The project initiates its sequence with the IR sensor actively reading and detecting the presence of a user's hand. Once a hand is detected, the information is swiftly communicated to the Arduino UNO. In response, the Arduino UNO sends a signal to the stepper motor, prompting it to engage and dispense tissue to the user. Adding an extra layer of intelligence, the project incorporates a mechanism to detect the presence of tissue within the dispenser. If there is still tissue available, a green LED indicator lights up, providing a visual cue of the adequate tissue supply. Conversely, when the tissue is depleted, a different set of responses is triggered. The system switches to alert mode, with a red LED lighting up to visually signal the absence of tissue. Simultaneously, a buzzer sounds, offering an audible alert. This dual-alert system aims to promptly notify users and, importantly, cleaning staff. For the cleaning staff, the illuminated red LED and the audible buzzer serve as clear indicators that the tissue roll needs replacement. This proactive alert system ensures that the dispenser is always stocked with tissues, contributing to a smooth and uninterrupted user experience while also streamlining the responsibilities of the cleaning staff. The touch-free tissue dispensing device implementation system, which uses an Arduino UNO microcontroller as its brain, is depicted in Figure 3. An Arduino UNO microcontroller board is attached to a number of different components to form the circuit. To be more precise, the Arduino UNO's pins 18, 19, 20, and 21 are connected to an infrared sensor, and pins 24, 25, 26, and 27 are connected to a Sharp infrared sensor. It is underlined that for the circuit to operate properly, all component connections-including those to the ground and power sources-must be made appropriately.

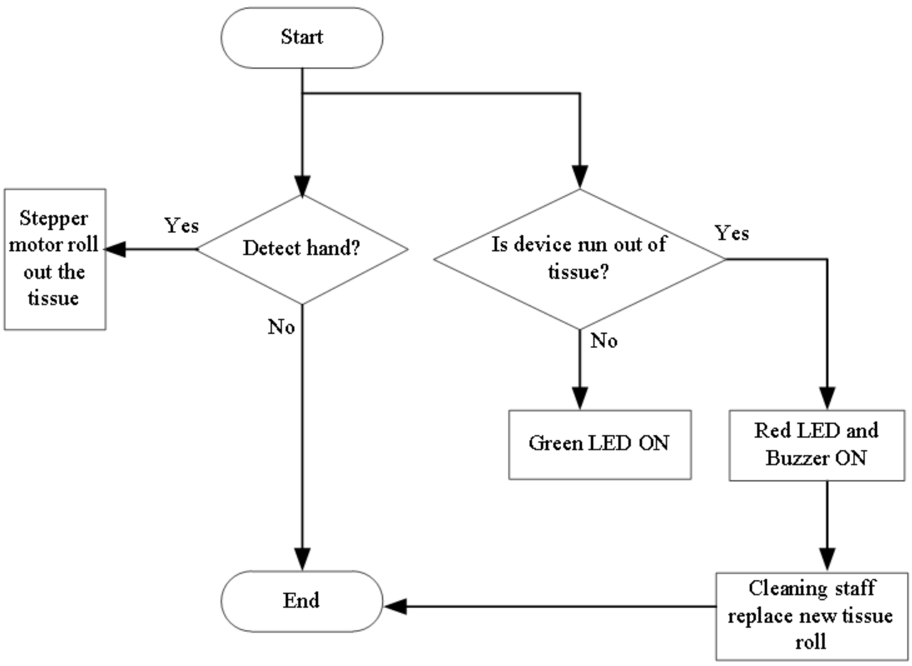


Figure 2. Flowchart of the system

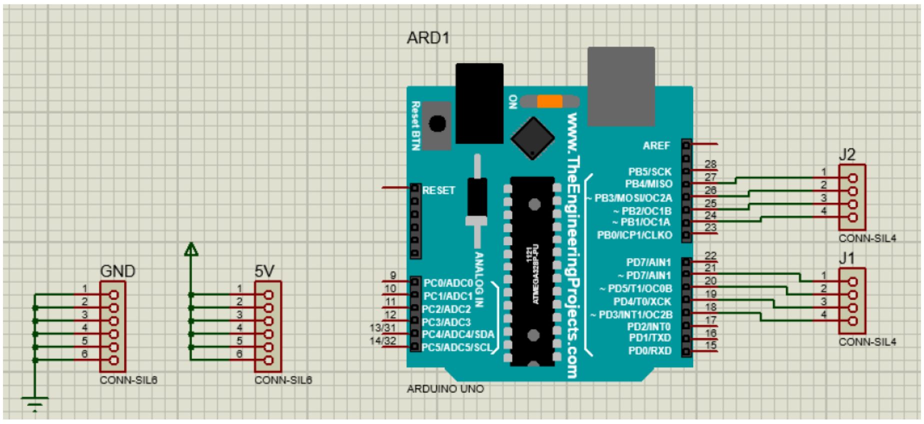


Figure 3. Touch-free tissue dispensing device implementation system using Arduino UNO

The necessary hardware is important in every way thus it's important to choose the most accurate sensor. For this system, IR sensors become the main components to operate the touch-free tissue dispensing device. It highlights how important the choice of sensor is to the overall accuracy and performance of the device. The ability of infrared sensors to verify if the selected sensor satisfies the specifications of the touch-free tissue dispensing device. It also emphasizes the primary purpose of the system, which is to accomplish high-accuracy touch-free operation, emphasizing the need for a comprehensive sensor to do this. All in all, it does a good job of conveying how crucial the IR sensor was to the creation of the touch-free tissue dispenser.

4. RESULT AND DISCUSSION

The components used are Arduino UNO, IR sensor, Sharp IR sensor, stepper motor, LED, and buzzer. The Arduino UNO is a popular microcontroller board that is widely used in various electronic projects and prototyping. The Arduino UNO is built around the Atmel ATmega328P microcontroller. This microcontroller has flash memory for storing the program, EEPROM for data storage, and RAM for runtime variables. The ATmega328P on the Arduino UNO operates at a clock speed of 16 MHz. The board has 14 digital input/output pins (of which 6 can be used as PWM outputs), providing the ability to interface with various sensors, actuators, and other electronic components. The IR sensor detects a user's hand. Once detected, the stepper motor dispenses tissue to the user. Additionally, the project checks if there's still tissue available. If there is, a green LED light up. But if the tissues run out, a red LED lights up, and a buzzer sounds. This signals the cleaning staff to promptly replace the tissue roll. Referring to Table 2, the system behavior is contingent upon the distance between the sharp IR sensor and the tissue. When this distance measures less than 14 cm, a specific set of actions is triggered. Firstly, the green LED is activated, illuminating to indicate that the condition of having sufficient tissue is met. Simultaneously, the red LED is deactivated, turning off, and any ongoing buzzer sound ceases. In essence, this operational state, denoted by a distance less than 14 cm, signifies that the tissue supply is adequate. The visual cue of the green LED provides a clear signal, and the absence of both the red LED and buzzer sound further confirms the system's acknowledgment of the satisfactory tissue level. This integration of distance sensing ensures a responsive and user-friendly experience, with immediate visual and auditory feedback based on the proximity of the tissue to the sharp IR sensor.

Table 2. Result for sharp IR sensor of touch-free tissue dispensing device

Distance between sharp IR sensor and tissue (cm)	Green LED	Red LED	Buzzer
< 14	On	Off	Off
≥ 14	Off	On	On

Referring to Table 3, the system's actions are directly influenced by the presence or absence of a hand, as identified by the IR sensor. When a hand is detected, the IR sensor activates, turning on, and concurrently, the stepper motor is automatically initiated, turning on as well. This synchronized response ensures that the system is ready to dispense tissue as soon as a user's hand is identified by the IR sensor.

Conversely, if no hand is detected, the IR sensor deactivates, turning off. In tandem with this, the stepper motor is also halted, turning off. This operational state signifies that the system remains in a standby mode when there is no hand present. This intelligent mechanism ensures energy efficiency and standby readiness, contributing to a responsive and resource-conscious system.

Table 3. Result for sharp IR sensor of touch-free tissue dispensing device

Detect hand	IR sensor	Stepper motor
Yes	On	On
No	Off	Off

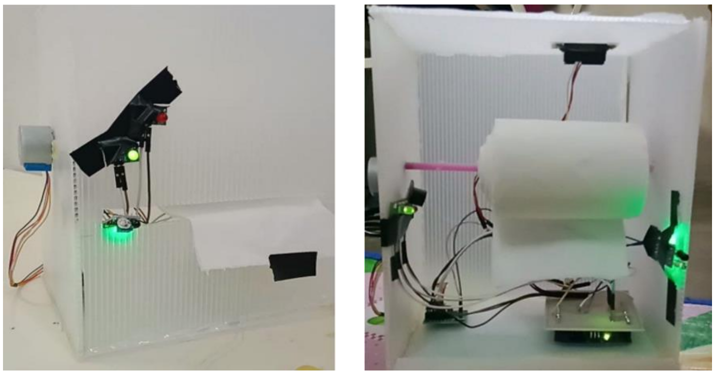
Figure 4 shows the overall prototype of touch-free tissue dispensing device. Figure 4(a) depicts the prototype of its overall system and Figure 4(b) shows the hardware part of touch-free tissue dispensing device. The first image, situated on the left, offers an external view of the project. This perspective provides an overview of the project's physical appearance, showcasing how it might be perceived in a real-world setting. The second image, positioned on the right, zooms in to reveal a more detailed internal view of the project. Here, the focus is on the printed circuit board (PCB) positioned atop the Arduino. This image allows us to observe the layout and arrangement of all the components used in the project. The components are strategically positioned on the PCB, demonstrating the thoughtful design and organization of the internal structure. This visual representation serves to provide a comprehensive understanding of both the external and internal aspects of the project's prototype. It offers a glimpse into how the physical components come together to create a functional and cohesive system, emphasizing both the practicality and aesthetics of the design.

The purpose of this study is to investigate how tissue dispensing affects daily activities and experiences. This study learns more about the function of tissue dispensing in a variety of settings, including homes, and public areas by investigating how tissue dispensers affect a range of aspects of daily life, such as hygiene practices, convenience, and general well-being. While previous research has examined the effects of touch-less systems of water, soap, and self-tissue dispenser system. They have not specifically discussed the effects the touch-less tissue dispensers since they have many functions of dispenser at one time. Besides, earlier studies have explored the impact of medication and pills dispenser systems which focused on dispenser systems to assist people in medication areas. They have not totally discussed the effects of tissue dispenser since they focused on medication areas.

From this study, it was found that all sensors worked as desired since all sensors functioned as shown in Tables 1 and 3. In this study, the suggested controller tended to do great work since the Arduino microcontroller fully utilized its function to make the system operate well, thus assisting the touch-free tissue dispensing device to function at its best. This study suggests focusing on the touch-free tissue system, which is the main problem that became the focus of this study. This study also suggests a higher performance of the IR sensor to detect human hands than the previous study, which used an ultrasonic sensor in their system. Thus, what distinguishes this study from previous work is that the tissue dispensing device used an IR sensor to detect human hands when approaching the device, while previous work utilized an ultrasonic sensor in their system. There are a lot of advantages to an IR sensor, including cost-effectiveness, accuracy in shorter ranges, faster response time, ease of installation, and the fact that this sensor consumes less power compared to an ultrasonic sensor. This study prepared a comprehensive work in terms of the function of an IR sensor in a way to produce a very effective touch-free tissue dispensing device. Like in the previous statement, the IR sensor has many advantages in its functionality to help the system work as desired. The choice of sensor will determine the effectiveness of the device since the main objective of the system is to produce a touch-free tissue dispensing device, which needs a comprehensive sensor to operate at the very best accuracy.

This study demonstrates that more accurate on detection of human hand since this study use more accurate sensor compared to previous study which more resilient and effective. Future studies of this study may put more innovation by using latest technology of IoT by utilizing either Blynk or Telegram. The touch-free dispensing equipment would be connected to the Blynk server by setting up a Blynk project. Sensors would be incorporated inside the device to track how much tissue is left in the dispenser. When the tissue level falls below a predetermined threshold, the device uses the Blynk.notify() function to send out a notification to the cleaning crew using the Blynk app. As an alternative, Bot Father also can be great development in future and integrate it with the touch-free dispenser. Using the Telegram Bot API, the device notifies members of a specific Telegram group or channel that the cleaning crew is a part of when it notices that the tissue is running low. Both approaches provide effective means of alerting cleaning staff members in a timely manner when refilling the tissue dispenser, guaranteeing that consumers will always have access to tissue. According to recent observations, the study that used an IR sensor to detect human hands performed better than the one that used an ultrasonic sensor in a system that was identical. The IR sensor's improved performance can be attributed to its decreased susceptibility to external interference, quicker reaction times, and accuracy in identifying objects at shorter distances. These results imply that, as compared to the use of an ultrasonic sensor, the application of an IR sensor is a more successful method for identifying human hands, resulting in enhanced system performance.

From this study, by delivering tissues without requiring physical contact, the touch-free tissue dispensing device reduces the risk of viruses and bacteria spreading. Important discoveries demonstrate that it efficiently distributes tissues upon hand wave, encouraging cleanliness in public areas. Because of its IR sensor sharp IR sensor technology, it guarantees a touchless experience, improving sanitation in places like public bathrooms, healthcare facilities, and transit. This invention has the potential to be very effective in stopping the spread of infectious diseases. Previous studies on touch-free tissue dispensing devices have primarily focused on their efficacy in promoting hygiene and reducing the spread of infectious diseases. These studies have examined various aspects, such as the technology used for touchless operation and the impact on overall sanitation in public spaces. In general, earlier research has established the foundation for comprehending the efficiency and real-world applications of touch-free tissue dispensers. The results offer significant perspectives for additional investigation and application of these tools in diverse contexts to encourage personal hygiene and lower the spread of contagious illnesses. Future studies on touch-free tissue dispensers could investigate several ways to improve their usefulness and efficacy. A future study could focus on developing hygienic aspects, environmental sustainability, long-term effects on public health, and sensor technologies by utilizing latest technology of IoT by utilizing either Blynk or Telegram. By tackling these research endeavours can enhance the efficacy of touch-free tissue dispensing devices in promoting hygiene and curbing the transmission of infectious diseases in public settings by tackling these research areas and contributing to their ongoing development and optimization. Tissue dispensers without touch, in other words, are a clever technique to prevent the spread of germs. Public spaces are made cleaner by the distribution of tissues in an eco-friendly manner. Previous research demonstrates their effectiveness. Improved hygiene, environmental friendliness, and long-term health effects can all be achieved through future studies. Our safety and well-being will be enhanced by this idea in future development. By offering tissues without requiring physical contact, touch-free tissue dispensers are an excellent method to stop the spread of germs. They are effective in boosting hygiene, according to earlier research. In the end, these gadgets contribute to making areas safer and cleaner for everyone.



(a) (b)

Figure 4. Prototype of touch-free tissue dispensing device (a) prototype of the system and (b) connection of the system for touch-free tissue dispensing device

5. CONCLUSION

In conclusion, the touch-free tissue dispensing device has not only met its objectives but has proven to be an effective solution in resolving the identified issues. The study findings demonstrate that this dispenser significantly aids users in tackling problems related to toilet paper waste. The critical aspect of alerting cleaning staff when supplies are low adds a proactive dimension to the system. The pressing issue of escalating tissue waste costs and environmental impact cannot be ignored. Without intervention, the problem is likely to exacerbate over time. Hence, this project proposes a forward-thinking solution. This innovation incorporates a touch-free sensor system within the tissue box, ensuring a more efficient and sustainable method of dispensing. By introducing such advancements, it aspires to revolutionize toilet paper usage, promoting both environmental responsibility and cost-effectiveness.

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