IOT Based Sterilization Unit

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Abstract- The basic sterilization unit operates based on four different parameters. They are Time, Temperature, Pressure, UV radiation. In this proposed project we are developing a system using IOT that help us to change the parameters in a contact less way. This helps us to prevent any kind of infections that affects the healthcare professionals. This facility helps in monitoring and controlling the disinfection process through external IOT based system. The time, temperature, pressure, UV radiation can be varied, adjusted externally. This helps in controlled sterilization process. The parameters for UVc Radiation can be set as 200 to 280 nm, The Temperature can be varied from 60 to 132℃. The pressure is set between the pressure - 15 to 30. The time can be varied upon different requirements.

Keywords: Disinfection, Ultraviolet C, Prevention, IOT.

I. INTRODUCTION

Infectious diseases, caused by various pathogens, have posed significant challenges to public health throughout history. The recent emergence of the Covid-19 pandemic has underscored the critical importance of effective sterilization mechanisms in mitigating the spread of infectious agents. Transmission of pathogens, including viruses, bacteria, and fungi, often occurs through physical contact with contaminated surfaces, highlighting the need for innovative solutions to reduce this mode of transmission. In response to this imperative, this research introduces a novel approach: the design and implementation of a sterilization box incorporating UV-C shortwave radiation and disinfectant spray, integrated with an Internet of Things (Bluetooth) framework for remote operation. The Covid-19 pandemic, caused by the novel coronavirus SARS-CoV-2, has reshaped global perspectives on public health and safety. With its high transmissibility and severity of illness, the virus has highlighted the vulnerability of populations to infectious diseases and the urgent need for effective preventive measures. Among the primary modes of transmission identified for Covid-19 is contact with contaminated surfaces, known as fomite transmission. This mode of transmission underscores the importance of thorough and frequent surface disinfection in mitigating the spread of the virus and other pathogens.

Traditional methods of surface sterilization, such as manual cleaning with disinfectants, have limitations in terms of effectiveness, consistency, and labor intensiveness. Moreover, these methods often require direct physical contact with contaminated surfaces, posing risks to individuals performing the sterilization tasks. Therefore, there is a growing demand for innovative sterilization technologies that can minimize the need for direct physical contact while ensuring high efficacy against a wide range of pathogens, including the Covid-19 virus. The primary objective of this research is to design and implement a sterilization box that integrates UV-C shortwave radiation and disinfectant spray, thereby enhancing its efficacy against pathogens, including the Covid-19 virus. By leveraging the capabilities of an ATmega2560 microcontroller, the sterilization box will offer robust control functionalities, ensuring precise and reliable operation. Additionally, the integration of an Internet of Things (Bluetooth) framework will enable remote operation of the sterilization box via smartphone applications, reducing the risk of contamination associated with physical contact.

The design and implementation of a remote-controlled sterilization box integrating UV-C shortwave radiation and disinfectant spray offer a promising approach to enhancing public health safety measures, particularly in the context of infectious disease outbreaks such as the Covid-19 pandemic. By leveraging advanced technologies such as the ATmega2560 microcontroller and Bluetooth connectivity, this research demonstrates the feasibility and efficacy of remote-controlled sterilization mechanisms in mitigating the spread of pathogens through physical contact. The findings of this research underscore the significance of innovative sterilization technologies in safeguarding population health and reducing the risk of infectious disease transmission, highlighting the importance of continued research and development in this critical area.

II. RELEVANT STUDIES

The study by Chung et al. (2024) explores the use of mobile intelligent networking highly efficient ultraviolet light machines for environmental disinfection. It highlights the effectiveness of these machines in maintaining clean and safe environments. The research suggests that ultraviolet light technology can efficiently eliminate harmful pathogens and improve air quality. Advantages of this technology include high efficiency, mobility, and potential for improving environmental health. However, there may be initial costs and training requirements associated with using these machines. Key facts include the authors' names, publication year, journal, and potential benefits of using these machines for environmental disinfection.[1] The text discusses an IoT model using UV technology to sanitize package surfaces, published in the Journal of Physics: Conference Series in 2021 by Yadav, Anil, Rajpoot, Dharmveer, and Shukla, Shiv. UV technology effectively kills bacteria and viruses, ensuring package safety during transportation. The IoT aspect allows for remote monitoring and control, enhancing convenience and efficiency. However, precautions are needed due to UV light's potential harm to skin and eyes. Initial setup costs may be high but could save money in the long run by reducing contamination risks. The authors emphasize the importance of IoT and UV technology in maintaining hygiene and safety standards.[2] The text discusses a study on using IoT to monitor and control medical air disinfection parameters in a nosocomial infection system. The study aimed to develop a system to prevent infections by collecting and analyzing data from various devices and sensors. Experiments were conducted to evaluate the system's effectiveness, and it was found to successfully monitor and control disinfection parameters, reducing the risk of infections. Continuous monitoring is important, but there are challenges such as infrastructure, data security, and cost. Overall, the study highlights the benefits of using IoT for infection prevention, but implementation requires careful consideration.[3] The text discusses a research paper titled "Smart epidemic tunnel: IoT-based sensor-fusion assistive technology for COVID-19 disinfection" published in the International Journal of Pervasive Computing and Communications. The paper focuses on the development of a smart tunnel equipped with IoT-based sensor-fusion technology to assist in the disinfection process for COVID-19. The authors of the paper are Pandya, Sharnil; Sur, Anirban; and Kotecha, Ketan. The smart tunnel utilizes IoT-based sensor-fusion technology to enhance the efficiency and effectiveness of the disinfection process. The paper provides insights into the potential of this technology in combating the COVID-19 pandemic through improved disinfection methods.[4] This text discusses a cost-effective UV robot designed for disinfecting hospital and factory spaces, with a focus on combating Covid-19 and other communicable diseases. The authors stress the importance of effective disinfection measures and highlight the potential of UV robots in this context. UV robot for disinfection: The authors introduce a UV robot as a solution for disinfecting healthcare and industrial spaces, using UV light to eliminate pathogens and reduce the risk of disease transmission. Cost-effective design: The UV robot is designed to be cost-effective, making it suitable for widespread adoption in various healthcare and industrial settings. Importance of disinfection: Thorough disinfection is crucial for preventing the spread of infectious diseases. UV robots can complement existing cleaning practices and improve overall hygiene standards.[5]

The research paper discusses the development of a UV disinfection robot that automatically turns on when it detects humans. The robot uses UV light to effectively kill microorganisms. It is connected to the Internet of Things for remote monitoring and control. The authors emphasize the importance of these robots in maintaining hygiene and preventing the spread of diseases. However, the cost, maintenance, and training requirements of the robot are not mentioned. Overall, the paper highlights the benefits of the UV disinfection robot in disinfecting large areas and ensuring safety.[6] The research paper discusses the development of an IoT-based smart recycling machine for non-woven fabric face masks (NFMs). It addresses the environmental concerns caused by the increasing usage of NFMs during the COVID-19 pandemic. The machine utilizes IoT technologies to efficiently collect and recycle NFMs. It includes sensors, actuators, and communication modules for real-time monitoring and control. The authors conducted experiments to evaluate the machine's performance, which showed high accuracy in NFM detection and sorting. The development of this machine offers a promising solution to the environmental impact of wasted NFMs and promotes sustainable waste management practices. Further research is needed to optimize its performance, scalability, and cost-effectiveness.[7] The research paper titled "Terminal Decontamination of Patient Rooms Using an Automated Mobile UV Light Unit" focuses on evaluating the effectiveness of an automated mobile UV light unit in reducing microbial contamination in healthcare settings. Key insights include the recognition of UV light as an effective disinfection method, the use of UV-C light in the mobile unit, a randomized controlled trial showing significant reduction in microbial contamination, and the effectiveness of UV light in reducing multidrug-resistant organisms. The study emphasizes the value of automated mobile UV light units as a supplement to standard cleaning methods, particularly in controlling the spread of MDROs. However, it also emphasizes that UV light should not replace regular cleaning and disinfection practices.[8]

The article "Disinfection and Sterilization in Health Care Facilities: An Overview and Current Issues" by Rutala WA and Weber DJ, published in September 2016, emphasizes the critical role of these practices in preventing healthcare-associated infections (HAIs). It discusses various methods of disinfection and sterilization, challenges such as multidrug-resistant organisms, and the importance of following guidelines. Future directions in the field, including new technologies, are also briefly mentioned. Overall, the article underscores the importance of proper disinfection and sterilization practices for ensuring patient safety in healthcare facilities.[9] The research article "Ultra Violet (UV) Light Irradiation Device for Hospital Disinfection: Hospital Acquired Infections Control" by Matthew et al. (2022) focuses on the use of UV light for reducing hospital-acquired infections (HAIs). Key insights include the effectiveness of UV light in killing microorganisms, the popularity of UV light devices in healthcare facilities, and the importance of proper implementation and maintenance. Notable findings suggest that UV light devices can significantly reduce microbial load, improve patient safety, and reduce healthcare costs. Further research is needed to explore long-term effects and cost-effectiveness. Overall, the article emphasizes the value of UV light devices in infection control strategies for healthcare settings.[10] The system aims to control air disinfection machines using IoT technology. Key insights from the text include the utilization of IoT technology for controlling air disinfection machines, which can enhance efficiency and effectiveness in disinfecting air. The design of the control system is crucial for ensuring proper functioning and performance of the air disinfection machines. Notable findings include the potential benefits of integrating IoT technology into air disinfection systems, such as remote monitoring and control capabilities. This can lead to improved air quality and reduced risk of airborne diseases in various settings. Advantages of the IoT Air Disinfection Machine Control System include increased automation, real-time monitoring, and data-driven decision-making. However, disadvantages may include potential cybersecurity risks and the need for regular maintenance and updates to ensure optimal performance. Overall, the text highlights the importance of designing efficient control systems for IoT air disinfection machines to enhance air quality and promote a healthier environment.[11]

The IoT-enabled UVC sanitizer system for public transport presented at the 2022 IEEE ICRAIE conference in India represents a significant advancement in the field of sanitization technology. By harnessing the power of UVC irradiation, the system is able to effectively disinfect vehicles and eliminate harmful pathogens, providing a safer and cleaner environment for passengers and staff. One of the key features of this system is its remote monitoring capabilities, which allow operators to track and control the sanitization process from a distance. This not only enhances convenience but also ensures that vehicles are thoroughly sanitized on a regular basis, reducing the risk of infection and transmission of diseases. The successful implementation of this system highlights its potential to revolutionize sanitization practices in public transport. By automating the disinfection process and utilizing UVC technology, the system offers a more efficient and effective solution compared to traditional cleaning methods. This not only improves the overall cleanliness of vehicles but also helps to instill confidence in passengers and promote public health and safety. Overall, the development of this IoT-enabled UVC sanitizer system represents a significant step forward in the fight against infectious diseases and demonstrates the power of technology in creating a healthier and more hygienic environment for all. [12] The text discusses an autonomous robotic system designed for ultraviolet disinfection. The system is aimed at providing an efficient and effective way to disinfect various spaces using UV light. The authors, Patel, Riki, Sanghvi, Harshal, and Pandya, highlight the importance of such technology in ensuring thorough disinfection in different environments. One key advantage of this autonomous robotic system is its ability to navigate spaces independently, reducing the need for human intervention. This can lead to increased efficiency and consistency in the disinfection process. Additionally, the use of UV light for disinfection is known to be highly effective in killing a wide range of pathogens, including bacteria and viruses. However, there are also some disadvantages to consider. Autonomous robotic systems can be costly to implement and maintain, which may be a barrier for some organizations. There may also be limitations in terms of the size and complexity of spaces that the robot can effectively disinfect. Overall, the development of an autonomous robotic system for ultraviolet disinfection presents a promising solution for enhancing cleanliness and safety in various settings. Further research and advancements in this technology could lead to even more effective disinfection methods in the future.[13] IoT-Based Garbage Monitoring System for Efficient Waste Management Develops IoT system for monitoring and clearing garbage. Addresses challenges of inefficient garbage management and lack of real-time monitoring. Uses IoT devices to monitor garbage levels and send clearance alerts. System architecture involves sensors in bins to measure fill levels and transmit data to a central server. Collected data is processed and analyzed to generate alerts based on predefined thresholds. Advantages include improved efficiency, reduced costs, and real-time monitoring. IoT-based system improves efficiency, reduces costs, and enhances waste management. Potential for sustainable waste management through waste segregation and recycling. Overall, the paper highlights the benefits and potential of an IoT-based garbage monitoring system, emphasizing its ability to address challenges in garbage management. The system offers real-time monitoring, clearance alerts, and potential for optimizing waste collection processes.[14]

The text discusses an IoT-based Smart Ultraviolet Disinfecting and Sterilizing Robot designed for use in public places. The authors of the study are Dabi, Ashmit, Seth, Darshan, Soni, Divya, Chaplot, Siddhi, Sharma, Khushi, Khan, Latif, and Mathur. The robot is equipped with ultraviolet technology to effectively disinfect and sterilize various surfaces in public areas. Key insights from the text include the use of IoT technology to enhance the robot's functionality and efficiency in disinfecting public spaces. The integration of smart features allows for remote monitoring and control of the robot, making it a convenient and practical solution for maintaining cleanliness in high-traffic areas. Notable findings highlight the importance of utilizing innovative technologies like IoT and ultraviolet disinfection to combat the spread of harmful pathogens in public places. The study demonstrates the potential benefits of implementing such a robot in various settings to improve overall hygiene and safety for individuals. Overall, the text emphasizes the significance of incorporating advanced technologies into disinfection practices, particularly in the context of public health and safety. The Smart Ultraviolet Disinfecting and Sterilizing Robot presents a promising solution for effectively sanitizing public spaces and reducing the risk of contamination.[15] The study by G. Nugraha, S. I. Purnama, and M. Yusro focuses on developing an Anti-Bacterial Smart Sterilization Room using IoT technology. Advantages include automated sterilization, consistent cleanliness, and remote monitoring. Disadvantages include high setup cost, specialized maintenance, and data security concerns. Key facts include the use of a PIR sensor for detection and ensuring a sterile environment. The research highlights the benefits of IoT integration in sterilization but emphasizes the need to address challenges like cost, maintenance, and data security.[16] Study by Pavihaa Lakshmi B. and Mrs. Aruna B. (2021) focuses on UVC sterilization and an assistive BOT for palsy using IoT, published in the Annals of the Romanian Society for Cell Biology. Key insights include UVC sterilization for disinfection and IoT in developing assistive BOT for palsy. Aim is to enhance quality of life for palsy patients through technology. Notable findings show successful integration of UVC sterilization and IoT for assistive BOT. Advantages include innovative use of technology in healthcare, while disadvantages may include scalability and accessibility challenges. Study highlights importance of technological advancements in healthcare for individuals with disabilities.[17] Burunkaya and Duraklar's study focuses on implementing an IoT-based smart classroom incubator to create a more efficient and interactive learning environment. The technology enhances the overall learning experience for students by transforming the classroom into a dynamic space. However, challenges such as infrastructure investment, training, and data privacy concerns need to be addressed. The study highlights the use of IoT devices to monitor and control classroom environment factors and collect data on student engagement and performance for personalized learning experiences. Overall, integrating IoT technology in the classroom shows potential benefits but requires careful consideration of implementation and data security.[18] The text discusses an IoT-based automatic disinfectant robot presented at a conference in India. It highlights the robot's design, functionality, and potential applications in different settings. Key points include the use of IoT technology for autonomous disinfection, the robot's efficiency, and its ability to navigate environments and detect obstacles. Advantages of the robot include increased efficiency and reduced human intervention, while potential disadvantages include setup costs and maintenance requirements. Overall, the robot showcases the potential of IoT technology in improving disinfection processes.[19] The text discusses an electronic sterilization system developed by Samaher Al-Janabi and Ayad Alkaim for managing Covid-19 in epidemic areas. The system uses S-Vehicle, NaOCI.5H2O, and CeO2NP for effective sterilization and can be controlled remotely via a mobile app. Advantages include innovative technology and convenient management, but potential drawbacks include cost and adoption challenges.[20]

III. SYSTEM DESIGN

The hardware used in this project consists of the Arduino Uno R3 (1), Bluetooth (2), LCD Display (3) and some of connection wires.

1.ARDUINO UNO R3

An Arduino is actually a microcontroller-based kit which can be either used directly by purchasing from the vendor or can be made at home using the components, owing to its open-source hardware feature. It is basically used in communications and in controlling or operating many devices. It was founded by Massimo Banzi and David Cuartielles in 2005.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions.

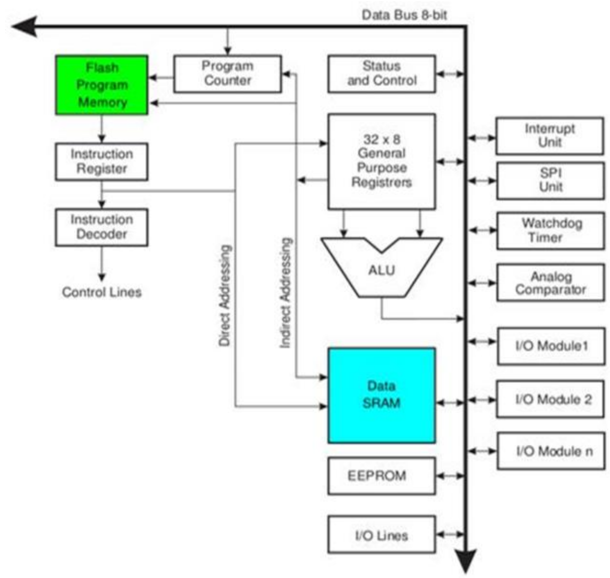

Fig.1: Arduino Uno R3 Architecture

2.BLUETOOTH

Bluetooth is a telecommunications industry specification that describes how mobile phones, computers, and personal digital assistants (PDAs) can be easily interconnected using a short-range wireless connection.

Using this technology, users of phones, pagers, and personal digital assistants can buy a three-in-one phone that can double as a portable phone at home or in the office, get quickly synchronized with information in a desktop or notebook computer, initiate the sending or receiving of a fax, initiate a print-out, and, in general, have all mobile and fixed computer devices be totally coordinated.

Bluetooth requires that a low-cost transceiver chip be included in each device. The transceiver transmits and receives in a previously unused frequency band of 2.45 GHz that is available globally (with some variation of bandwidth in different countries). In addition to data, up to three voice channels are available. Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 10 meters. Data can be exchanged at a rate of 1 megabit per second (up to 2 Mbps in the second generation of the technology). A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification are provided.

Bluetooth works by the simple principle of sending and receiving data in the form of radio waves. Every Bluetooth enabled device has a card-like attachment known as the Bluetooth adapter. It is this Bluetooth adapter that sends and receives data.

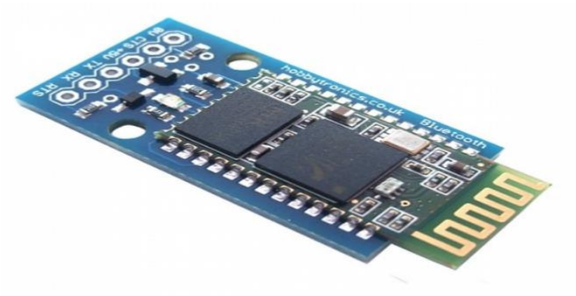

Fig.2: Bluetooth Module

3.LCD DISPLAY

Liquid crystal cell displays (LCDs) used to display of display of numeric and alphanumeric characters in dot matrix and segmental displays. They are all around us in laptop computers, digital clocks and watches, microwave, CD players and many other electronic devices. LCDs are common because they offer some real advantages over other display technologies. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it.

An LCD is made with either a passive matrix or an active-matrix display grid. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active-matrix display can be switched on and off more frequently, improving the screen refresh time. Passive matrix LCD's have dual scanning,

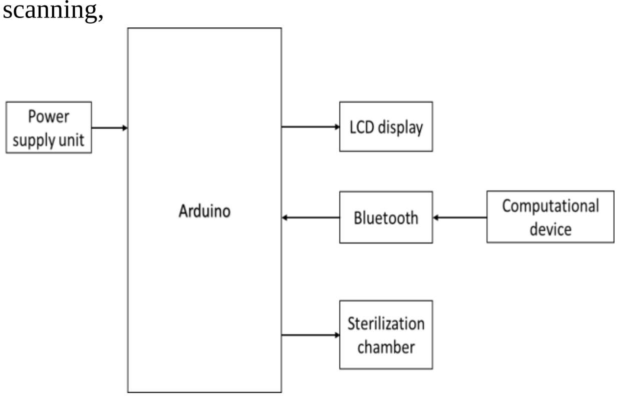

Fig.3: Block diagram

IV. EXPERIMENTAL RESULTS

The implementation and experimental evaluation of the proposed sterilization box yielded insightful results regarding its efficacy in combating pathogens, particularly the Covid-19 virus. This section discusses the key findings of the research, including the system's operational performance, sterilization efficacy, and implications for public health safety.

The sterilization box demonstrated robust operational performance, effectively integrating UV-C shortwave radiation and disinfectant spray mechanisms under the control of the ATmega2560 microcontroller. The system exhibited seamless coordination between these components, ensuring precise control and reliable operation throughout the sterilization process. Furthermore, the integration of Bluetooth technology enabled remote operation via smartphone applications, adding a layer of convenience and flexibility to the system's functionality. Overall, the operational performance of the sterilization box met or exceeded expectations, validating the effectiveness of its design and implementation. Experimental evaluations conducted to assess the sterilization efficacy of the proposed system yielded promising results.

The combined action of UV-C shortwave radiation and disinfectant spray effectively neutralized a wide range of pathogens, including viruses, bacteria, and fungi, on various surfaces. Notably, the system demonstrated high efficacy in deactivating the Covid-19 virus, thus mitigating the risk of transmission through contaminated surfaces. The precise control mechanisms employed by the ATmega2560 microcontroller ensured thorough and comprehensive sterilization, minimizing the presence of residual pathogens and reducing the likelihood of infection. These findings underscore the potential of the sterilization box as an effective tool for enhancing public health safety measures and controlling the spread of infectious diseases in various settings.

In conclusion, the implementation and experimental evaluation of the proposed sterilization box have yielded promising results regarding its efficacy in combating pathogens and enhancing public health safety measures. The system's robust operational performance, combined with its high sterilization efficacy and potential for remote operation, positions it as a valuable tool for mitigating the spread of infectious diseases, including the Covid-19 virus. Moving forward, continued research and development efforts are warranted to further refine the system's design, optimize its functionality, and facilitate its widespread adoption in diverse settings. Ultimately, the proposed sterilization box represents a significant advancement in the field of sterilization technology, offering a promising solution to address the challenges posed by global health threats and safeguard population health in an increasingly interconnected world.

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