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Sensor and AI-Based Pre-Detection Systems Transfiguring Intoxication and Smoking

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Abstract

The ubiquitous problems of drunkenness and uncontrolled smoking continue to pose substantial hazards to public health, safety, and productivity in a world that is becoming more linked and protective of its personal safety. The costs to society and the economy are substantial, and they range from automobile accidents caused by impaired driving to accidents that occur in the workplace, and from chronic health disorders that are connected to smoking to the risk of fires. A new frontier in preventive technology is emerging, however, and it is comprised of advanced artificial intelligence (AI) and sensor-based systems that are geared for the pre-detection of smoking and intoxication. The use of these cutting-edge solutions has the potential to transform our strategy from reactive mitigation to proactive prevention, thereby protecting lives and habitats through the prevention of potential harm. Intoxication and smoking treatments that are currently available frequently fall short of expectations. After an incident or at a traffic stop, breathalyzers are often utilized to investigate the situation. As a result of human enforcement, smoking regulations are frequently disregarded, which causes people to be exposed to secondhand smoke and increases the risk of fire. Due to the limitations of current reactive procedures, there is an urgent requirement for real-time, non-invasive, and intelligent technologies that are able to recognize possible problems before they become more severe. When it comes to our efforts to make communities safer and healthier, the development of AI and sensor-based drunkenness and smoking pre-detection systems represents a huge step forward. The potential to avoid a large number of accidents, health crises, and fatalities is enormous, despite the fact that there are still significant obstacles to overcome, such as ethical considerations and issues of public acceptance.

Key terms: Sensors, artificial intelligence, pre-detection, intoxication, smoking

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INTRODUCTION

The quest for improved public safety, health, and operational efficiency is driving innovation across a wide range of industries that are becoming increasingly linked. Integrated detection systems that recognize intoxication and smoking are among the most promising breakthroughs in information technology. Moving beyond the capabilities of traditional smoke alarms and breathalyzers, these advanced technologies provide proactive real-time monitoring capabilities, which have the potential to revolutionize safety measures in a variety of settings [1–4].

The issue of intoxication, whether caused by alcohol, drugs, or even extreme exhaustion, continues to be a widespread concern globally. It impairs judgment, lowers reaction times, and greatly contributes to accidents, injuries, and fatalities across numerous sectors, from road safety to industrial workplaces, and even personal well-being. The breathalyzer has been the dominant instrument for real-time assessment for several decades; however, a new generation of advanced intoxication detection devices is currently evolving, which promises to provide a more complete, proactive, and less intrusive method for recognizing impairment [5–9].

The paradigm is evolving from reactive measures (such as roadside sobriety tests after an incident) to proactive prevention, with the goal of identifying impairments before they lead to injury. These new methods have resulted in this transformation. The necessity for such systems arises from the presence of considerable and frequently avoidable dangers.

- *Intoxication:* Alcohol and drug impairments are the leading causes of accidents and fatalities on roads, in workplaces, and in public spaces. They compromise judgment, reaction time, and coordination, thereby posing a direct threat to individuals and those around them. Existing methods often rely on reactive testing after an incident or visible impairment, which can occur too late.
- *Smoking:* Secondhand smoke poses a serious health hazard to nonsmokers. Furthermore, smoking in restricted areas (hospitals, aircraft, public transport, and hotels) creates significant fire risks and violates regulations, leading to fines and property damage. Traditional detection is often passive and relies on human reporting or the detection of established fires.

Upon detection, the system can trigger various automated responses:

- *Real-time alerts:* Security personnel, supervisors, or even the individual.
- *Automated shutdowns:* Such as preventing a vehicle from starting.
- *Recording of incidents:* For compliance and analysis.
- Activation of ventilation systems.

Applications Across Sectors

- *Automotive:* Integrated into vehicles, these systems can prevent impaired driving by locking the ignition or alerting authorities. They are invaluable to commercial fleets (trucking, taxis, and public transport) to ensure driver safety.
- *Workplace safety:* In industries such as manufacturing, construction, and logistics, detection systems can monitor workers in high-risk environments, preventing accidents due to impairment. They can also enforce smoking policies in hazardous or clean environments.
- *Public spaces and hospitality:* Airports, train stations, hospitals, hotels, and casinos can use these systems to enforce no-smoking policies, reduce fire risks, and identify individuals who may be in danger to themselves or others due to intoxication.
- *Residential and smart homes:* Future applications might include smart home integration to promote healthier living environments and safety.
- *Correctional facilities:* To prevent the use of contraband substances.

Benefits Beyond Detection

- *Enhanced safety:* Significantly reduces accidents and injuries.
- *Improved health:* Reduces exposure to secondhand smoke and discourages smoking.
- *Regulatory compliance:* Helps organizations adhere to strict safety and health regulations, avoiding hefty fines.
- *Reduced liability and costs:* lower insurance premiums, preventing property damage, and mitigating legal risks.
- *Operational efficiency:* Automated monitoring frees up human resources from constant surveillance.
- *Proactive intervention:* Allows timely intervention before incidents occur, rather than reactive responses.

While promising, these systems face important challenges:

- *Privacy concerns:* Continuous monitoring raises significant questions about individual privacy and data security. Therefore, transparent policies and robust data protection are important.
- *Accuracy and false positives:* Distinguishing between actual impairment/smoking and other factors (e.g., strong perfume, vaping, and a naturally unsteady gait) requires highly sophisticated algorithms and ongoing refinement.
- *Public acceptance:* Implementing such systems requires careful communication and education to gain public trust and to avoid a "big brother" perception.
- *Cost:* Initial investment and maintenance can be substantial, although often offset by long-term savings.
- *Ethical deployment:* Ensuring that the technology is used fairly, without bias, and only for its intended safety and health purposes is paramount.

Greater miniaturization, increased precision, and pervasive integration are future directions for drunkenness and smoking detection systems are headed towards. It is reasonable to anticipate that these systems will be seamlessly integrated into our infrastructure as artificial intelligence (AI) skills continue to progress and sensor technology becomes more affordable. This includes anything ranging from smart buildings and automobiles to public transport hubs and personal wearables.

At the end of the day, these intelligent detection systems are not simply about enforcing regulations; rather, they are about encouraging safer surroundings, protecting health, and utilizing technology to create a society that is more accountable and secure for everyone. Finding a happy medium between innovation and concerns about privacy and ethics is essential for the successful and widespread adoption of these technologies [10–15].

SENSORS AND ARTIFICIAL INTELLIGENCE TRANSFIGURING INTOXICATION AND SMOKING DETECTION

The pursuit of safer settings continues to push the bounds of innovation in a world that is becoming increasingly driven by data and intelligent technologies. Intoxication and smoking are two major public health and safety concerns that have long been sources of substantial obstacles. These two issues are responsible for a seemingly endless number of accidents, health complications, and regulatory headaches. A new era of proactive detection and prevention is about to begin, and it is going to be ushered in by the strong combination of AI and improved sensor technologies [16–18].

This cutting-edge technology is not merely a notion from a distant future; rather, it is rapidly becoming a reality, delivering intelligent solutions for a wide range of issues, including public health, workplace compliance, and car safety. Before digging into technology, it is essential to have a solid understanding of the widespread impact that certain behaviors currently have:

- *Intoxication:* Whether due to alcohol or other impairing substances, intoxication severely compromises judgment, reaction time, and coordination. This has led to a tragic number of road accidents, workplace injuries, and incidents in public spaces. Current detection methods often rely on reactive measures (e.g., breathalyzer tests after an incident) or human observations, which can be subjective and fallible.
- *Smoking:* Beyond direct health risks to smokers, secondhand smoke poses serious dangers to others. Moreover, smoking in prohibited areas (e.g., public transport, hospitals, fuel stations, and airplanes) is a fire hazard and a violation of public health regulations. Traditional detection often relies on visual cues or basic smoke detectors that can be slow, prone to false alarms, or easily circumvented.

The AI- and sensor-based system address these challenges using a multi-layered approach are as follows.

The Sensors: The Eyes and Noses of the System

This technology leverages various sophisticated sensors, each designed to capture specific data points.

Intoxication Detection

- *Breathalyzer sensors:* Advanced versions that can be integrated discreetly, measuring blood alcohol content (BAC) from exhaled breath.
- *Biometric sensors:* They monitor heart rate variability, skin conductance, and pupil dilation, which can change under the influence of certain substances.
- *Behavioral sensors (cameras and accelerometers/gyroscopes):* High-resolution cameras combined with AI can analyze subtle changes in facial expressions, eye movements (e.g., drooping eyelids, saccades), head posture, and overall body language. Accelerometers and gyroscopes can detect erratic movements, changes in gait, or signs of drowsiness.
- *Voice analysis:* AI can detect slurred speech or changes in vocal patterns, indicative of impairment.

Smoking Detection

- *Particulate sensors:* Highly sensitive sensors that detect specific particulate matter released by burning tobacco or vaping aerosols and differentiate them from general dust or steam.
- *Volatile organic compound (VOC) sensors:* Identify the unique chemical signatures of smoke and vapor, offering greater accuracy than traditional smoke alarms.
- *Thermal cameras:* Can detect the heat signature of a lit cigarette or vapor device.
- *Visual recognition (cameras):* AI-powered cameras can identify patterns of smoking (e.g., hand-to-mouth movements, exhaling smoke/vapor clouds) even in low-light or crowded environments.

The AI: The Brain of the Operation

Raw sensor data are noisy without intelligence. This is where AI, specifically machine learning algorithms, comes into play.

- *Data fusion:* The AI system integrates and correlates data from multiple sensors simultaneously. For example, a slight change in eye movement combined with a detected trace of alcohol in the breath and a minor sway could strongly indicate impairment.
- *Pattern recognition:* AI models are trained on vast datasets of both impaired/smoking and normal behavior. They learn to identify subtle and complex patterns that humans might miss, distinguishing genuine threats from benign activities.
- *Real-time analysis:* The AI processes data in milliseconds, allowing for immediate detection and alerts.
- *Adaptive learning:* Continuously refined through new data, AI can improve its accuracy over time, reducing false positives and negatives.
- *Contextual awareness:* Advanced systems can consider the environment (e.g., time of day and movement of a vehicle versus a stationary person) to enhance detection accuracy.

A ubiquitous smart detection system is becoming possible because of the confluence of AI, Internet of Things (IoT), and sophisticated sensor technology. As AI algorithms continue to advance in sophistication and sensors continue to shrink in size, become more powerful, and become more affordable, these systems will become increasingly widespread [19–25].

The ultimate objective is not the implementation of punitive surveillance but rather the development of surroundings that are safer, healthier, and more accountable for all individuals. Through intelligent detection and mitigation of hazards connected with drunkenness and smoking, AI and sensor-based systems are set to become silent guardians, thereby having a significant impact on the safety and well-being of the public. The issue lies in the development of these powerful technologies in a responsible manner, ensuring that they look out for the best interests of humanity while still protecting fundamental rights.

SENSOR AND AI-BASED INTOXICATION AND SMOKING PRE-DETECTION SYSTEMS

This pursuit of safety, health, and productivity is of utmost importance in a society that is becoming increasingly interconnected. Accidents and long-term health problems continue to be significantly influenced by human mistakes, which are frequently worsened by impairments or harmful behaviors. Just for a moment, try to picture a future in which possible dangers are recognized before they cause harm. This is precisely the promise that is being made by newly developed AI and sensor-based pre-detection systems for smoking and intoxication.

To identify subtle indications and patterns suggestive of impairment or smoking behavior, these cutting-edge systems utilize the power of advanced sensors in conjunction with intelligent AI algorithms. This provides a proactive approach to risk reduction [25–33]. At the heart of these systems are highly developed sensor arrays and highly effective AI engines.

Advanced Sensors

Chemical Sensors

Designed to detect specific VOCs associated with alcohol (ethanol), drugs (e.g., THC metabolites, opioid traces), or components of smoke and vapor (nicotine, carbon monoxide, specific particulate matter). These devices can be integrated into breathalyzers, air quality monitors, and wearable devices.

Thermal and Infrared Sensors

It can detect changes in skin temperature, blood flow, or specific heat signatures associated with fever (a symptom of some illnesses that could affect judgment) or even heat from a lit cigarette.

Optical and Vision Sensors (Cameras)

The optical and vision sensors coupled with computer-vision AI. These can analyze:

- *Facial cues:* pupillary dilation, eye redness, droopy eyelids, and facial flushing (intoxication).
- *Body language and gait:* Unsteady walking, poor balance, fidgeting, slowed reflexes, or jerky movements (for intoxication).
- *Behavioral patterns:* Frequent hand-to-mouth gestures, clandestine movements, and exhalation patterns (for smoking/vaping).
- *Smoke/vapor plume detection:* Visual identification of smoke or vapor clouds.

Acoustic Sensors (Microphones)

It is used to analyze speech patterns, slurring, or changes in voice tone and pitch, which can indicate impairment.

Biosensors (Wearables)

Emerging technologies can monitor heart rate variability, sweat composition, or even micro-expressions for signs of physiological stress or drug presence.

Artificial Intelligence

The true intelligence of these systems lies in AI, particularly machine learning and deep learning algorithms.

- *Data fusion:* AI combines data streams from multiple sensors, providing a holistic and more accurate assessment than any single sensor.
- *Pattern recognition:* AI is trained on vast datasets of both impaired and unimpaired, smoking and non-smoking behaviors, and environmental signatures. It learns to recognize subtle and complex patterns that humans might miss.
- *Predictive analytics:* Beyond simple detection, AI can analyze trends and early indicators to predict the likelihood of impairment or smoking *before* it becomes a significant risk.
- *Contextual awareness:* Advanced AI can learn environmental cues, distinguish between similar-looking substances (e.g., steam versus vapor), and adapt to individual baselines that are permissible and ethical.

DESIGN STEPS FOR SENSOR AND ARTIFICIAL INTELLIGENCE BASED INTOXICATION AND SMOKING PRE-DETECTION SYSTEMS

The hidden dangers of drunkenness and smoking continue to pose substantial issues in a variety of settings, including workplaces, healthcare facilities, public areas, and transportation, among others. Some systems can detect events after they have occurred; however, the actual frontier is pre-detection, which involves identifying behaviors or physiological indicators that suggest an impending risk. This enables prompt intervention and preventive actions to be undertaken. Because of the confluence of advanced sensor technologies and AI, this lofty objective is becoming an increasingly feasible option.

To design these systems, several important elements must be considered, including the following.

Accuracy and Reliability

Minimizing false positives and negatives is paramount. This requires high-quality sensor calibration, robust AI training datasets, and validation against real-world scenarios. Multi-modal sensor fusion significantly enhances accuracy.

Privacy and Ethics by Design

This is perhaps the most sensitive aspect.

- *Anonymization:* Data should be processed and stored with privacy in mind, anonymizing personal identifiers whenever possible.
- *Consent:* Clear communication and explicit consent regarding data collection and usage are essential, particularly in non-mandatory environments.
- *Purpose limitation:* Data should only be used for its stated purpose (e.g., safety, health, and compliance) and not for surveillance or discrimination.
- *Transparency:* Users must understand how the system works, what data is collected, and how alerts are generated.
- *Non-intrusiveness:* The system should blend seamlessly into the environment to avoid overt surveillance or discomfort.

User Acceptance and UX

For widespread adoption, the system must be:

- *Unobtrusive:* Ideally, it operates in the background without requiring active user engagement.
- *Respectful:* It should avoid making users feel constantly monitored or judged.
- *Fair:* The bias in algorithms must be diligently addressed to ensure equitable treatment across all user demographics.

Hardware Integration and Form Factor

- *Discreet placement:* Sensors should be integrated into the existing infrastructure (e.g., vehicles, smart building components, wearable devices) to be as invisible as possible.
- *Robustness:* Designed for a specific environment (temperature, humidity, dust, and vibration).
- *Power efficiency:* Especially critical for battery-operated or portable units.

Scalability and Connectivity

- *IoT compatibility:* Systems should be integrated easily with existing IoT ecosystems for data transmission and centralized monitoring.
- *Edge computing:* Processing complex AI algorithms at the sensor level (edge) reduces latency and bandwidth requirements and enhances real-time responsiveness.

Actionable Outputs and Intervention Protocols

Risk detection is the first step. The system was designed as follows.

- *Generate timely alerts:* Notify relevant parties (e.g., drivers, supervisors, security personnel) promptly and discreetly.

- *Trigger appropriate responses:* This could range from a gentle reminder, notification to a designated support person, or, in critical scenarios, automatic system shutdowns (e.g., preventing a vehicle from starting).
- *Provide contextual information:* Beyond just an alert, ideally, the system provides enough data for a human to understand the context and make an informed decision.

Despite its enormous potential, there are still substantial obstacles to overcome. Public acceptance, which is mostly driven by concerns regarding privacy and surveillance, is a significant obstacle. It is impossible to achieve hundred percent accuracy owing to the complexity of human behavior and physiology, which necessitates careful management of false positives through meticulous management. To accept new technologies in a responsible manner, regulatory frameworks must evolve.

The development of such a complex system is a multi-faceted endeavor that calls for competence in the areas of data science, ethics, hardware, and software. The important design steps involved in the development of AI and sensor-based pre-detection systems for drunkenness and smoking are outlined in this article. Figure 1 illustrates these steps are as follows.

Phase 1: Define the Problem and Scope
Conceptualization and Problem Definition

- *What exactly are we detecting?* Is alcohol intoxication, specific drug use, or smoking/vaping—Each method requires different sensing approaches.
- *What is the intended environment?* A manufacturing plant, vehicle, hospital, or public restroom—The environment dictates the sensor choice, privacy considerations, and deployment logistics.
- *Who are the target users/beneficiaries?* Employees, drivers, patients, and the public—This influences the user interface, alert mechanisms, and legal and ethical frameworks.
- *What is the desired outcome?* Is it intended to trigger an intervention, send an alert, restrict access, or simply gather data for trends?
- *What level of accuracy is acceptable?* False positives can lead to inconvenience or disciplinary action, whereas false negatives can endanger lives.

Identify Key Indicators and Behaviors

- *Intoxication:* Speech patterns (slurring, volume changes), gait abnormalities, facial micro-expressions (flushing, drooping eyelids), eye movements (nystagmus), body odor changes, reduced reaction time, and erratic behavior.
- *Smoking/vaping:* Presence of smoke/vapor, specific chemical compounds (e.g., nicotine byproducts), hand-to-mouth gestures, characteristic lighting/inhaling movements, and specific device detection (e.g., vapor pens).
- *Physiological markers:* Heart rate variability, skin temperature, breath composition.

Phase 2: Data Acquisition and Engineering
Sensor Selection and Data Acquisition Strategy

This is the core of the system and requires a multi-modal approach for robust detection.

Chemical Sensors

This may be the most direct result. Breathalyzers, for instance, analyze alcohol vapor content, whereas more advanced sensors can detect VOCs associated with cannabis or other substances. Particulate matter sensors (PM2.5, PM10) are crucial for identifying smoke, along with specific gas sensors that can detect components such as carbon monoxide, nicotine, or vape aerosols. Breathalyzers (alcohol) and VOC sensors (alcohol, cannabis metabolites, and nicotine).

Optical Sensors (Cameras)

Cameras integrated with computer-vision AI can identify subtle behavioral cues. For intoxication, this might include changes in gait, posture, facial expressions (e.g., glazed eyes, drooping eyelids), pupil dilation, or reaction times. For smoking, cameras can detect hand-to-mouth gestures, the presence of smoke plumes, or even the distinct glow of a cigarette or a vapor device. Detecting flushing, eye drooping, and micro-expressions.

- *Body pose estimation:* Analyzing gait, balance, and hand-to-mouth gestures for smoking.
- *Object detection:* Identifying cigarettes, lighters, vape devices.
- *Thermal cameras:* Detecting changes in skin temperature or blood flow patterns.

Thermal Sensors

Changes in body temperature can sometimes correlate with intoxication, although this is less direct and is typically used in conjunction with other data points.

Auditory Sensors

While less common for direct detection, the analysis of speech patterns, slurring, or changes in voice tone could potentially indicate impairment. These sensors are acoustic sensors (microphones) that analyze speech patterns (pitch, volume, slurring, and prosody) for intoxication.

Wearable/Environmental Sensors

Smartwatches, rings, or environmental sensors embedded in rooms or vehicles can monitor vital signs (heart rate variability and skin conductance); movement patterns, or air quality changes that might signal the presence of smoke or an impaired state. Smartwatches, rings, and patches monitor heart rate, skin conductivity, movement, and potentially specific chemical markers via sweat.

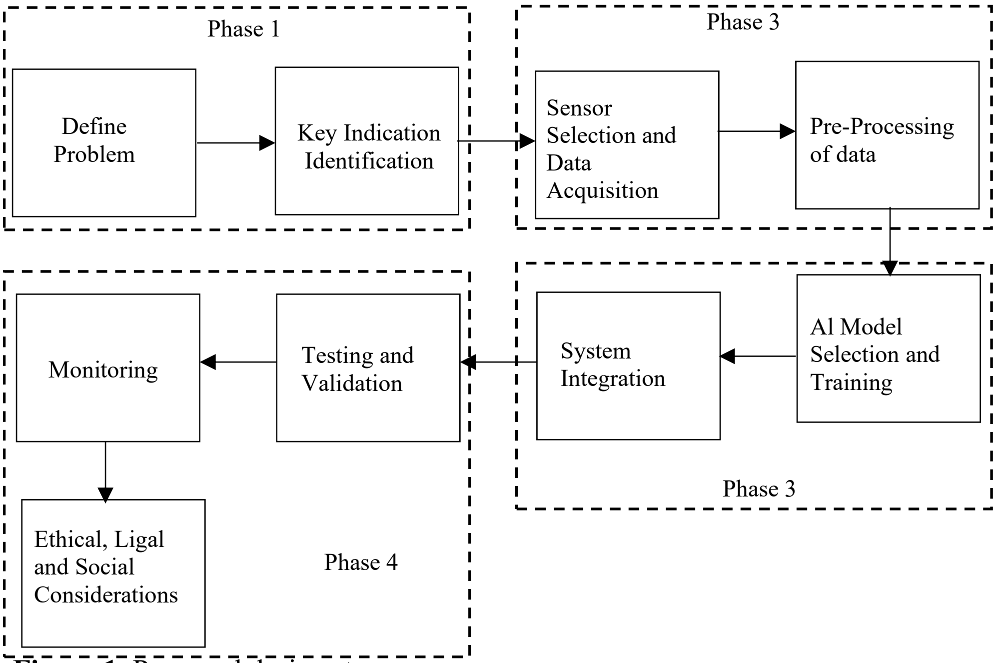

Figure 1. Proposed design steps.

Radar/Lidar

Detecting subtle body movements, gait changes, or even breathing patterns from a distance.

Environmental Sensors

Smoke/vapor detectors, air quality sensors to confirm presence of airborne compounds.

Data Acquisition

Establishing protocols for ethical and consent-based data collection, ensuring diversity in data (different demographics, conditions, and levels of impairment/smoking) to prevent bias.

Data Pre-Processing and Feature Engineering

Raw sensor data are often noisy, incomplete, and not directly usable by AI models, as shown in Figure 2.

- *Noise reduction and filtering:* Removing irrelevant signals, environmental interference.
- *Synchronization:* Aligning data streams from multiple sensors taken at different sampling rates.
- *Normalization and scaling:* Standardizing data ranges for consistent model input.
- *Feature extraction:* This is crucial for AI. The system requires distilled, meaningful features instead of raw pixels or sound waves.
    - *Vision:* Facial landmarks, movement vectors, optical flow, smoke plume density, shape, and movement.
    - *Audio:* Mel-frequency cepstral coefficients (MFCCs), pitch contours, speaking rate, pause duration.
    - *Chemical:* Specific compound concentrations, change over time.
    - *Physiological:* Heart rate variability metrics, skin temperature gradients.

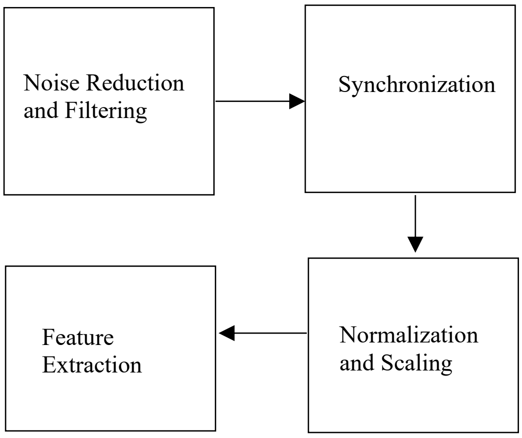

Figure 2. Data pre-processing and feature engineering.

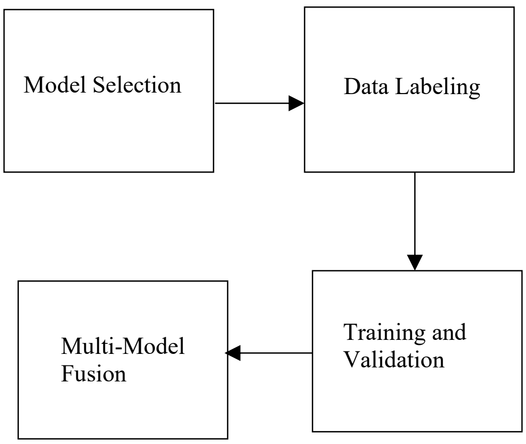

Figure 3. AI model selection and training.

Phase 3: AI Model Development and Integration

AI Model Selection and Training

As shown in Figure 3, it is explained as follows.

Model Selection

- *Deep learning (DL):* In particular, convolutional neural networks (CNNs) are used for image/video data (facial analysis, smoke detection) and recurrent neural networks (RNNs)/transformers for sequential data (speech, time-series physiological data).

- *Traditional machine learning (ML):* Support vector machines (SVMs), random forests, and gradient boosting for simpler feature-based classification are often used in conjunction with DL for multi-modal fusion.

Data Labeling

Meticulously tagging vast amounts of data with ground truth (e.g., “intoxicated,” “sober,” “smoking in progress”). However, this is often the most time-consuming step.

Training and Validation

The labeled dataset was split into training, validation, and test sets. Iteratively, training models, hyperparameter tuning, and cross-validation are used to optimize the performance and prevent overfitting.

Multi-Modal Fusion

Combining outputs from different sensor modalities (e.g., vision, audio, and chemical) at the data, feature, or decision level to improve accuracy and robustness.

System Integration and Prototyping

- *Hardware integration:* Embedding sensors, processing units (edge AI for real-time processing), and communication modules into a cohesive device or system infrastructure.
- *Software architecture:* Development of the software stack, including sensor drivers, data pipelines, AI inference engines, alert systems, and user interfaces.
- *Prototyping:* Building initial prototypes for functional testing in controlled environments. Focusing on real-time processing capabilities and latency.

Phase 4: Testing, Deployment, and Ethical Governance

Rigorous Testing, Validation, and Refinement

- *Alpha/beta testing:* Deploying prototypes in diverse real-world scenarios with a controlled group of users.
- *Performance metrics:* Evaluating accuracy, precision, recall, F1-score, and critically, *false positive rate* (FPR) and *false negative rate* (FNR). For pre-detection, balancing the FPR is crucial.
- *Edge case handling:* Testing under various lighting conditions, background noise, user demographics, and different levels of impairment/smoking habits.
- *Continuous improvement:* Using feedback and performance data to retrain models, refine algorithms, and iterate on hardware/software design.

Deployment, Monitoring and Maintenance

- *Scalable deployment:* Planning for widespread distribution and installation.
- *Real-time monitoring:* Systems are implemented to track sensor health, AI performance, and anomalies.
- *Over-the-air (OTA) updates:* Allowing for remote software and model updates to improve performance and adapt to new scenarios.
- *Data privacy and security:* Implementing robust encryption, anonymization techniques, and secure data storage to protect sensitive user information. Adhering to regulations such as General Data Protection Regulation (GDPR) and Health Insurance Portability and Accountability Act (HIPAA).

Ethical, Legal and Social Considerations

This is not a standalone step, but an overarching principle guiding the entire design process.

- *Privacy by design:* Minimizing data collection, processing data on-device where possible (edge AI), and ensuring transparency regarding data usage.

- *Bias mitigation:* Actively working to prevent algorithmic bias based on race, gender, age, or other protected characteristics during data collection and model training.
- *Transparency and explainability:* Communicating how the system works, what it detects, and its limitations.
- *Consent:* Obtaining explicit and informed consent from individuals where personal data was collected, especially in non-mandatory scenarios.
- *Potential for misuse:* Acknowledging and designing safeguards against the system being used for surveillance, discrimination, or punitive measures without adequate oversight.
- *Regulatory compliance:* Ensuring adherence to local and international laws regarding surveillance, data privacy, health, and labor.

DISCUSSION

Intoxication Pre-Detection

Imagine a system in a commercial vehicle: as the driver approaches, thermal cameras might detect subtle facial flushing, whereas a breath sensor in the steering wheel confirms trace alcohol. AI then analyzes these inputs along with pre-recorded baseline data (e.g., driver's typical gait and alertness levels). If a pre-determined threshold is crossed, it could trigger an alert to a supervisor, prevent the vehicle from starting, or recommend a further test. In a public space, discreet ceiling-mounted sensors might detect uncharacteristic gait patterns or slurred speech, alerting security personnel to a potential safety concern.

Smoking Pre-Detection

In a non-smoking zone, such as a hospital or factory floor, air quality sensors constantly monitor specific particulate matter or chemical compounds associated with smoke or vapor. Concurrently, vision systems may identify individuals with specific hand-to-mouth motions or by exhaling a visible plume. AI correlates these indicators, filtering out false positives (e.g., steam from a coffee cup) and, upon confirmation, can send an alert, trigger a localized announcement, or even activate a designated ventilation system.

The discussion on AI and sensor-based intoxication and smoking pre-detection is not about a simple "yes" or "no." Instead, it calls for a thoughtful, multi-faceted approach:

- *Rigorous testing and validation:* Extensive real-world testing is essential to refine algorithms and ensure high accuracy and reliability across diverse populations and conditions.
- *Transparency and explainability:* Users and the public need to understand how these systems work, what data they collect, and how decisions are made. Black-box AI fosters mistrust.
- *Robust privacy safeguards:* Implementing strong data anonymization, encryption, and strict access controls coupled with clear data retention policies is nonnegotiable.
- *Ethical guidelines and oversight:* Establishing independent ethical review boards and developing industry-wide best practices can help to guide responsible development and deployment.
- *Public dialogue and education:* Fostering open discussions with citizens, policymakers, and civil liberties advocates is vital for shaping acceptable deployment strategies.
- *Focus on empowerment, not just enforcement:* While enforcement is a component, these systems should also explore how they can empower individuals to make healthier choices and proactively enhance their safety.

Key Applications and Benefits

1. *Workplace safety:* Critical in industries such as manufacturing, construction, transportation, and healthcare to prevent accidents caused by impaired judgment, ensuring worker safety and compliance.
2. *Transportation:* Integrated into vehicles (cars, trucks, and public transport) to monitor drivers, significantly reducing drunk or drugged driving incidents. It could also be used in airports or on aircraft to detect smoking violations.

3. *Public spaces:* Stadiums, concert venues, schools, hospitals, and hotels can use these systems to maintain a safe, healthy, and compliant environment, protecting patrons and staff from secondhand smoke and potential incidents related to public intoxication.
4. *Residential and hospitality:* Smart home systems could integrate detection for family safety, while hotels could deter smoking in non-designated rooms, reducing cleaning costs, and enforcing policies.
5. *Healthcare:* While not primarily for “pre-detection” of patient conditions, passive monitoring could alert staff to patients attempting to smoke where forbidden or provide early behavioral cues indicative of other issues.

Creating surroundings that are safer and healthier is a huge step forward, and AI and sensor-based drunkenness and smoking pre-detection technologies represent a significant leap forward. It is reasonable to anticipate that these “smart guardians” will be seamlessly incorporated into our infrastructure as the technology improves, miniaturizes, and becomes more sophisticated with enhanced AI and edge computing. This includes anything from vehicles and offices to smart cities and locations that are centers for public transportation.

It is necessary to navigate intricate ethical landscapes and ensure that technology supports mankind rather than intruding upon it to complete the following voyage. On the other hand, these systems can proactively mitigate hazards, save lives, and build a society that is more responsible and healthier for everyone if they are designed with careful consideration, robust regulation, and a focus on human well-being taken into consideration.

CONCLUSION

An important step forward in the direction of preventive health and safety management is the development of AI and sensor-based pre-detection systems for drunkenness and smoking. A rigorous design process that prioritizes accuracy, robustness, privacy, and user confidence is essential to the success and ethical acceptance of such systems, despite the enormous technological promises. To foster healthier societies and create safer surroundings, we can harness the power of AI by carefully navigating these design phases. In conclusion, AI and sensor-based pre-detection systems designed to identify drunkenness and smoking offer a frontier that has enormous potential to create surroundings that are safer and healthier. Nevertheless, to fully realize this promise, a delicate balance must be struck between the aspirations of technology and the responsibilities of society. By participating in strong public discourse, emphasizing ethical design, and establishing clear regulatory frameworks, we can make use of these powerful tools to enhance the well-being of the collective without compromising fundamental human rights.

REFERENCES

1. Mulla NR, Kazi KSL. Air flow analysis in sensor-based aircraft wings design. Recent Trends Fluid Mech. 2025;12(2):29–39.
2. Mulla NR. A study on machine learning for metal processing: a new future. Int J Mach Des Technol. 2025;1(1):56–69.
3. Kazi KSL, Mulla NR. Sensor-based aircraft wings design using airflow analysis. Int J Image Process Smart Sens. 2025;1(1):55–65.
4. Mulla NR, Liyakat KKS. Node MCU and IoT centered smart logistics. Int J Emerg IoT Technol Smart Electron Commun. 2025;1(1):20–36.
5. Todakar RD, Jadhav VK, Kazi KSL. Kinetic power gyms for revolutionizing fitness. J Telecommun Switch Syst Netw. 2025;12(2):13–21.
6. Kazi KSL. The future is smelling: exploring the potential of e-nose. J Semicond Devices Circuits. 2025;12(1):16–27.
7. Kazi KSL. E-skin: a revolutionized technology. Res Rev J Embedded Syst Appl. 2025;13(1):1–11.
8. Babitha M, Sushama C, Gudivada VK, Kazi KSL, Bandaru SR. Trends of artificial intelligence for online exams in education. Int J Eng Comput Sci Eng. 2022;14(1):2457–63. doi:10.9756/INT-JECSE/V14I1.290.

9. Kazi S, Shaikh M, Kazi K. Machine learning in the production process control of metal melting. J Adv Mach. 2023;8(2):23-8.
10. Mishra SB, Kazi SLS, Kazi KSL. Nanotechnology's importance in mechanical engineering. J Fluid Mech Mech Des. 2024;6(1):1–9.
11. Mishra SB, Kazi SLS, Kazi KSL. Review of the literature and methodological structure for IoT and PLM integration in the manufacturing sector. J Adv Mach. 2024;9(1):1–5.
12. Aavula R, Deshmukh AB, Mane VA, Chavhan GH, Sayyad LK. Design and implementation of sensor and IoT-based remembrance system for closed one. Telematique. 2022;21(1):2769–2778.
13. Kazi KSL. IoT-based substation health monitoring. In: Saikia R, Kumari P, Singh S, Jadhav S, Pradhan B, Goni KM, Zandekar AL, editors. Magnification of Research: Advanced Research in Social Sciences and Humanities: Innovative Approaches and Insights for Academic Excellence. ERU, USA and ERC India: Independently Published; 2023. p. 160–71.
14. Kazi KSL. System for love healthcare for loved ones based on IoT. In: Saikia R, Keerthi BKC, Kannadhasan S, Fukey L, editors. Research Exploration: Transcendence of Research Methods and Methodology. 5th ed. Guwahati (IN): Eudoxia Education Pvt Ltd, Research Beacon Publication; 2025. p. 295–305.
15. Kazi KSL. Smart motion detection system using IoT: a NodeMCU and Blynk framework. J Microelectron Solid State Devices. 2023;10(3):1–8.
16. Mulani AO. IoT-based air, water, and soil monitoring system for pomegranate farming. Ann Agri-Bio Res. 2024;29(2):71-86. doi:10.53941/agrbio.2024.100009.
17. Parihar B, Kiran A, Valaboju S, Rashid SZ, Kazi KSL, Liz ADRS. Enhancing data security in distributed systems using homomorphic encryption and secure computation techniques. ITM Web Conf. 2025;76:02010. doi:10.1051/itmconf/20257602010.
18. Veena C, Mulagundla S, Kazi KSL, Saha B, Reddy SR, Shirisha N. HEECCNB: an efficient IoT-cloud architecture for secure patient data transmission and accurate disease prediction in healthcare systems. 2023 Seventh International Conference on Image Information Processing (ICIIP), Solan, India. 2023. pp. 407–410. doi:10.1109/ICIIP61524.2023.10537627.
19. Kazi KSL, Khadake SB, Tamboli DA, Sawant VA, Mallad HM, Sathe S. AI-driven IoT (AIIoT)-based decision-making—KSK approach in drones for climate change study. 2024 4th International Conference on Ubiquitous Computing and Intelligent Information Systems (ICUIS), Gobichettipalayam, India. 2024. pp. 1735–1744. doi:10.1109/ICUIS64676.2024.10866450.
20. Prasad KR, Karanam SR, Ganesh D, Kazi KSL, Talasila V, Purushotham P. AI in public–private partnership for IT infrastructure development. J High Technol Manag Res. 2024;35(1):100496. doi:10.1016/j.hitech.2024.100496.
21. Kazi KSL. Malicious node detection in IoT networks using artificial neural networks: a machine learning approach. In: Singh VK, Sagar AK, Nand P, Astya R, Kaiwartya O, editors. Intelligent Networks: Techniques and Applications. Boca Raton (FL): CRC Press; 2024. p. 16. doi:10.1201/9781003541363.
22. Kazi KS. KK approach for IoT security: T-cell concept. In: Kumar R, Peng S, Jain P, Elngar A, editors. Deep Learning Innovations for Securing Critical Infrastructures. Hershey (PA): IGI Global Scientific Publishing; 2025. p. 369–90. doi:10.4018/979-8-3373-0563-9.ch022.
23. McManus RJ, Mant J, Haque MS, Bray EP, Bryan S, Greenfield SM, et al. Effect of self-monitoring and medication self-titration on systolic blood pressure in hypertensive patients at high risk of cardiovascular disease: the TASMIN-SR randomized clinical trial. JAMA. 2014;312(8):799–808. DOI: 10.1001/jama.2014.10057. PubMed: 25157723.
24. Natale P, Ni JY, Martinez-Martin D, Kelly A, Chow CK, Thiagalingam A, et al. Perspectives and experiences of self-monitoring of blood pressure among patients with hypertension: a systematic review of qualitative studies. Am J Hypertens. 2023;36(7):372–84. DOI: 10.1093/ajh/hpad021. PubMed: 36840919.
25. Naseer A, Alkazemi BY, Waraich EU. A big data approach for proactive healthcare monitoring of chronic patients. In: 8th International Conference on Ubiquitous and Future Networks (ICUFN). IEEE; 2016. p. 943–5. DOI: 10.1109/ICUFN.2016.7536935.

26. Yip B, Hirai HW, Kuo YH, Meng HM, Wong S, Tsoi KKF. Blood pressure management with data capturing in the cloud among hypertensive patients: a monitoring platform for hypertensive patients. In: IEEE International Congress on Big Data. IEEE; 2015. p. 305–8. DOI: 10.1109/BigDataCongress.2015.50.
27. Nandyal S, Gada AR. A holistic approach for patient health care monitoring system through IoT. In: 2nd International Conference on Green Computing and Internet of Things (ICGCIoT). IEEE; 2018. p. 68–72. DOI: 10.1109/ICGCIoT.2018.8753098.
28. Kim JY, Wineinger NE, Steinhubl SR. The influence of wireless self-monitoring program on the relationship between patient activation and health behaviors, medication adherence, and blood pressure levels in hypertensive patients: a substudy of a randomized controlled trial. J Med Internet Res. 2016;18(6):e116. DOI: 10.2196/jmir.5429. PubMed: 27334418.
29. Alfian G, Syafrudin M, Ijaz MF, Syaekhoni MA, Fitriyani NL, Rhee J. A personalized healthcare monitoring system for diabetic patients by utilizing BLE-based sensors and real-time data processing. Sensors (Basel). 2018;18(7):2183. DOI: 10.3390/s18072183. PubMed: 29986473.
30. AbuDagga A, Resnick HE, Alwan M. Impact of blood pressure telemonitoring on hypertension outcomes: a literature review. Telemed J E Health. 2010;16(7):830–8. DOI: 10.1089/tmj.2010.0015. PubMed: 20815751.
31. Yarows SA, Julius S, Pickering TG. Home blood pressure monitoring. Arch Intern Med. 2000;160(9):1251–7. DOI: 10.1001/archinte.160.9.1251. PubMed: 10809027.
32. Verma N, Singh S, Prasad D. A review on existing IoT architecture and communication protocols used in healthcare monitoring system. J Inst Eng (India) Ser B. 2022;103(1):245–57. DOI: 10.1007/s40031-021-00632-3.
33. Ullah SE, Alauddin T, Zaman HU. Developing an e-commerce website. 2016 International Conference on Microelectronics, Computing and Communications (MicroCom), Durgapur, India. 2016. p. 1–4. DOI: 10.1109/MicroCom.2016.7522526.

