Autonomous UV Sterilization Robots in Smart Healthcare: A Comprehensive Review

[*1]M.Madhumitha,[*2] Dr. F. Emerson Solomon

[*1] PG Scholar ,[*2] Professor

Department of Biomedical Engineering, Bharat Institute of Higher Education and Research, India

Abstract: Healthcare-associated infections constitute a critical issue of hospitals and smart healthcare settings. Handwashing and chemical decontamination are usually not regularized and expose healthcare workers to the risk of infections [1]. The problem is solved through autonomous ultraviolet (UV) sterilization robots, which are contactless and safe due to UV-C radiation to inactivate the bacteria and viruses [2]. The recent studies are interested in enhancing these robots with autonomous navigation, human detection, and Internet of Things (IoT)-based patient monitoring to make their work safe and intelligent [3]. The current paper contains a brief state of autonomous UV sterilization robots in the medical field. The review describes the principle of UV sterilization [7], autonomous mobile robot navigation [10], and human detection method based on deep learning including YOLO and Faster R-CNN [5]. The IoT and cloud technologies are mentioned in connection with real-time observation, data delivery, and distant control of the robots and patients [4]. The similarities and differences are discussed in a comparative analysis of the existing systems and include the differences in navigation, safety, integration of IoT, and monitoring. Lastly, the existing issues and research proposals are presented to aid in the creation of safe, low-cost, and intelligent UV sterilization robots to be used in intelligent hospitals.

Keywords: UV sterilizing robot, robotics in healthcare, human detection, IoT, smart hospital

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1. Introduction

HAIs remain a significant issue within hospitals and healthcare organizations globally because they cause morbidity, mortality, and overall cost of treatment in patients [1]. In the commonly congested clinical settings, including intensive care units, operation theaters, and isolation wards, contamination of surfaces and medical equipment as well as air circulation can lead to the spread of pathogens in a relatively easy way [25]. The conventional methods of disinfection are primarily based on manual cleaning with the help of the chemical agents as it is highly human-dependent and does not provide consistent sterilization success [2]. Moreover, constant contact with chemical disinfectants can lead to health complications of medical workers and environmental problems.

The UV-C radiation has become a promising solution to contactless disinfection of healthcare settings. The UV-C light, which is usually between the wavelength of 200-280 nm, kills microorganisms by destroying their DNA and RNA effectively preventing their multiplication [7]. There is a substantial amount of research and testing conducted in hospitals that has proven that UV-C disinfection can greatly decrease the contamination with bacteria and viruses when combined with the regular cleaning procedures [8],[26]. Consequently, UV-based systems have received some attention regarding infection control particularly in situations of pandemic where fast and effective sterilization is required.

Although effective, direct exposure to UV-C has severe health effects on humans such as skin burns and eye damage [7]. This is one of the safety considerations that restrict the application of fixed or manual operated UV systems in congested areas. To address this shortcoming, autonomous UV sterilization robots have been introduced to do the disinfection without the presence of humans thereby guaranteeing safety whilst still being effective [3]. These robots combine UV lamps and mobile robotic platforms and as a result, they can move methodically in the hospital rooms and corridors.

The more recent discoveries in autonomous mobile robotics have added more features to UV sterilization robots. With the help of sensors, cameras, and simultaneous localization and mapping (SLAM) algorithms, robots are able to move through complex indoor environments, avoid obstacles, and disinfect the entire area [10]. Mobile robots are also more flexible and efficient than their stationary counterparts and can serve a large medical facility [17]. However, the aspect of navigation in itself does not suffice in ensuring safe operations in the real- life situations within hospitals where there can be an unexpected human presence.

Modern UV sterilization robots are becoming more complex with regard to computer vision and artificial intelligence human detection systems to overcome safety issues. Deep learning models like You Only Look Once (YOLO) or Faster Region-Based Convolutional Neural Networks (Faster R-CNN) allow real-time detection of human beings based on the input of cameras [5], [6]. Once a human is registered, the robot may switch off the UV lamps instantly or the robot may switch its course to avoid exposure to dangerous conditions [18]. These safety measures enable UV robots to work consistently even in semi-occupied areas which is critical in actual application [37].

Together with disinfection and safety, the introduction of Internet of Things (IoT) technologies has made UV sterilization robots intelligent medical devices. IoT systems can be used to relay an operational state of a robot-like disinfection time, UV power, battery life, and error warnings to central servers or even cloud-based systems [4]. The healthcare personnel have an opportunity to observe the functioning of robots remotely, plan the disinfection work, and process the previous experience to enhance the methods of infection control [11]. Cloud and edge computing is also applicable to low-latency decision- making with regard to safety-critical operations [12].

Other areas that have been studied in recent years to enhance the scope of UV robots include incorporating patient monitoring into an enhanced disinfection robot. Vital signs including body temperature, heart rate, oxygen saturation and patient movement can be measured by contactless sensors placed on robot platforms [27], [29]. These systems decrease the workload of medical staff and risk of infection and provide an opportunity to supervise a patient constantly [30]. This disinfection and monitoring, and connectivity are in line with the vision of smart healthcare environments. In summary of the discussion, Table I provides the important motivations and the technologies that enable the creation of autonomous UV sterilization robots in healthcare.

ASPECT	DESCRIPTION	KEY REFERENCES
Infection Control	Reduction of HAIs using Contactless UV-C disinfection	[7],[25],[26]
Automation	Minimizing human effort and exposure	[2],[3]
Safety	Human detection and UV shutdown mechanisms	[5],[6],[18]
Intelligence	AI-based navigation and decision-making	[10],[15]
Connectivity	IoT, Cloud, and edge-based monitoring	[4],[11],[12]
Patient Care	Contactless patient monitoring	[27],[29],[30]

Table I: Resumes the main motivations and EnablingTechnologies, which promote the innovations of autonomous UV sterilization robots in healthcare.

To conclude, autonomous UV sterilization robots are a potentially valuable solution to the enhancement of healthcare facility hygiene, safety, and efficiency. These systems help in the move to intelligent and resilient smart hospitals by incorporating UV disinfection, autonomous navigation, human detection, IoT connectivity and patient monitoring. In this fast- growing field, the subsequent passages are an in-depth review of the available literature, methodology, comparative studies, and future studies.

2. Related Works

The analyzed literature will be divided according to the central theme of the research in a structured review-writing pattern that is often applied in IEEE review papers.

Group 1: General Healthcare Robotics and Autonomous Systems

The former type of works is dedicated to the use of autonomous robots in healthcare settings [1], [3], [39], [40]. Huang et al. [1] systematically reviewed the literature on intelligent physical robots applied in healthcare and identified cleaning, monitoring, and assistance as their applications. The research found out that autonomy, safety, and system integration were keynges. Shin et al. [3] surveyed autonomous mobile robots in the medical field and discovered the dependability of navigation and secure human-robot contacts as research topics. Silvera-Tawil [39] conducted a survey of healthcare robotics and stated that despite the growing adoption rate of robotic systems, they are yet to be integrated with digital health platforms. Yang et al. [40] surveyed the applications of robots in healthcare and came to the conclusion that the future robots should be capable of assisting several healthcare-related activities rather than performing only one purpose.

Group 2: UV Sterilization and Disinfection Technologies

The second category of sources is devoted to disinfection technologies based on ultraviolet [2], [7], [8], [25], [26]. Mehta and Saxena [2] described the study review of the UV disinfection robots and validated the fact that they are effective in reducing the microbial contamination in hospitals. Raeiszadeh and Adeli [7] investigated UV disinfection systems in the COVID-19 pandemic and noted the need to pay attention to the safety issues because of the adverse effects of human factors. exposure. Kowalski [8] gave the essential principles of UV germicidal irradiation, such as the dosage and limits of exposure. Ramos et al. [25] and Maugeri et al. [26] provided systematic hospital research and demonstrated that UV-C disinfection can significantly decrease healthcare-associated infections provided that it is accompanied with manual cleaning.

Group 3: Autonomous UV Sterilization Robots

The third category focuses on robotic UV sterilization devices [16]-[21], [33], [36], [38]. Chanprakon et al. [17] designed an autonomous UAV to clean up hospital rooms but it was with less navigation intelligence. Kamlaskar et al.

[19] suggested an automated room sanitizer with the help of UV-C tubes with pre-defined functionality. Awang et al.

[21] developed a UV floor sterilization robot which was controlled by Android. Sivayamini et al. [33] proposed an autonomous movement UV doctor robot with an IoT. Oseni et al. [36] emphasized the significance of the clinical robots automation but observed that there is no standardized performance testing of the UV robots.

Group 4: Human Detection and Vision-Based Safety

The fourth category deals with human detection and safety systems with computer vision [5], [6], [9], [18], [37]. YOLO was proposed by Redmon et al. [9] as a real-time object detector, appropriate in safety-critical robotic tasks. Faster R-CNN was proposed by Ren et al. [6], which has more detection accuracy but needs more computer resources. Azmin et al. [18] combined the vision-based navigation and human detection in UV robot to enhance the safety of the operations. Zachariae et al. [37] pointed out that it is crucial to have a reliable human detection to accept human-robot interaction within hospitals.

Group 5: IoT, Cloud, and Edge-Based Healthcare Systems

This team looks at the integration of IoT and cloud solutions in healthcare robotics [4], [11]-[13], [20], [22], [32], [34]. Islam et al. [4]

has provided an overview of the IoT in healthcare. Medical IoT data issues were debated by Dimitrov [11]. To minimize the latency in IoT systems, Shi et al. [12] proposed edge computing. Singh and Jindal [20] suggested a UVC sanitizing system based on IoT. Prasad et al. [22] and McGinn et al. [32] installed UV robots and monitored them on the cloud, whereas Matthew et al. [34] investigated biomedical robots that are 5G-enabled.

Group 6: Robotic Patient Monitoring Systems

The last category is concerned with patient monitoring and assistance robotic systems [27]-[31]. The proposal of Wu et al. [27] was an interactive patient monitoring robot with the use of. learning-based models. Contactless patient monitoring robotic arm was designed by Akash et al. [28]. Mireles et al. A mobile home-care vital sign monitoring robot was developed by [29]. Ali et al. [30] and Amrutha et al. [31] emphasized robotic systems, which minimize human interaction and yet provide an opportunity to monitor the patients at all times.

2.1 Literature Distribution Analysis

I have created a chart that represents the distribution of the 40 references in categories of research.References are distributed across research categories are:

- Robotics – 11.1%
- UV Disinfection – 13.9%
- Autonomous UV Robots – 25.0%
- Human Detection – 13.9%
- IoT & Cloud – 22.2%
- Patient Monitoring – 13.9%

Figure.1: The distribution of the reviewed studies (Refs. 1-40) by years.

The Figure 1 shows the distribution of the forty reviewed studies per year (Refs. [1]-[40]). Every bar is the count of publications on autonomous UV sterilization robots and healthcare robotic systems every year. The pronounced rise of publications after 2020 is a result of the heightened research interest because of the necessity of automation in the hospital and the post-pandemic challenges in terms of infection control.

3. Review Methodology

This review is based on a systematic and structured review technique as per IEEE review paper [15]. This methodology is aimed at providing transparency, reproducibility, and exhaustiveness of existing literature of the study in the field of autonomous UV sterilization robots in intelligent healthcare settings.

A. Review Objectives

The main aims of this review are to:

i. Discuss the current UV sterilization technologies in healthcare.

ii. Research independent robotic facilities that are carried out in disinfection.

iii. Study human detection and safety systems.

iv. Assess IoT-related monitoring and communication systems.

v. Determine gaps in the research and future directions.

B. Data Sources and Search Strategy

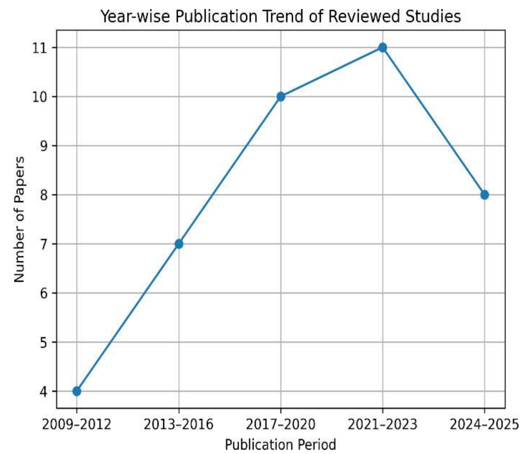
The pertinent research papers were gathered in large scientific databases such as IEEE Xplore, ScienceDirect, SpringerLink, and MDPI. These databases were chosen since they contain high-quality journals and conferences on robotics, healthcare technology, and IoT. Keywords that were used to search the information included, but were not limited to, the following_ UV sterilization robot, healthcare robotics, autonomy disinfection, human detection, and IoT patient monitoring.

C. Data Sources and Search Strategy

The pertinent research papers were gathered in large scientific databases such as IEEE Xplore, ScienceDirect, SpringerLink, and MDPI. These databases were chosen since they contain high-quality journals and conferences on robotics, healthcare technology, and IoT. Keywords that were used to search the information included, but were not limited to, the following_ UV sterilization robot, healthcare robotics, autonomy disinfection, human detection, and IoT patient monitoring.

D. Inclusion and Exclusion Criteria

Peer-reviewed journal articles and IEEE conference papers that are dated 2009-2025 were only taken into account [2]. Research on chemical disinfection, robotics in non-health care, or non-autonomous systems were eliminated. The screening was also done by removing duplicate publications



and non-English publications.

E. Paper Selection Process

Selection of the papers was based on four steps: identification, screening, eligibility assessment, and final inclusion.

Firstly, a considerable amount of articles was found by the use of keywords. The duplicates and irrelevant papers, after being eliminated, through screening of the title and abstracts, were subjected to full-text analysis.

Lastly, the number of selected high-quality and relevant studies was forty, which was subject to detailed review. Table II: Overview of Methodology used in the review.

STEP	DESCRIPTION
Data Sources	IEEE Xplore, ScienceDirect, Springer, MDPI
Keywords	UV sterilization robot, healthcare robotics, IoT, human detection
Time Period	2009–2025
Total Papers	40
Paper Types	Journals and IEEE Conferences
Classification	6 thematic groups

Table II: Review Methodology Summary.

F. Quality Assessment Criteria

Based on every chosen study, the most important information was taken like UV sterilization, navigation approach, human sensory detection system, IoT or cloud connection, patient monitoring feature, and the limitations reported. The reviewed works were grouped into six thematic groups based on these qualities to allow them to be compared and identify gaps in research.

G. Data Extraction and Classification

Based on every chosen study, the most important information was taken like UV sterilization, navigation approach, human sensory detection system, IoT or cloud connection, patient monitoring feature, and the limitations reported. The reviewed works were grouped into six thematic groups based on these qualities to allow them to be compared and identify gaps in research.

3.1 Methodology Flow Diagram

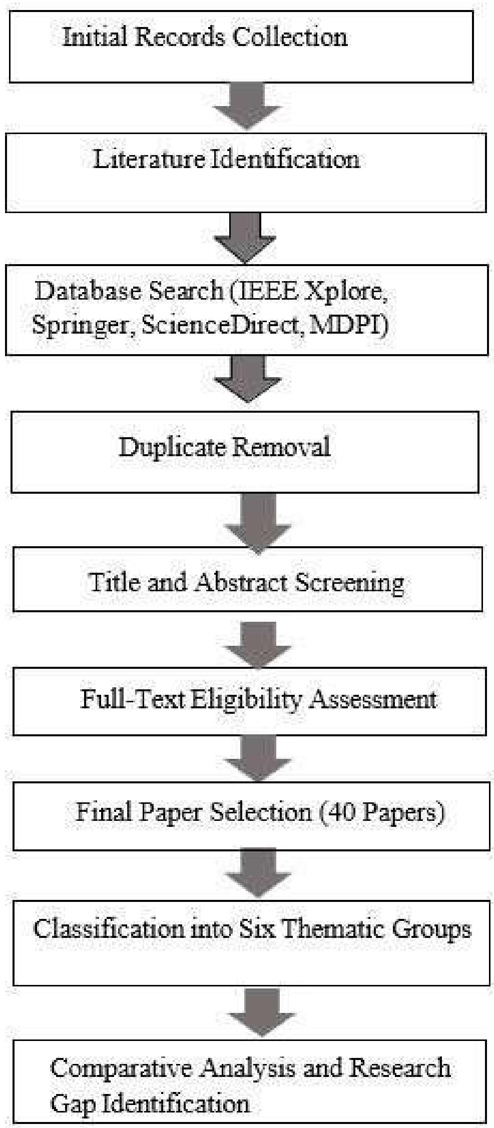


Figure 3: Flow chart of the systematic review process which will be used in the process of literature selection and analysis.

Figure 3 shows the method of systematic review used in the study. Database searches were used at first to identify relevant articles, then duplicates were eliminated, and screening was done according to titles and abstracts. Eligibility assessment on full-text was subsequently done and a final sample of forty high- quality articles was obtained.

These studies were further broken down into six thematic areas that would allow a systematic comparative study and the gaps in research.

A comparative analysis of available literature was done after systematically selecting and categorizing the pertinent literature to assess the functionality of existing systems. The reviewed works are analyzed in the following section according to the major characteristics of UV sterilization, autonomous navigation, human detection, and integration with IoT and are aimed at determining the research trends and gaps.

4. Comparative Study and Analysis

Group 17, Grouped object Textbox 23, Textbox This section is the whole comparative study of 40 reviewed works connected with the autonomous UV sterilization robots and healthcare robotic systems. Table III is a summary of the feature functions of each study: capability of UV sterilization, autonomous navigation, human detection, IoT or cloud integration, and ability to monitor the patient. The comparison shows the strengths, weaknesses and the features lacking in current systems.

Group 24, Grouped object Textbox 27, Textbox IN Table III, indicates the whole feature is implemented, grouped object Textbox 27, indicates the partial or limited or not implemented and the feature is not discussed in the study reviewed.

4.1 omparative Study

References	UV Sterilization	Autonomous Navigation	Human Detection	IOT/Cloud	Patient Monitoring	Key Limitation
[1]	✓	✕	✕	✕	✕	Fixed UV unit, no mobilit

						y
[2]	✓	✓	✕	✕	✕	**No human safety mechanism**
[3]	✓	✓	✕	✓	✕	**Standalone UV robot**
[4]	✓	✕	✕	✓	✕	**Manual operation**
[5]	✕	✓	✓	✕	✕	**No disinfection function**
[6]	✕	✓	✓	✓	✕	**Vision only, no UV**
[7]	✓	✕	✕	✕	✕	**Fixed room installation**
[8]	✓	✓	✕	✕	✕	**Predefined path only**
[9]	✓	✓	✕	✓	✕	**No real-time safety**
[10]	✕	✓	✕	✕	✕	**Navigation only**
[11]	✓	✕	✕	✓	✕	**No autonomy**
[12]	✓	✓	✕	✕	✕	**No cloud support**
[13]	✓	✓	o	✕	✕	**Limited sensing**
[14]	✕	✓	✓	✓	✕	**No sterilization**
[15]	✓	✓	✕	✕	✕	**No safety layer**
[16]	✓	✕	✕	✕	✕	**Manual UV control**
[17]	✓	✓	✕	✓	✕	**No human detection**
[18]	✕	✓	✓	✓	✕	**No UV module**
[19]	✓	✓	✕	✕	✕	**Static UV dosage**
[20]	✓	✕	✕	✓	✕	**Limited validation**
[21]	✓	✓	✕	✕	✕	**Indoor only**
[22]	✕	✓	✓	✕	✕	**Vision-based only**
[23]	✓	✕	✕	✕	✕	**Non-autonomous**
[24]	✓	✓	✕	✓	✕	**No patient interface**
[25]	✓	✕	✕	✕	✕	**Fixed UV exposure**
[26]	✕	✓	✓	✓	✕	**No disinfection**
[27]	✕	✓	✕	✓	✓	**Assistive robot only**
[28]	✕	✓	✕	✓	✓	**No UV capability**

[29]	✕	✓	✕	✓	✓	Patient monitoring only
[30]	✕	✓	✕	✓	✓	No sterilization
[31]	✓	✓	✕	✕	✕	No network intelligence
[32]	✓	✕	✕	✓	✕	Manual navigation
[33]	✓	✓	✕	✕	✕	No Safety intelligence
[34]	✕	✓	✓	✕	✕	Vision research only
[35]	✓	✓	✕	✓	✕	No patient data
[36]	✓	✕	✕	✕	✕	Fixed UV lamp
[37]	✕	✓	✓	✓	✕	No disinfection
[38]	✓	✓	✕	✕	✕	Navigation - Focused
[39]	✓	✕	✕	✓	✕	Limited autonomy
[40]	✓	✓	✓	✓	✕	No patient monitoring

Table III: Comprehensive Comparative Analysis of Reviewed Works (Refs. 1–40)

V.A Comparative Analysis Based on Table IIIV

Sterilization Capability A significant percentage of the analyzed literature is devoted to the efficacy of UV sterilization in the health care setting [7], [17], [25]. Nevertheless, most of these systems are installed as stationary systems or manual devices that lack autonomous movement. Even though UV-C radiation is demonstrated as an efficient method to inactivate pathogens, the lack of smart control and automation makes it impossible to implement it safely and at scale in a real hospital environment.

A. Healthcare Robots Autonomous Navigation Autonomous navigation has been extensively studied in the research of healthcare robots [10], [17], [38]. A number of UV sterilization robots use a set of established paths or simple obstacle avoidance software. The more sophisticated systems use SLAM-based navigation to enhance the effectiveness of coverage. However, navigation ability is not enough without the safety awareness and system level integration.

B. Human Detection and Safety Mechanisms Human detection is the least discussed feature in the works reviewed as it is evident in Table III. Few studies involve the use of a vision-based or deep learning

C. model like YOLO and Faster R-CNN to detect humans [5], [6], [18]. This is a serious weakness, as unintentional exposure to UV-C radiation is very dangerous to human health. This is because the absence of smart safety features greatly limits practical use.

D. IoT and Cloud Integration IoT and cloud connectivity can provide remote monitoring, data recording, and system monitoring within a healthcare setting [4], [11], [32]. Although a few UV robotic systems facilitate cloud-based monitoring, the problem of communication latency, cybersecurity and data privacy remain a significant challenge. As a result, there are a lot of UV sterilization robots that remain beasts to this day without network intelligence.

E. Patient Monitoring Capabilities Patient monitoring functions are mainly carried out in assistive and telehealth robots, as opposed to UV sterilization systems [27], [29], [30]. These robots can detect vital signs and decrease close human interaction yet they cannot disinfect. As it is indicated in Table III, the convergence between patient monitoring and UV sterilization functionality is lacking.

F. Cited Research Gap and Motivation Based on the comparison carried in Table III, it is clear that no current system incorporates UV sterilization, autonomous navigation, human detection, monitoring based on the IoT and patient monitoring into a single system. The existence of such a critical research gap highly encourages the creation of the fully integrated, intelligent, and safety-conscious UV sterilization robots of the new smart healthcare setting.

Gap Identified	Matching Future Direction
Lack of human detection	Edge AI safety models
No integration	Unified robot architecture
Cloud latency	Edge–cloud hybrid
Fixed UV dose	Adaptive UV control
No validation	Clinical trials

Table IV: Gap–To–Future-Scope Linkage.

Table IV presents the various UV dose control strategies in terms of flexibility, safety, and cost of the system. The control of UVs by hand and time, which is not adaptable to dynamic environments and can be treated as a danger to the safety of individuals, can be replaced by sensor-based and AI-controlled systems, which provide better safety and efficiency at the cost of an increased system complexity.

Feature Category	Number of Papers	Percentage (%)
UV Sterilization	32	80
Autonomous Navigation	26	65
Human Detection	9	22.5
IoT / Cloud Integration	14	35
Patient Monitoring	8	20
Fully Integrated Systems	0	0

Table V: Distribution of Feature Coverage in Reviewed Studies (Refs. 1–40)

Table V is a statistical summary of the major functional features in the literature reviewed. The findings show that there is a high focus on UV sterilization andautonomous navigation, with the abilities of human detection and monitoring of patients being rather poor.

5. Discussion

The review examined forty articles on the topic of autonomous UV sterilization robots, human detection, IoT integration, and patient monitoring of intelligent healthcare settings [1]-[40]. It can be clearly understood that the current research is quite disjointed according to the comparative study. The majority of the literature pays attention to one or two items, like the effectiveness of UV disinfection [7], [25], autonomous navigation.

Instead of creating integrated systems, [10], [17], or IoT-based monitoring [4], [11], could be used. Based on Table III, it can be seen that most UV sterilization robots do not have human detection measures, which is a severe safety issue because UV-C radiation is harmful to health.

on skin and eyes [7]. Few works utilize computer vision or deep learning methods to detect humans [5], [6], [18], and even the systems are not always connected to the IoT or monitoring patients. This restricts the application of this in the actual hospital settings where continuous monitoring and recording of data is a requirement.

The IoT and the cloud are extensively covered in the literature on healthcare monitoring [4], [11], [13], however, they have not yet been combined with UV sterilization robots [20], [22], [32]. Cloud systems offer scalability and remote monitoring, although they create latency and data protection issues, particularly when making safety-related decisions [12]. Edge computing has been proposed as a solution but extremely few UV robotic systems implement edge intelligence.

Patient monitoring robots are primarily designed as individual aid systems [27], [29], [30]. These robots decrease the direct contact of people and the risk of infection, yet they cannot carry out disinfection jobs. The non-convergence of UV sterilization, human safety, IoT connection and patient monitoring is evidently reflected in the feature distribution provided in Fig. X, where human detection and integrated intelligence are underrepresented.

Altogether, the discussion proves that there is no existing single system that can provide a comprehensive solution that would include all the mandatory functions that are needed within smart healthcare environments. The above observation is a powerful drive to conduct future studies on an integrated, intelligent and safety conscious UV sterilization robotic system. These observations highlight the need to establish fully integrated, safety-conscious and clinically-approved robotic disinfection systems, as it is further discussed in the concluding section.

Gap Identified	Matching Future Direction
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7. Conclusion and Future Scope

This review has critically evaluated forty studies that are associated with autonomous UV sterilization robots, human detection, IoT-based supervision, and robotic patient care within a smart healthcare setting [1]-[40]. The comparative analysis shows clearly that the majority of the existing systems focus on the components separately but not as a system. UV sterilization technology has been shown to be effective in minimizing healthcare-associated infections but its use without smart safety features is life- threatening to human health. Likewise, autonomous navigation technologies, IoT connectivity, and patient monitoring technologies have grown up on their own, however, little is done in terms of uniting all of them into a single robotic system.

It has been shown that the least developed feature is human detection, which is the most important feature in UV safety. The remote monitoring and IoT and cloud platforms make it possible.

scalability, but latency and data security issues limit their applications to safety-critical applications. Physical contact is effectively reduced by patient monitoring robots, which are employed with the combination of disinfection tasks very infrequently. Consequently, the vast majority of systems are not built to incorporate UV sterilization, autonomous driving, smart human recognition, Internet of Things-related control, and patient monitoring in one platform.

Future studies need to concentrate on the fully integrated and smart UV sterilization robots, which integrate these functions. The major trends are application of edge AI to identify human beings in real time, safe and efficient UV dose application to sterilize, protection of healthcare data with secure IoT infrastructures, and affordable robots that can be used in large hospitals. The real-world adoption will also require clinical validation and normal safety standards

To sum up, autonomous UV sterilization robots will become a successful solution to the next generation of smart healthcare settings. The future development of autonomous UV sterilization robotics will be instrumental in enhancing the power of hospital infection control and empowering smart healthcare systems. Solving the mentioned integration and safety gaps will offer a great deal of reliability, acceptance, and overall influence in the area of hospital infection control.

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