

Mini-Dry: An Automated Solution to Dry and Sterilize Baby Essentials with Ease

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Abstract—In this paper, we present the design and development of an innovative Automatic Portable Dryer System and Sterilizer Unit tailored specifically for the needs of infants and toddlers. The system aims to revolutionize the process of drying and sterilizing essential baby items such as clothes, feeding bottles, and shoes, providing convenience and peace of mind to parents and caregivers. The design prioritizes portability, enabling parents and caregivers to utilize the unit conveniently in various settings, whether at home, during travel, or in daycare facilities. Compact dimensions and lightweight construction enhance usability, making the system a practical solution for busy parents seeking reliable infant care equipment. The Automatic Portable Dryer System and Sterilizer Unit presented in this paper offer a comprehensive solution to the challenges faced by parents and caregivers in maintaining hygiene and cleanliness for their infants' essentials. The integration of innovative technologies and user-centric design principles positions the system as a promising advancement in infant care equipment, promising enhanced convenience, safety, and peace of mind for parents and caregivers worldwide.

Index Terms—Microcontroller, Dehumidifier, Sterilizer, UV-C, Magnet, Sens

I. INTRODUCTION

The care and hygiene of infants and toddlers constitute a paramount concern for parents and caregivers worldwide. Among the myriad tasks involved in infant care, the maintenance of clean and sterilized essentials such as clothes, feeding bottles, and shoes stands as a critical aspect ensuring the well-being of young children. However, traditional methods are often cumbersome and time consuming, posing

challenges for multitasking parents and caregivers. Key features of the system include rapid drying capabilities, utilizing controlled airflow and temperature to expedite the drying process without compromising fabric integrity. Additionally, the sterilization function employs proven methods to eliminate harmful pathogens, safeguarding the health and well-being of infants. The Automatic Portable Dryer System and Sterilizer Unit offer a groundbreaking solution for maintaining infant hygiene, easing the burdens faced by parents and caregivers worldwide. Through this project, we aspire to contribute to the well-being and safety of infants worldwide, empowering caregivers and parents with a reliable and convenient solution for the essential task of drying and sterilizing baby items. This paper outlines our endeavor to develop an innovative solution aimed at revolutionizing the process of drying and sterilizing baby essentials.

II. MOTIVATION

Parents are increasingly conscious of creating a safe and germ free environment for their infants. The advanced sterilization feature assures them that the baby's clothes are not only dry but also free from harmful bacteria and pathogens, promoting the overall well-being of their child. The space-saving nature of the Automatic Baby Cloth Dryer and Sterilizer Unit makes it an ideal addition to any home, accommodating the needs of modern families with constrained living spaces.

III. OBJECTIVES

The primary objective of this project is to develop an Automatic Portable Dryer System and Sterilizer Unit within required range.

- A. Design and build a portable device that effectively dries baby essentials (shoes, clothes, feeding bottles) while simultaneously sterilizing them using a UVC lamp.
- B. Ensure the drying process is safe and gentle for the delicate baby essentials.
- C. Eliminate or significantly reduce harmful bacteria and germs on the baby essentials using UVC lamp sterilization.

The secondary objectives include:

- D. To develop a system that is compact and portable, makes it suitable for travel or outdoor use, allowing parents to maintain hygiene and cleanliness while on the move.
- E. Optimize the system's power consumption to ensure sufficient battery life for portable operation.

IV. LITERATURE REVIEW

Safira Fegi Nisrina et al. proposed "Sterilizer container using UV-C" with an attempt to sterilize goods after we use them. This medical device aims to sterilize goods, either directly or indirectly, with the objective of preventing the adherence of bacteria and viruses to human body and clothing. The Sterilization Container is designed as a space intended to eliminate microorganisms. In the study titled 'Sterilization Container Using UV-C', UV-C lamps were employed to enhance the container's functionality, along with the addition of a disinfectant spray activated by a button according to requirements. However, further refinement and development are necessary to achieve optimal results. Future iterations could involve integrating a temperature sensor and updating the IoT interface, with the aim of enhancing user-friendliness and reducing sterilization process duration. [1]

Asfandyar Khan et al. developed "A review of UV radiation protection on humans by textiles and clothing". This review deals with the pros and cons of ultraviolet (UV) radiation on human beings and the role of textile clothing and the chemicals used for textiles to protect from their harmful effects. UV radiation is categorized into UVA, UVB, and UVC, with UVC and a significant portion of UVB being absorbed by the ozone layer, while UVA penetrates the Earth's atmosphere. Prolonged exposure to solar or artificial UV radiation poses considerable risks to human health, with UVR recognized as a significant carcinogen. Excessive sunlight exposure can lead to various types of skin cancer, particularly in individuals with fair skin, affecting areas like the lips, skin squamous cells, basal cells, and cutaneous melanoma. This article aims to present a comprehensive overview of the adverse effects of UVR on human skin, considering factors influencing UV irradiance and the

protective capabilities of textile clothing. [2]

Silindir et al. developed a review paper on "Sterilization Methods and the Comparison of E-Beam Sterilization with Gamma Radiation Sterilization". The industrial application of radiation has witnessed an annual increase of 10-15 percent over previous years, with more than 180 gamma irradiation facilities operating in 50 countries by 1994. Ionizing radiation serves as the primary mechanism in radio sterilization, which is a terminal sterilization method. While gamma irradiation has long been utilized for sterilization, electron beam (e-beam) sterilization represents a relatively recent advancement in sterilization processes for various products, materials, and some pharmaceuticals, albeit without official recognition as a sterilization method yet. Despite being commercialized over 40 years ago, extensive research has been conducted on the impact of e-beam sterilization on pharmaceuticals. The by-products of this process can be analyzed and evaluated for safety using instruments in analytical chemistry. Consequently, for many complex pharmaceutical products unable to withstand heat or steam sterilization, radio-sterilization emerges as a preferable option. [3]

V. SURVEY

Drying clothes, especially those of infants and toddlers, poses unique challenges for parents. In this study, we aimed to explore the difficulties faced by parents in this regard and gather insights to inform the development of more effective drying solutions. We conducted a survey involving 10 participants, specifically targeting parents of babies and toddlers. The survey comprised three main sections: demographic information, challenges encountered during clothes drying, and suggestions for improvement.

Demographic Information: 70% of respondents reported residing in houses, while 20% lived in apartments, and the remaining 10% resided in flats.

Challenges Encountered: Rain was cited as a challenge by 10% of respondents, highlighting the weather-dependent nature of outdoor drying. Lack of sunlight was mentioned by 40% of participants, underscoring the importance of natural light for effective drying and sterilization. Improper sterilization emerged as a significant concern, with 80% of respondents expressing apprehension about this issue. Space limitations were identified by 60% of participants, reflecting the constraints faced in urban dwellings where outdoor space is limited.

Suggestions for Improvement: Portable and compact designs were recommended by respondents, emphasizing the need for flexibility and space-saving solutions. Easy portability was highlighted as a key feature, enabling parents to carry the drying apparatus wherever needed. Efficient drying capacity was desired, with respondents expressing a preference for machines capable of drying larger quantities of clothes simultaneously. **Discussions:** The survey results underscore the multifaceted nature of

challenges faced by parents when drying clothes, particularly those of infants and toddlers. The findings highlight the importance of developing innovative solutions that address issues such as space limitations, weather dependency, and sterilization concerns. Portable, compact, and efficient drying solutions emerged as key priorities, reflecting the practical needs of parents in today's urban environments.

VI. TARGET USERS

Parents in Urban Areas: Families living in urban environments such as flats, apartments, where space is limited and traditional drying methods may not be feasible.

New Parents: Specifically, parents of newborns or infants who require frequent washing and drying of baby clothes, blankets, and other essentials, and prioritize hygiene and cleanliness.

Travelers: Individuals or families who frequently travel or are on the move and require a portable solution for drying baby clothes while away from home.

Health-Conscious Consumers: Users who prioritize hygiene and seek innovative solutions that incorporate disinfection technologies such as UV light to ensure the cleanliness of baby clothes.

Busy Parents: Those who have busy schedules and limited time to dedicate to household chores, including laundry, and seek convenient solutions to simplify their daily routines.

VII. SCIENTIFIC SCOPE OF THE RESEARCH PROPOSAL

The scientific scope for an automatic baby cloth dryer and sterilizer unit involves incorporating various technological and scientific principles to achieve efficient and safe drying and sterilization processes. Here are key scientific aspects to consider:

A. Drying Technology

Explore advanced drying technologies such as infrared drying, microwave drying, or other energy-efficient methods to ensure quick and uniform drying of baby clothes. Scientifically optimize the drying process to minimize energy consumption while maintaining the fabric's integrity.

B. Sterilization Methods

Integrate scientifically proven sterilization methods such as UV-C light, ozone, or steam to effectively eliminate bacteria, viruses, and allergens from baby clothes. Research the optimal parameters and exposure times for these sterilization techniques to ensure thorough disinfection without causing damage to the fabrics.

C. Material Science

Conduct material science research to identify fabrics that are not only gentle on a baby's skin but also conducive to rapid drying and effective sterilization. Consider incorporating antimicrobial or antibacterial materials to enhance the overall hygiene of the baby clothes.

D. Sensor Technology

Implement advanced sensor technologies to monitor humidity levels, temperature, and the moisture content of the clothes. Utilize this data to optimize drying times and ensure that clothes are adequately dried without any risk of overheating or damage.

E. Human Factors and Ergonomics

Apply principles of human factors and ergonomics to design a user-friendly interface. Consider the ease of use for parents, ensuring that the device is intuitive and safe, with features such as child-lock mechanisms and easy loading and unloading.

F. Energy Efficiency

Investigate energy-efficient technologies and sustainable design practices to reduce the environmental impact of the device. This may involve optimizing the power consumption of the unit, exploring renewable energy sources, or implementing energy recovery systems.

G. Microbiology and Virology

Collaborate with experts in microbiology and virology to validate the effectiveness of the sterilization process against a wide range of pathogens commonly found on baby clothes.

H. Automation and Smart Technology

Integrate smart technology, such as Internet of Things (IoT) connectivity, to enable remote monitoring and control of the unit. Implement machine learning algorithms to adapt drying and sterilization cycles based on usage patterns, further enhancing efficiency.

I. Safety Standards and Regulations

Stay abreast of safety standards and regulations related to baby products. Ensure that the unit complies with international safety guidelines, addressing concerns such as electrical safety, temperature control, and the emission of any by-products during the sterilization process.

J. User Feedback and Research

Conduct user feedback studies and research to continuously improve the product based on the experiences and preferences of parents. Implement iterative design processes, incorporating scientific findings and user insights to enhance the overall performance and usability of the unit.

By addressing these scientific aspects, the automatic baby cloth dryer and sterilizer unit can not only provide a convenient solution for parents but also ensure the safety, hygiene, and well-being of infants and toddlers.

VIII. SOCIAL RELEVANCE AND IMPORTANCE

- Ensuring the cleanliness and hygiene of baby clothes is of paramount importance. A cabin-based baby clothes drying system addresses this by incorporating sterilization features, safeguarding infants from harmful bacteria and allergens.
- Modern lifestyles often leave parents with limited time for household chores.
- Families residing in urban areas, where outdoor drying may be impractical or restricted, face challenges in ensuring proper drying and hygiene of baby clothes. The Automatic Baby Cloth Dryer and Sterilizer Unit offers a practical indoor solution, catering to the needs of urban dwellers and apartment living.

- An Automatic Baby Cloth Dryer and Sterilizer Unit, designed with energy efficiency in mind, contributes to reducing the overall environmental impact associated with baby clothes drying, aligning with growing eco-conscious consumer preferences.
- For new parents, adapting to the demands of childcare can be overwhelming. An Automatic Baby Cloth Dryer and Sterilizer Unit simplifies the process, and providing a user-friendly solution for those navigating the early stages of parenthood.
- Automatic Baby Cloth Dryer and Sterilizer Unit ensures a gentle yet effective process, reducing the risk of skin irritation and meeting the specific needs of babies with sensitive skin.
- The system not only meets practical needs but also resonates with tech-savvy parents who appreciate innovative solutions that make parenting more manageable. [4]

IX. USE CASE DIAGRAM

The use case diagram for the proposed project is shown in figure below.

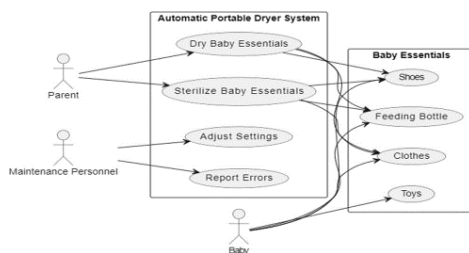


Fig. 1. Use Case Diagram

X. DETAILED BLOCK DIAGRAM

Proposed detailed block diagram is shown in figure below.

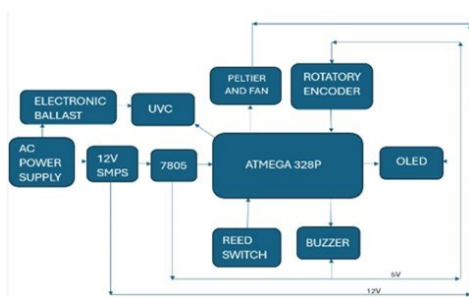


Fig. 2. Detailed Block Diagram

XI. EXPLANATION

This circuit controls a UV lamp and Peltier using a microcontroller and a rotary encoder for user input. The knob on the encoder sends signals to the microcontroller, which then controls a transistor that acts like a switch for the lamp. A voltage regulator ensures steady power, while a capacitor smooths it and a diode safeguard from voltage spikes. For safety, a reed switch can be added to disable the circuit if the UV lamp enclosure isn't securely closed. Additionally, a buzzer can be integrated to sound when the lamp is on, and a Peltier cooler could be included for temperature control. While the circuit uses an NPN transistor and MOSFETs.

XII. PARTICULARS OF EQUIPMENTS REQUIRED

- Atmega 328p
- Peltier Module
- Reed switch
- UV-C lamp (11 watt)
- Buzzer
- 0.96-inch OLED
- Rotary encoder
- Neodymium Magnet
- Heat Sink
- Fan

XIII. APPLICATIONS

An Automatic Baby Cloth Dryer and Sterilizer Unit could have several applications, especially if it incorporates innovative features to cater to the specific needs of drying baby clothes. Here are some potential applications:

Home Use

Convenience: Parents can use the system at home to conveniently dry baby clothes without the need for a separate drying space.

Energy Efficiency: If the system incorporates energy-efficient technologies, it could be an environmentally friendly option for home use.

Childcare Facilities

Daycares and Nurseries: Childcare facilities can use the system to efficiently dry the clothes of multiple babies, ensuring a constant supply of clean and dry garments.

Hygiene: The system can contribute to maintaining a hygienic environment by quickly drying clothes, reducing the risk of bacterial growth. [6]

Hospitals and Maternity Wards

Newborn Units: In hospitals and maternity wards, a dedicated drying system could be used to ensure that baby clothes are promptly dried and ready for use, supporting the needs of newborns and their parents. [6]

Travel and Portable Solutions

Traveling Families: A compact and portable version of the system could be useful for families on the go, ensuring that baby clothes are dried efficiently even during travels.

Laundromats

Specialized Services: Laundromats catering to families with babies could offer specialized drying services using such systems, providing an added convenience for parents.

Retail Stores

In-Store Services: Baby clothing stores may integrate the system as part of their in-store services, allowing customers to quickly dry newly purchased items before leaving the store.

Product Testing and Development

Research and Development Labs: Manufacturers and researchers in the baby product industry could use these systems for testing and developing new and improved drying technologies for baby clothes.

Emergency Situations

Emergency Shelters: In emergency situations or shelters, having a dedicated system for drying baby clothes could be beneficial for families with infants.

XIV. CONCLUSION

In conclusion, our baby cloth drying and sterilizing system represents a significant advancement in childcare technology, addressing the dual concerns of hygiene and convenience for parents. Through the utilization of UV light technology, we have engineered a sterilization process that effectively eliminates harmful bacteria and germs from baby clothes, providing a reliable solution for maintaining optimal cleanliness. This ensures that infants are surrounded by garments free from potential sources of illness or skin irritations, contributing to their overall well-being.

With safety as a paramount concern, our baby cloth drying system is designed to provide peace of mind to parents, offering a reliable and efficient solution to their laundry needs. By streamlining the sterilization and drying process, we empower parents to prioritize their baby's hygiene without compromising on convenience. As a result, our system represents a valuable addition to any household, enhancing the overall care-giving experience for both parents and infants alike.

In essence, our baby cloth drying system stands as a testament to the power of innovation in addressing everyday challenges faced by parents. Through the integration of UV light sterilization and dehumidification, we offer a comprehensive solution for maintaining clean, dry, and hygienic baby clothes. With its user-friendly design and emphasis on safety, our system sets a new standard for efficiency and reliability in childcare technology, supporting parents in their quest to provide the best possible care for their little ones.

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