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Sensor-Based Intelligent Wearable Sun-Glasses

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Abstract

The sudden onset of rain is a familiar and annoying experience for anyone who wears glasses. Vision becomes hazy, droplets obscure the world, and the frequent desire to wipe the face results in smudges and disrupted activities. While sunglasses shield our eyes from the sun's glare, they provide no protection from the elements. What if eyewear could intelligently adjust itself not only to light but also to precipitation? Imagine a world in which sunglasses do more than just filter ultraviolet rays; they also actively detect rain and automatically clear vision. The revolutionary leap poised to alter the experience of wearing eyewear is sensor-based intelligent sunglasses equipped with an integrated rain detection and wiper system. This notion lies behind these revolutionary sunglasses. Traditionally worn eyewear provides no protection against raindrops, which might obstruct vision. Consequently, this involves either messy wiping with a hand or cloth (which frequently leaves streaks), or the complete removal of the glasses. Both options are problematic, particularly when engaging in activities such as driving, cycling, or working outside. For a long time, there has been an obvious need for a hands-free and autonomous solution. A fascinating intersection of microelectronics, materials science, and wearable technology has led to the development of sensor-based smart glasses that also have integrated wipers. Such inventions may move from the domain of science fiction into the realm of everyday reality as miniaturization continues to advance and power management continues to improve.

Keywords: Sensors, sun-glasses, rain detection, wipers, dust

INTRODUCTION

Sunglasses have been a fashion accessory and a need for protecting one's eyes for many decades. Their major purpose has been to reduce glare and prevent dangerous ultraviolet rays, and this has been the case with fashionable big frames as well as traditional aviators. Nevertheless, the world of eyewear is currently on the verge of undergoing a huge upheaval, as a result of the introduction of smart sunglasses that are based on sensors. These are not merely an upgrade; rather, they constitute a fundamental change that promises dynamic adaptation, increased safety, and seamless integration into our connected lives [1–3].

A form of adaptation has been provided by traditional photochromic lenses, often referred to as "transitional lenses." These lenses darken when exposed to ultraviolet light and clear when used indoors. Although they are effective, their response time can be lengthy, and their tint level is often a universally applicable chemical reaction.

This idea is taken to a whole new level with the introduction of sensor-based smart eyewear. The tint of these glasses may be actively and instantly adjusted thanks to the incorporation of miniature light sensors (typically ambient light and UV

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sensors), a tiny microprocessor built into the glasses themselves, and advanced electrochromic or liquid crystal layers embedded within the lenses.

Consider the following scenario: you are out on a stroll, enjoying the sunshine, then suddenly the sky darkens, and a few drops of rain fall on your face without warning. You quickly seek cover, wishing you had been better prepared. Suppose your sunglasses, which are the very accessory you rely on to protect you from ultraviolet light, were able to provide you with an early warning?

Enter the forward-thinking idea of sensor-based sunglasses for rain detection, a futuristic combination of fashion, technology, and functionality that is ready to change how we interact with the environment. Imagine a future where eyewear not only protects eyes from the sun but also functions as an intelligent companion, discreetly guiding through the unpredictable vagaries of nature [4–10].

These smart sunglasses are more than simply an accessory; they are a step toward a lifestyle that is more intuitive, connected, and prepared. They represent a step toward a way of life in which technology works invisibly to enrich our everyday experiences.

Imagine a world in which sudden rain does not cause vision to become blurry, and where droplets that fall down the lenses of sunglasses do not require squinting, pulling over, or uncomfortably wiping them with your sleeve. This is not a scene from a future movie; rather, it is the thrilling possibility of a new frontier in wearable technology: smart glasses that employ sensors and come equipped with a rain detection and wiper system integrated into the spectacles themselves.

The frustration of rain-streaked lenses is universal for everyone who wears protective eyewear, such as glasses or sunglasses. It makes visibility difficult, particularly when driving or riding, and it continuously interferes with activities that take place outside. What if your eyewear could automatically detect precipitation and clear itself independently?

Traditional glasses provide no protection against the elements. Lenses can be rendered opaque by precipitation, mist, or even heavy spray, transforming a clear view into a twisted jumble. Not only is this an annoyance, but it also poses a considerable risk to safety because it increases reaction time and obscures important information. There are several circumstances in which manual wiping is not only inefficient but also impractical because it leaves smudges behind.

Just for a moment, picture yourself walking along a city street with your sunglasses precisely adjusting to adapt to the changing light. Suddenly, a light drizzle of rain starts to fall. Instead of having to struggle to see through lenses that are splattered with water or fumbling around for a cloth, your glasses will gently whir as small wipers instantly clear your vision. This is not science fiction; it is the prospective future of smart eyewear; the design steps involved are a fascinating combination of sensor technology, micro-mechanics, and intelligent software [11–16].

One of the most prevalent problems for individuals who wear glasses and for cyclists is decreased vision due to water. The idea behind sensor-based sunglasses that also have a wiper system and rain detection is to solve this problem. The sophisticated design process that may bring such a forward-thinking device to reality is something that we should investigate further.

INTELLIGENT LENSES

By integrating cutting-edge sensor technology with small mechanical engineering, the idea of sensor-based smart glasses with integrated wipers proposes a solution that directly addresses this issue. The Way That It Operates:

1. *Rain Detection Sensors:* The core of this innovation lies in highly sensitive, miniaturized sensors embedded discreetly within the glass frame or around the lens periphery. These could be:
   - *Optical Sensors:* Similar to those used in modern car windshield wipers, these detect changes

in light refraction caused by water droplets on the lens surface.
- *Capacitive Sensors:* These measure changes in electrical capacitance when water makes contact with the lens, indicating the presence of liquid.
- *Piezoelectric Sensors:* These could detect the subtle vibrations caused by falling raindrops, triggering the system.
- *Humidity Sensors:* While not directly detecting rain on the lens, these could serve as a pre-emptive measure, activating the system when atmospheric humidity reaches a certain threshold.

2. *Micro-Wiper System:* Once rain is detected, a sophisticated, almost imperceptible micro-wiper system springs into action.
   - *Miniature Motors:* Tiny, efficient motors, powered by a small, integrated battery, would drive the wiper mechanism. These motors would be designed for quiet, smooth operation.
   - *Flexible Blades:* Ultra-thin, durable, and highly flexible wiper blades, possibly made from advanced polymers or composites, would sweep across the lens surface. Their design would minimize obstruction and maximize cleaning efficiency.
   - *Discreet Placement:* The wipers could be positioned along the top or bottom edge of the frame, retracting completely when not in use, or even be designed as a thin, unobtrusive strip that spans the lens.
3. *Intelligent Control Unit:* A miniature processing unit (microcontroller) would interpret the sensor data in real-time, determining the intensity of the rain and adjusting the wiper speed and frequency accordingly. This ensures optimal visibility without unnecessary operation, conserving battery life.

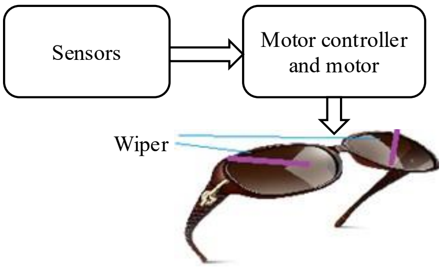

Figure 1. Proposed method.

The suggested system is depicted in Figure 1, which includes sensors, a motor controller, and a motor operating device. This system is coupled to the wiper located on the spectacles. The wiper is activated upon the beginning of precipitation [17–21].

Because of their size, the obstructions they cause, and their aesthetics, conventional mechanical wipers, such as those seen on a car, are not suitable for spectacles. The discussion, however, centers on several novel, non-contact procedures, as seen in Figure 2:

- *Ultrasonic Vibrations:* This is a leading contender. Piezoelectric actuators embedded in the frame or lens edges could generate high-frequency ultrasonic vibrations. These vibrations would cause water droplets to coalesce and then literally "jump off" the hydrophobic surface of the lens, much like self-cleaning oven technology or advanced camera lens cleaners.
- *Micro-Air Jets:* Tiny, precisely directed air nozzles could be incorporated into the frame, delivering concentrated bursts of air to clear water from the lens surface. This would require compact air compressors and efficient power management.
- *Electro-Wetting/Electro-Osmosis:* This cutting-edge technology manipulates the surface tension of liquid droplets using an electric field. By applying a voltage, water droplets can be made to spread out and then rapidly retract, effectively clearing the surface. This offers very precise control but is complex to miniaturize.
- *Advanced Hydrophobic/Oleophobic Coatings:* While not active "wipers," these coatings are essential enablers. They prevent water droplets from adhering or smearing, allowing the active

clearing mechanisms (ultrasonic, air jets) to work far more effectively by causing water to bead up and roll off easily.

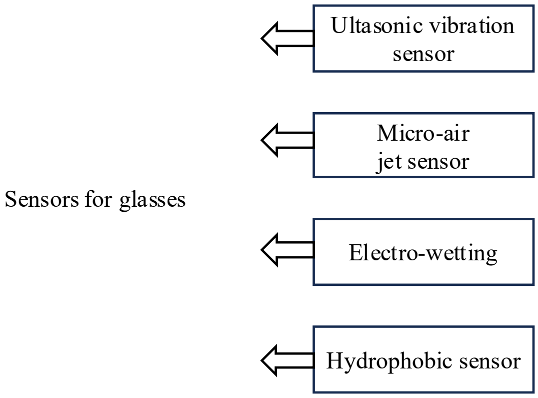

Figure 2. Sensors for smart glasses.

While rain detection and wiping are the primary functions, this technology opens the door to a host of other possibilities:

- *Self-Cleaning:* The same wiper system could be activated manually or automatically to clear dust, smudges, and fingerprints from the lenses, keeping them pristine.
- *Anti-Fogging:* Integrating tiny heating elements or even micro-fans could prevent lenses from fogging up in humid or cold conditions, a common issue for all eyeglass wearers.
- *Adaptive Tinting:* Combined with photochromic technology, the glasses could not only adjust to changes in light but also anticipate weather conditions, tinting appropriately before a sunshower.
- *Augmented Reality Integration:* While not directly related to clarity, the sophisticated sensor array could also feed environmental data into an AR display, providing real-time weather updates, navigation, or other contextual information.

The applications for such smart eyewear are vast:

- *Commuters:* Cyclists, motorcyclists, and pedestrians would experience safer, more comfortable journeys.
- *Outdoor Enthusiasts:* Hikers, runners, campers, and adventurers would maintain clear vision no matter the weather.
- *Professionals:* Construction workers, field scientists, delivery drivers, and anyone working outdoors would benefit from uninterrupted visibility.
- *Everyday Wearers:* Simply navigating daily life in unpredictable weather would become much more convenient.

Bringing this vision to mass market reality involves several engineering hurdles:

- *Miniaturization:* Making the wipers, motors, and sensors small enough to integrate seamlessly into stylish, lightweight frames without adding bulk or significantly altering aesthetics.
- *Power Efficiency:* Ensuring long battery life in such a compact form factor.
- *Durability & Reliability:* The system must withstand constant exposure to the elements, dust, and daily wear and tear.
- *Cost:* High-tech components and precision manufacturing could make these glasses expensive initially.
- *Maintenance:* How easy would it be to clean or replace the micro-wiper blades?

This idea of sensor-based smart glasses with integrated wipers represents a considerable leap forward in personal convenience and safety, notwithstanding the presented hurdles. If sensor technology continues to advance, micro-electromechanical systems (MEMS) continue to decrease in size, and battery efficiency continues to improve, then the dream of automated, clear vision in any weather

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conditions appears to be getting closer to reality [22–25].

Self-wiping smart glasses are no longer a far-off vision; they are pushing the boundaries of wearable technology and promising a future in which our relationship with the elements will be governed by intelligent design, leaving us with a truly unimpeded perspective of the world. Clear vision appears to have a brighter future than ever before, regardless of the weather [26].

First and foremost, before delving into the components, it is necessary to describe the fundamental problem and the desired solution. The problem is that rain makes it difficult to see through eyeglasses, and cleaning manually is an inconvenience. Solution: Rain can be detected automatically, and lenses can be actively cleared of precipitation. Key requirements for the system are as follows:

- Accurate and fast rain detection.
- Effective and quiet lens clearing.
- Compact, lightweight, and aesthetically pleasing design.
- Long battery life.
- Durable and weather-resistant construction.
- Minimal obstruction of user's field of view.

DESIGN STEPS: BRINGING THE CONCEPT TO REALITY

Figure 3 shows the design steps for intelligent glasses employing rain detector sensors.

1. Rain Detection System: The Eyes of the Glasses
   This is the system's foundation. How do the glasses "know" it is raining?
   - *Sensor Selection:*
     - *Optical/Infrared (IR) Sensors:* A common choice. This involves an IR emitter and receiver. When water droplets land on a specific area of the lens (or a dedicated sensor window), they refract or scatter the IR light differently, causing a change in the received signal. This change indicates the presence of rain.
     - *Capacitive Sensors:* Similar to smartphone touchscreens, these can detect changes in capacitance caused by water on their surface. They can be integrated discreetly along the edges of the lens.
     - *Acoustic Sensors (Less Common):* Microphones could potentially detect the sound pattern of raindrops, but this is less reliable for specific lens-clearing and more prone to false positives (e.g., general street noise).

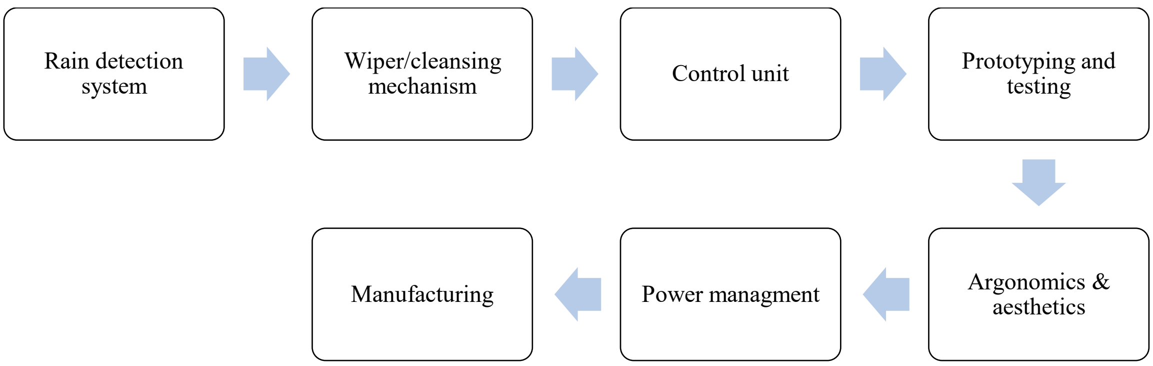

Figure 3. Design steps.

- *Sensor Placement:* Critical for accuracy and aesthetics. Sensors should be placed unobtrusively, perhaps embedded in the frame near the top edge of the lenses or as a transparent overlay on a non-vision-critical part of the lens.
- *Algorithm Development:* The raw sensor data needs intelligent processing. The microcontroller must differentiate between brief splashes, persistent rain, condensation, and

general humidity. Thresholds and time-based filtering will be crucial to prevent accidental wiper activation.

2. Wiper/Cleansing Mechanism: The Active Clearing System
   Once rain is detected, how is it cleared? This is where miniaturization and precision engineering are paramount.
   - *Mechanism Options:*
     - *Micro-Wipers:* The most direct approach. This involves incredibly small, lightweight wiper blades (perhaps silicone or a soft polymer) driven by miniature stepper or coreless DC motors. The challenge is designing a path that clears the full lens area without being bulky or obstructing vision when inactive.
   - *Design Consideration:* The wipers could be housed in the upper frame, deploying downwards, or integrated into the lens itself via a transparent track.
     - *Piezoelectric Vibration:* A more elegant, non-mechanical approach. Piezoelectric actuators can vibrate the lens at high frequencies, causing water droplets to coalesce and roll off (hydrophobic effect assisted by vibration). This is quieter and has fewer moving parts but may be less effective for heavy, persistent rain.
     - *Air Blasts (Less Practical):* Tiny air pumps could generate precise air streams to clear water. However, the size, noise, and power consumption would likely make this impractical for eyewear.
     - *Hydrophobic Coatings (Passive Enhancement):* While not an active clearing system, advanced superhydrophobic coatings are essential. They ensure water beads up and rolls off easily, making the active clearing mechanism more efficient and requiring less effort.
   - *Power Transmission:* If micro-wipers are used, tiny gears and shafts would be required to transfer motion from the motor to the wiper arm. These components must be incredibly durable and precise.
3. Control Unit & Software: The Brains of the Operation
   This is the central nervous system, integrating sensor input with actuator output.
   - *Microcontroller (MCU):* A low-power, compact MCU (e.g., an ARM Cortex-M series or similar) would process sensor data, manage power, and control the wiper motor(s).
   - *Firmware Development:*
     - *Sensor Data Processing:* Interpreting raw data, filtering noise, and deciding when to activate the wipers.
     - *Wiper Control Logic:* Determining wiper speed, duration, and frequency based on rain intensity.
     - *Power Management:* Implementing sleep modes, low-power states, and intelligent battery usage.
     - *User Interface (Optional):* Basic LEDs for status, or Bluetooth connectivity for a companion smartphone app to adjust settings or update firmware.
4. Power Management: Keeping It Running
   Wearable tech demands efficient, long-lasting power.
   - *Battery:* Miniaturized Lithium-Polymer (LiPo) batteries offer high energy density in a small form factor. Battery cells would need to be discreetly integrated into the arms or frame of the glasses.
   - *Charging:* USB-C charging port or, ideally, wireless charging capabilities for convenience and better water resistance.
   - *Power Management ICs (PMICs):* Essential for efficient charging, discharging, and overall power regulation, extending battery life and ensuring safety.
5. Ergonomics & Aesthetics: Wearability is Key
   No matter how advanced the technology, if it is uncomfortable or unsightly, it will not be adopted.
   - *Form Factor:* All components (sensors, motors, battery, PCB) must be seamlessly integrated into a sleek, lightweight frame that resembles regular glasses. The challenge is minimizing bulk.

- *Weight Distribution:* Balanced weight across the Nose Bridge and ears for comfort during extended wear.
- *Durability & Water Resistance:* The entire system must be sealed and rated for water resistance (e.g., IPX7) to withstand rain and splashes.
- *Material Selection:* Lightweight yet robust materials like titanium, high-grade plastics, or carbon fiber composites.
- *Optical Clarity:* The sensors and wiper mechanism must not interfere with the user's field of vision or compromise the optical quality of the lenses themselves. The lenses may also incorporate smart tinting for sun protection.

6. Prototyping & Testing: Iterate and Refine
   This is an iterative process of building, testing, and refining.
   - *Rapid Prototyping:* 3D printing custom frames and component mounts, breadboarding electronics.
   - *Environmental Testing:* Simulating various rain conditions (light drizzle, heavy downpour, splash) to validate sensor accuracy and wiper effectiveness.
   - *Durability Testing:* Stress tests for the wiper mechanism, battery cycles, and overall structural integrity.
   - *User Trials:* Gathering feedback on comfort, ease of use, and overall experience.
7. Miniaturization & Manufacturing: Ready for Production
   The final hurdle is to transition from a functional prototype to a mass-producible product.
   - *Custom PCBs (Printed Circuit Boards):* Designing highly compact, multi-layered PCBs to fit within the narrow confines of the glasses frame.
   - *Custom Components:* Sourcing or manufacturing specialized micro-motors, gears, and wiper blades.
   - *Assembly Automation:* Developing precise assembly processes, potentially involving robotics for microscopic components.

If successful, the design and development of sensor-based eyewear equipped with rain sensing and wipers promises to bring about a new level of convenience and safety for anyone who has ever struggled with impaired vision during a sudden deluge. It would transform a typical inconvenience into a seamless and clear-sighted experience.

DISCUSSION

Imagine that you leave your house and go out into a sudden downpour, but instead of fumbling for a tissue or clumsily wiping your glasses with your sleeve, your vision is unaffected by the rain. This is not a scene from a far-off science fiction film; rather, it is a notion that is now being studied and developed: sensor-based smart glasses that are equipped with automated rain detection and a responsive "wiper" mechanism.

All individuals, including motorists, bikers, construction workers, and pedestrians who are just passing by, are subject to the persistent nuisance of rain covering their eyeglasses. Traditional approaches involve human labor and frequently cause disruptions. The promise of smart glasses, on the other hand, opens the door to a truly hands-free and uninterrupted visual experience, even in inclement weather.

Despite its promise, the realization of this vision involves substantial hurdles:

- *Miniaturization:* Integrating sensors, actuators, power sources, and control electronics into a sleek, lightweight pair of glasses without being cumbersome or unsightly.
- *Power Consumption:* Active clearing systems, especially ultrasonic or air jets, can be power-intensive. Ensuring long battery life in a compact form factor is crucial.
- *Durability and Maintenance:* The system must withstand the elements, be resistant to damage, and be easy to clean (the "wiper" mechanism itself).

- *Cost:* Initial development and manufacturing costs will likely be high, making them a premium product.
- *Field of View:* Any clearing mechanism must not obstruct the user's field of view or cause distracting visual artifacts.
- *Reliability:* The system must be highly reliable, distinguishing actual rain from other environmental factors, and activating consistently when needed.

It is a testament to the continued desire for seamless technological integration into our everyday lives that the conversation surrounding sensor-based smart glasses for rain detection and automated wiping is taking place. The notion is becoming closer to being a reality as sensor technology continues to become more compact and economical, as well as micro-actuator and surface science continue to progress.

It is possible that the future of eyeglasses will involve more than just correcting eyesight or displaying information; rather, it will involve actively ensuring that the wearer's vision is not constrained in any way, regardless of the weather. These intelligent glasses have the potential to reimagine how we interact with our surroundings. They provide a look into a future in which technology will anticipate our requirements and ensure that our vision is, both literally and symbolically, of the highest possible clarity.

CONCLUSION

A big step forward in the process of personalized environmental adaptation is represented by the development of sensor-based smart glasses that incorporate rain detection and wiper systems. Through the use of cutting-edge sensor technology and thorough engineering, this invention has the potential to completely free individuals who wear glasses from the persistent annoyance of having their eyesight clouded by rain. This research and development represents a fundamental dedication to improve the comfort, safety, and convenience of users in any and all weather conditions. In order to provide a fully hands-free and consistently clear vision of the world, it is not enough to simply add a feature; rather, it is necessary to completely reimagine how eyewear may interact with our surroundings. In light of the fact that we are looking into the future, these smart glasses are well on their way to becoming a vital tool. They will guarantee that the wearer's eyesight will remain exceptionally clear regardless of the weather.

REFERNCES

1. Mulani AO, Bang AV, Birajadar GB, Deshmukh AB, Jadhav HM, Liyakat KK. IoT based air, water, and soil monitoring system for pomegranate farming. Ann Agri-Bio Res. 2024;29(2):71–86.
2. Parihar B, Kiran A, Valaboju S, Rashid SZ, Liz DRA. Enhancing data security in distributed systems using homomorphic encryption and secure computation techniques. ITM Web Conf. 2025;76:02010.
3. Veena C, Sridevi M, Liyakat KKS, Saha B, Reddy SR, Shirisha N. HEECCNB: An efficient IoT-cloud architecture for secure patient data transmission and accurate disease prediction. In: Proc. 7th Int Conf Image Inf Process (ICIIP); 2023. p. 407–10.
4. Tamboli DA, Sawant VA, MH M, Sathe S. AI-driven-IoT (AIIoT) based decision-making—KSK approach in drones for climate change study. In: Proc. 4th Int Conf Ubiquitous Comput Intell Inf Syst (ICUIS); 2024. p. 1735–44.
5. Prasad KR, Karanam SR, et al. AI in public-private partnership for IT infrastructure development. J High Technol Manag Res. 2024;35(1):100496.
6. Liyakat KKS. Detecting malicious nodes in IoT networks using machine learning and artificial neural networks. In: Proc. Int Conf Emerg Smart Comput Informatics (ESCI); 2023. p. 1–5.
7. KSK. A novel approach on ML based palmistry. Grenze Int J Eng Technol. 2024;10(2):5186–93.
8. KSK. IoT based boiler health monitoring for sugar industries. Grenze Int J Eng Technol. 2024;10(2):5178–85.

9. Keerthana R, K V, Bhagyalakshmi K, Papinaidu M, V V, Liyakat KKS. Machine learning based risk assessment for financial management in big data IoT credit. SSRN Electron J. 2025.
10. Iyakat KKS. Heart health monitoring using IoT and machine learning methods. In: Shaik A, editor. AI-Powered Advances in Pharmacology. IGI Global; 2025. p. 257–82.
11. Liyakat KKS. AI-driven-IoT-based decision making in kidney diseases patient healthcare monitoring: KSK approach. In: Polat LÖ, Polat O, editors. AI-Driven Innovation in Healthcare Data Analytics. IGI Global; 2025. p. 277–306.
12. Liyakat KKS. Machine learning approach using artificial neural networks to detect malicious nodes in IoT networks. In: Udgata SK, Sethi S, Gao XZ, editors. Intelligent Systems. Lecture Notes in Networks and Systems. Vol. 728. Singapore: Springer; 2024.
13. Pradeepa M, et al. Student health detection using a machine learning approach and IoT. In: 2022 IEEE 2nd MysuruCon. 2022.
14. Mahant MA. Machine learning-driven Internet of Things-based healthcare monitoring system. In: Wickramasinghe N, editor. Digitalization and the Transformation of the Healthcare Sector. IGI Global; 2025. p. 205–36.
15. Mulani AO, Liyakat KKS, Warade NS, et al. ML-powered Internet of Medical Things structure for heart disease prediction. J Pharmacol Pharmacother. 2025.
16. Odnala S, Shanthy R, Bharathi B, Pandey C, Rachapalli A, Liyakat KKS. Artificial intelligence and cloud-enabled e-vehicle design with wireless sensor integration. SSRN Electron J. 2025.
17. Neeraja P, Kumar RG, Kumar MS, Liyakat KKS, Vani MS. DL-based somnolence detection for improved driver safety and alertness monitoring. In: 2024 IEEE IC2PCT. 2024. p. 589–94.
18. Magadum PK. Machine learning for predicting wind turbine output power in wind energy conversion systems. Grenze Int J Eng Technol. 2024;10(1):2074–80.
19. Nerkar PM, Dhaware BU. Predictive data analytics framework based on heart healthcare system using machine learning. J Adv Zool. 2023;44(Special Issue 2):3673–86.
20. Shinde SS, Nerkar PM, Kazi SS, Kazi VS. Machine learning for brand protection: A review of a proactive defense mechanism. In: Khan M, Haq MAU, editors. Avoiding Ad Fraud and Supporting Brand Safety. IGI Global; 2025. p. 175–220.
21. SilpaRaj M, Kumar RS, Jayakumar K, Gopila M, Kumar SS. Scalable IoT-enabled intelligent solutions for proactive energy engagement in smart grids. In: Kannadhasan S, et al., editors. Proc Int Conf Sustainability Innovation in Computing and Engineering (ICSICE 24). 2025.
22. Upadhyaya AN, Surekha C, Malathi P, Suresh G, Suriyan K, Liyakat KKS. Pioneering cognitive computing for transformative healthcare innovations. SSRN Electron J. 2025.
23. Patil JM, Velapure AS, Khadake SB. The intersection of nanotechnology and IoT: New era of connectivity. Int J Appl Nanotechnol. 2025;11(1):9–17.
24. Mulla NR, Liyakat KKS. Node MCU and IoT Centered Smart Logistics. Int J Emerg IoT Technol Smart Electron Commun. 2025;1(1):20–36.
25. Todakar RD, Jadhav VK. Kinetic Power Gyms for Revolutionizing Fitness. J Telecommun Switch Syst Netw. 2025;12(2):13–21.
26. Liyakat KKS. Cardiovascular Modeling with Computational and Mathematical Methods. Res Rev J Bioinform. 2025;12(2):1–11.