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Ethical Concerns of Autonomous Vehicles: An AI Framework

PRIYANKA BEHKI • VAIBHAVI SHREYA • RESHMA • ANIYA KUMARI • SANSKAR

Abstract. Autonomous vehicles (AVs) are a promising technical development that has the ability to completely rework the transportation enterprise. However, there are a whole lot of moral problems with their full-size utilization that need to be well explored. The ethical components of AV improvement and alertness are examined in this paper, with specific emphasis on problems of safety and accountability. When designing and using AVs, safety should come first. To keep away from mishaps and store lives, it is essential to guarantee the dependability and sturdiness of AV structures. The allocation of risks and the possibility that AVs would get worse already-current societal injustices are also moral problems. Another important issue inside the development of AVs is privateness worries. Concerns concerning personal privacy and the possibility of misuse of facts are raised through the gathering and use of facts by AVs. To keep the general public's acceptance as true with statistics safety and openness must be guaranteed. Bias and equity are huge moral issues as proper. AVs want to be made with identical remedies for all customers of the street in mind, without discrimination allowed. To keep away from unexpected results, viable biases within the algorithms utilized in AVs have to be thoroughly tested and corrected. Accountability is but every other vital ethical issue. It can be tough to assign blame for AV-associated incidents without cautiously weighing ethical and legal frameworks. Clear liability tips can help to keep public confidence and sell the use of independent cars.

Keywords: Autonomous Vehicles, Synthetic Intelligence, Ethical issues, Choice-making, Data privateness.

INTRODUCTION

The creation of self-driving motors, powered via sophisticated AI systems, guarantees to reduce site visitors' accidents, enhance transportation efficiency, and provide mobility to the ones unable to force. However, these blessings include huge moral questions that should be addressed to ensure that the deployment of such technology is in the public's first-class interest.

Ethical concerns associated with self-driving vehicles more often than not revolve across the choice-making abilities of AI, the protection and reliability of self-sufficient structures, the ability for bias in AI algorithms, and the broader societal influences, together with job displacement and adjustments in urban infrastructure. This paper aims to provide a comprehensive evaluation of those moral dilemmas and advises a study method to look into these problems prescribed. By combining a comprehensive literature evaluation with public opinion facts, we are trying to provide a holistic view of the ethical landscape surrounding self-sufficient cars.

A further important factor of AV improvement is privacy. Concerns concerning personal privateness and the possibility of statistical misuse are raised with the aid of the collection and use of information via AVs. To preserve the general public's acceptance as true, information security and openness must be assured. To shield humans' privateness, certain guidelines need to be established for information series, garage, and dissemination [Rof18].

When growing AVs, fairness and prejudice are important ethical elements to recollect. All avenue customers ought to be dealt with fairly and without discrimination, that's why those systems want to be evolved, therefore. It is essential to very well investigate the algorithms hired in AVs for any potential biases and take suitable action to rectify them to keep away from unforeseen repercussions.

Accountability is yet every other essential ethical problem. It can be hard to assign blame for AV-associated incidents without cautiously weighing moral and prison frameworks. Clear legal responsibility tips can help to hold public self-assurance and promote the use of self-sufficient automobiles.

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This essay will move into outstanding depth about these moral problems, searching on the possible repercussions of ignoring them and suggesting solutions. We may fit toward a future wherein independent cars (AVs) are created and utilized in a safe, morally sound, and equitable manner by acknowledging and resolving the moral issues raised by these vehicles [Rof18, Gar24].

When it involves the development and use of AVs, safety is critical. It is critical to assure the dependability and resilience of these structures to avoid mishaps and shop human lives. To lessen feasible dangers, strict protection standards and testing protocols must direct the improvement of self-sufficient vehicles. Furthermore, the distribution of dangers amongst numerous road customers wishes to be carefully taken into consideration, as self-sufficient automobiles (AVs) may additionally create new ethical conundrums on the subject of setting safety first.

ETHICAL CONCERNS

Safety and Reliability

A critical ethical difficulty inside the deployment of self- using cars is making sure the protection and reliability of the AI structures that govern them. These cars should navigate tricky and unpredictable environments, making critical choices that might have severe consequences. The mission is to lay out AI systems which could consistently make safe selections across all possible scenarios.

1. Unpredictability: AI structures have to be adept at handling unexpected occasions, together with a toddler all of sudden acting inside the roadway or abrupt changes in climate conditions.
2. System Failures: The capability for system disasters necessitates robust fail-safes and redundancies to guard both passengers and pedestrians.
3. Human-AI Interaction: In semi self-sustaining vehicles, the handover among autonomous and guide manipulation can cause confusion, increasing the hazard of injuries. Maintaining the Integrity of Specifications.

Decision Making in Life-Threatening Scenarios

The "trolley problem," or the moral conundrum of making decisions under life-threatening circumstances, is a difficult one. Programming AI to select between two undesirable outcomes, such running over a pedestrian or diverting into oncoming traffic, is required for this. The conundrum calls into question the moral foundation that directs AI decision [Gar24].The "trolley problem," or the moral conundrum of making decisions under life-threatening circumstances, is a difficult one. Programming AI to select between two undesirable outcomes, such running over a pedestrian or diverting into oncoming traffic, is required for this. The conundrum calls into question the moral foundation that directs AI decisions. Unpredictability: AI structures have to be adept at handling unexpected occasions, together with a toddler all of sudden acting inside the roadway or abrupt changes in climate conditions.

1. *Moral Algorithms*: The programming of AI to make ethical choices is important. Should the system prioritize the safety of occupants over pedestrians, or vice versa.
2. *Transparency*: The choice-making system of AI must be transparent to foster public agreement and expertise.
3. *Accountability*: Determining who is liable for the AI's choices in crucial conditions—whether it's the manufacturers, programmers, or the AI itself—is crucial for attention.

Privacy Concerns

Self-driving motors depend upon significant information series, along with GPS monitoring, video recordings, and real-time verbal exchange with different motors and infrastructure. This raises good sized privateness concerns concerning dealing with and capability misuse of personal data.

1. *Data Collection*: The enormous statistics collected through self-sufficient cars might be liable to breaches and misuse, necessitating sturdy records protection measures.

2. *Surveillance*: There is a danger that these cars may want to facilitate mass surveillance, tracking people's actions without their express consent.

3. *Data Ownership*: Questions surrounding the possession of the facts accumulated by independent automobiles and the extent of user management over their records want to be addressed.

Societal Impact

The enormous adoption of self-driving vehicles is predicted to have extensive societal implications, including process displacement, modifications in city planning, and environmental results [Gar24, Lee22]. Ethical concerns contain managing these impacts to make sure they advantage society as a whole.

1. *Job Displacement*: The automation of using responsibilities may additionally bring about substantial activity losses within sectors which include trucking and taxi offerings, requiring strategies to address employment affects.

2. *Urban Planning*: The upward thrust of self-sustaining motors could necessitate modifications in infrastructure, together with decreased parking necessities and new visitors' management structures.

3. *Environmental Impact*: While self-driving vehicles have the potential to reduce emissions through more efficient driving, they may also contribute to increased vehicle usage and urban sprawl, necessitating careful environmental planning.

BACKGROUND

Evolution of Self-Driving Car Technology

The development of self-driving vehicle generation has stepped forward from early concepts to superior structures capable of limited self-sustaining operation. Key milestones include:

1. *Early Concepts and Experiments (Twenties-Nineteen Sixties)*: Initial experiments with self-sufficient vehicle thoughts started in the 1920s, with exceptional tendencies like the 1948 invention of cruise control through Ralph Teetor and early semi-autonomous motors within the Nineteen Seventies by using Japan's Tsukuba Mechanical Engineering Laboratory.

2. *Foundational Research and DARPA Challenges (Eighties-2000s)*: The Eighties saw the launch of Carnegie Mellon University's Navlab and ALV initiatives, marking huge strides in self-sustaining riding generation. The Nineties and early 2000s were marked through breakthroughs together with the first coast-to-coast self-sustaining adventure in 1995 and the DARPA Grand Challenges, which drove widespread improvements in self-reliant vehicle skills [Zha22].

3. *Commercialization and Advancements (2009-Present)*: Google's self-driving car undertaking, released in 2009, catalyzed in addition development. Key achievements consist of Waymo's release of business self-riding taxis in 2018 and the introduction of SAE Level three motors through Honda in 2021. Despite these advances, as of early 2024, completely autonomous vehicles (Level five) remain unavailable, with most systems operating at Level 2 or three automation.

Systematic Literature Review (See Table 1).

Table I

Description of Papers

Project title	Author's name	Year	Description
Safety Ethics in AV Design and Testing	Koopman and Widen	2024 [Koo24]	Widen 2024 Ethical dilemmas in AV design and testing, the significance of protection in early development, moral frameworks like IEEE 7000.

Project title	Author's name	Year	Description
The folly of trolleys: Ethical challenges and autonomous vehicles	Heather M. Roff	2018 [Rof18]	In Trolley Problem, Unfortunately, focus in this ethical hassle on my own appears to blind specialists and practitioners alike from grappling with other unaddressed moral demanding situations.
Ethical Decision- Making in Autonomous Vehicles: Challenges and Research Progress	Hong Wang et al.	2020 [Wan20]	This paper evaluates the efforts and development related to the numerous components of ethical demanding situations in self-sufficient automobiles.
AI's Role in Autonomous Decision- Making	Garlikopati and Shetiya	2024 [Gar24]	Integration of AI and studying algorithms in AVs, moral worries approximately bias, levels of autonomy.
A Framework for Ethical Decision- Making in Autonomous Driving	Lee and Park	2022 [Lee22]	IEEE Conference on Intelligent Transportation Systems - Proposes a comprehensive framework for enforcing moral selection-making algorithms in Avs.
Ethical Implications of Data Sharing in Autonomous Vehicle Development	T. Yamamoto, E. Silva, H. Chang	2024 [Yam24]	The paper explores the moral challenges in accumulating, sharing, and using huge-scale datasets for AV development. It proposes pointers for accountable information practices, addressing privacy issues, consent problems, and the capacity for data misuse.
Cultural Differences in Moral Perceptions of Autonomous Vehicle Decisions	J. Zhao, K. Liang, T. Honda	2022 [Zha22]	This examines reveals that cultural backgrounds significantly affect ethical judgments in independent car decision-making, emphasizing the need for culturally adaptive ethical AI structures.
Explainable AI for Autonomous Vehicle Decision- Making: Enhancing Trust and Transparency	R. Brown, S. Lee, F. Garcia	2023 [Bro23]	This study gives an explainable AI framework for self-sufficient automobile decision-making, enhancing transparency and user believe via human-interpretable factors of automobile moves.

RESEARCH METHODOLOGY

Ethical Analysis Framework

1. *PPN (Parallel Processing Network):* The Parallel Processing Network (PPN) employs a completely unique architecture that utilizes parallel processing for segmentation and reconstruction duties. This approach is notably useful for scenarios in which high-velocity performance is vital, including in autonomous motors that want to method large amounts of records in actual-time. PPN converts 3-D point cloud information into 2D Bird's Eye View Maps, simplifying the environmental representation for decision-making tactics. Built the use of TensorFlow, PPN leverages the framework's robust scalability and performance. Though the version's accuracy and uncertainty quantification are not explicitly documented, its layout inherently prioritizes velocity and segmentation performance over probabilistic modeling. Its center packages are in item detection and segmentation, that are essential for self-reliant structures navigating complex environments.

2. *YOLO V7 (You Only Look Once, Version 7):* The Parallel Processing Network (PPN) employs a completely unique architecture that utilizes parallel processing for segmentation and reconstruction duties. This approach is notably useful for scenarios in which high-velocity performance is vital, including in autonomous motors that want to method large amounts of records in actual-time. PPN converts 3-D point cloud information into 2D Bird's Eye View Maps, simplifying the environmental representation for decision-making tactics. Built the use of TensorFlow, PPN leverages the framework's robust scalability and performance. Though the version's accuracy and uncertainty quantification are not explicitly documented, its layout inherently prioritizes velocity and segmentation performance over probabilistic modeling. Its center packages are in item detection and segmentation, that are essential for self-reliant structures navigating complex environments.

3. *GPR (Gaussian Process Regression):* Gaussian Process Regression (GPR) is primarily based on a probabilistic model that excels in duties requiring particular prediction, mapping, and localization. Unlike item detection fashions like YOLO and PPN, GPR does not immediately procedure LiDAR information however it makes a specialty of non-stop records regression. GPR uses the Gaussian Process framework to model relationships among records factors, allowing it to offer correct predictions with uncertainty estimates. The model's accuracy is dependent on the choice of kernel and hyperparameter tuning. Implemented with the use of Python and scikit-examine, GPR may additionally require greater computational sources than different fashions, but its capability to offer uncertainty quantification makes it beneficial in applications in which danger management is crucial, which includes independent navigation in unpredictable environments (Fig. 1).

Feature	PPN	YOLO V7	GPR
Architecture	Parallel Processing (Segmentation and Reconstruction)	Single-Stage Detector	Gaussian Process
Framework	TensorFlow	PyTorch	Python, sci-kit-learn
LiDAR Processing	Converts 3D point clouds to 2D Bird's Eye View Map	Directly processes 3D point clouds	Not applicable
Real-time Performance	Optimized for high-speed racing	Designed for high-speed applications	May require more computational resources for complex tasks
Accuracy	Not explicitly mentioned	Enhanced accuracy compared to previous versions	Depends on the choice of kernel and hyperparameters
Uncertainty Quantification	Not explicitly mentioned	Not explicitly mentioned	Provides probabilistic predictions with uncertainty estimates
Regression Model	Not applicable	Not applicable	Yes
Use Cases	Object detection and segmentation in autonomous vehicles	Object detection and tracking in real-time applications	Prediction, mapping, and localization in AVs

Fig. 1 Comparison of the model used

Basic Working of System / Flowchart

This flowchart (Fig. 2) outlines a method for detecting insulator defects using devices that are getting to know. It starts with dataset practice and photo preprocessing, followed with the aid of photograph annotation and switch getting to know. The version undergoes schooling with hyperparameter tuning and validation using a checking out photograph set. After deciding on the premiere version, put up-processing with Non-Maximum Suppression (NMS) is executed, leading to the final step of insulator disorder detection.

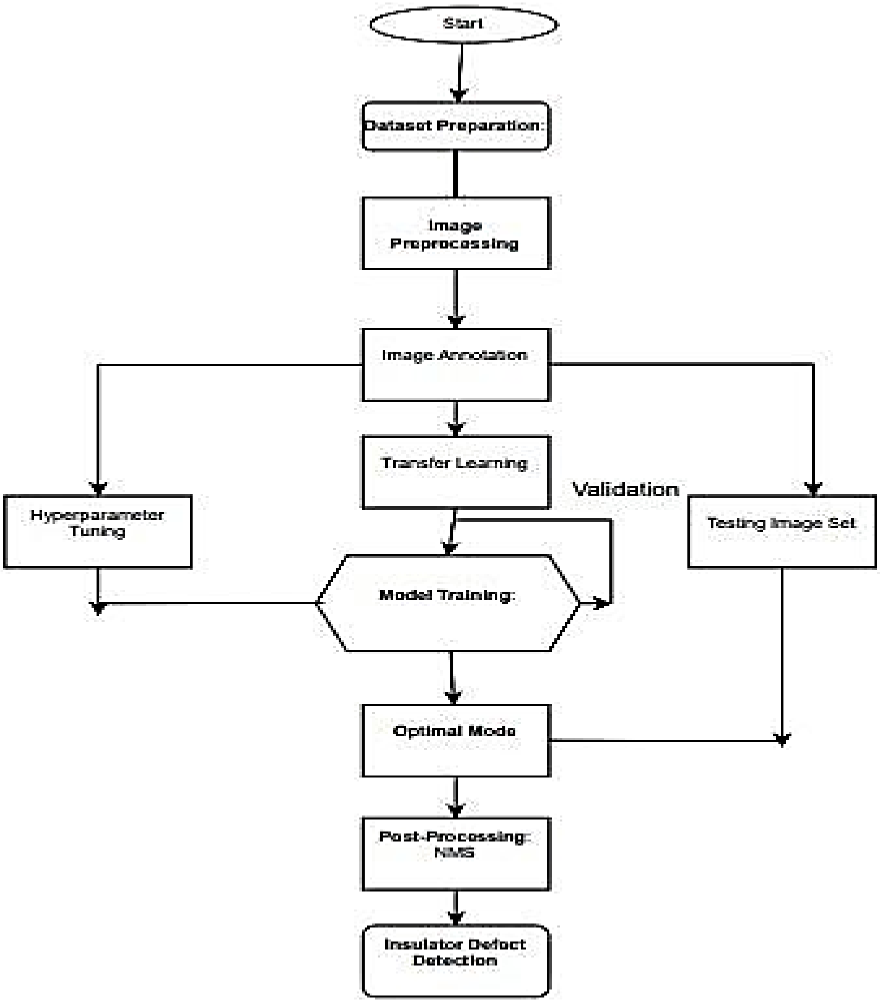

Fig. 2 Flowchart of the AV model

AI Frameworks Used in Autonomous Vehicles

1. *TensorFlow*: An open-source gadget learning framework, TensorFlow is widely used in self-sufficient using, especially its variant TensorFlow 3-D, which complements obligations like LiDAR-primarily based 3-D item detection and scene interpretation [Koo24, Bro23].

2. *PyTorch*: Known for its flexibility and ease of use, PyTorch is usually used for laptop vision obligations inclusive of item detection and lane segmentation, with agencies like Tesla and Uber leveraging it for dynamic deep getting to know experimentation.

3. *Reinforcement Learning Frameworks (OpenAI Gym)*: Provides a general environment for checking out reinforcement mastering models, together with Driver Gym, which focuses on autonomous riding scenarios through deep reinforcement learning.

4. *Robot Operating System (ROS)*: This open-supply robotics framework helps the improvement of self-sufficient riding structures with the aid of providing t tools for sensor facts evaluation, obstacle avoidance, and mapping, with modular integration across exclusive hardware systems.

Other Frameworks:

a) *Object Detection & Path Planning*: Frameworks like PVANET, RCNN, and CNN-based models handle object detection, motion prediction, and obstacle avoidance. Advanced algorithms like Q-Learning and Model Predictive Control improve decision- making and maneuver optimization.

b) *Sensor Fusion & Cybersecurity*: 3D SLAM fuses multiple sensor data for accurate mapping, while cybersecurity frameworks like TARA address potential threats to autonomous vehicle systems.

RESULTS

Some important aspects that need careful consideration include safety, privacy, accountability, and justice. To avoid mishaps and save lives, it is crucial to guarantee the dependability and durability of AV systems. To keep the public's trust, privacy must be protected and misuse of the data AVs acquire must be avoided. Promoting fairness requires addressing biases in AV algorithms and making sure that every road user is treated equally (Table 2).

Table 2

Level of Autonomous Driving and Their Features

Autonomy Level	Technology Involved	Main Features	Functionality Description
L1 (Assisted Driving)	Scikit-learn	Basic automation; focuses on traditional machine learning methods like regression and classification.	Provides basic driver assistance features such as sensing, alerting, and limited intervention in hazardous situations.
L2 (Partial Automation)	TensorFlow, PyTorch, Keras, YOLO, Parallel Perception, CNN, R-CNN	Intermediate automation; frameworks provide capabilities for more complex tasks and basic decision- making, particularly in vision and perception tasks.	Handles navigation and lane control; limited adaptation to environmental conditions such as stop- and-go traffic.
L3 (Conditional Automation)	TensorFlow, PyTorch, Keras, YOLO, R-CNN, Deep Learning	Advanced automation; systems handle autonomous tasks with minimal human intervention, using complex models suitable for various applications.	Enables dynamic adjustment to specific traffic and road conditions, providing full vehicle control under certain limitations. Complex decision-making with moderate driver intervention is needed.
L4 (High Automation)	TensorFlow, PyTorch, Keras, Parallel Perception, CNN	Fully autonomous; frameworks facilitate real- time decision-making and operate effectively across diverse environments, particularly in AI perception systems.	Offers nearly complete control of the vehicle under predefined scenarios, including handling traffic in complex urban settings.
L5 (Full Automation)	TensorFlow, PyTorch, Generative AI	General intelligence capabilities; designed for extensive model architecture and capable of handling complex problem- solving tasks across multiple domains.	Fully autonomous driving across all environmental conditions, requiring no human input. Capable of advanced situational adaptation and decision-making.

The pie chart of self-sustaining automobile incident information (Fig. 3 and 4) highlights key agencies involved in self-using generation, balancing superior driver assistance structures (ADAS) and fully self-sufficient using systems (ADS). Tesla leads with 2,146 incidents, in large part from its Autopilot function. Waymo, a pioneer in ADS, suggested 415 incidents, while General Motors and Cruise also contribute with ADAS and ADS technologies. Honda, Subaru, and Toyota cognizance on ADAS for safety, while Zoox and Argo AI work on completely self-sufficient cars, reflecting various strategies in self-riding innovation and protection."

CONCLUSION

Technological trends and ethical considerations interact intricately within the development and alertness of autonomous vehicles (AVs). The ethical problems surrounding the creation, improvement, and use of AVs have to be addressed to assure their safe and accountable integration into society.

Deep mastering, reinforcement gaining knowledge of, and computer vision are some examples of AI models and strategies which are important to AVs' ability to feel their surroundings, make judgements, and tour thoroughly. But the use of those AI equipment also brings up ethical questions about responsibility, justice, and bias.

We can also strive towards a destiny in which AVs are created and deployed in a manner that advantages society as an entire by means of carefully weighing these ethical dimensions and putting in place the essential safeguards. To establish ethical requirements, encourage openness, and ensure that autonomous automobiles have evolved and run in an accountable and responsible way, researchers, legislators, and commercial enterprise executives have to keep collaborating.

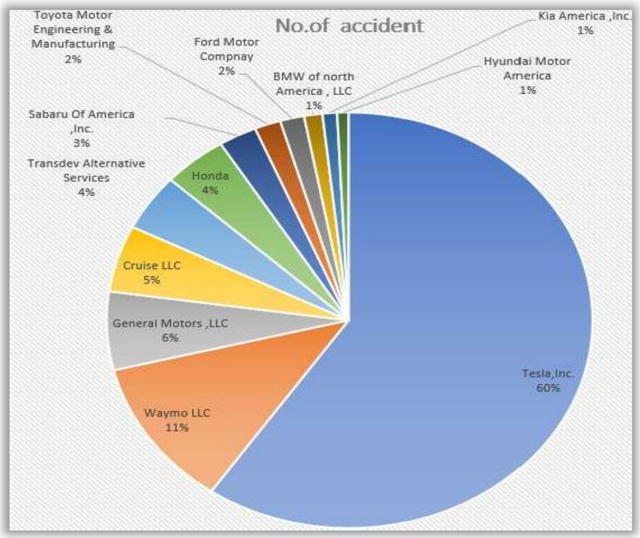

Fig. 3 No. of accident occurred by AV by companies

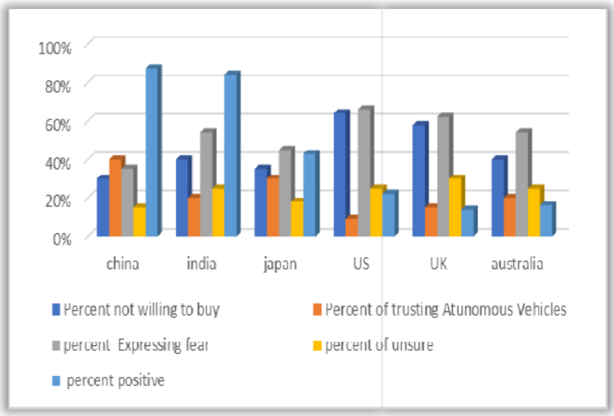

Fig. 4 Public Perception of Autonomous Vehicles by Country

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МЕТАДАННЫЕ / METADATA

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Название: Этические проблемы автономных транспортных средств: структура ИИ.

Аннотация: Автономные транспортные средства (AV) являются многообещающей технической разработкой, способной полностью изменить транспортное предприятие. Однако существует множество моральных проблем с их полномасштабным использованием, которые необходимо тщательно изучить. В этой статье рассматриваются этические компоненты улучшения и бдительности AV с особым акцентом на проблемах безопасности и ответственности. При проектировании и использовании AV безопасность должна быть на первом месте. Чтобы избежать несчастных случаев и сохранить жизни, важно гарантировать надежность и прочность конструкций AV. Распределение рисков и возможность того, что AV усугубят существующую общественную несправедливость, также являются моральными проблемами. Еще одним важным вопросом в разработке AV является беспокойство о конфиденциальности. Опасения относительно личной конфиденциальности и возможности неправомерного использования фактов возникают при сборе и использовании фактов AV. Чтобы сохранить общественное признание как истинное с помощью статистики, необходимо гарантировать безопасность и открытость. Предвзятость и справедливость также являются огромными моральными проблемами. AV-автомобили должны быть сделаны с одинаковыми средствами защиты для всех клиентов на дороге, без какой-либо дискриминации. Чтобы избежать неожиданных результатов, жизнеспособные предубеждения в алгоритмах, используемых в AV-автомобилях, должны быть тщательно проверены и исправлены. Ответственность — это всего лишь другой важный этический вопрос. Может быть сложно назначить виновных в инцидентах, связанных с AV, без тщательного взвешивания этических и правовых рамок. Четкие советы по ответственности могут помочь сохранить общественное доверие при использовании независимых автомобилей.

Ключевые слова: Автономные транспортные средства, синтетический интеллект, этические вопросы, принятие решений, конфиденциальность данных.

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About the authors | Об авторах

Priyanka Behki
Chandigarh University, India.
Assistant Professor. Her Interest includes Machine learning, Cloud computing, Internet of Things, Artificial Intelligence, cybersecurity and Data structures.
E-mail: behkipriyanka1998@gmail.com

Vaibhavi Shreya
Chandigarh University, India.
Pursuing her degree of bachelor's in engineering. She has experience internship in Metacrafters (Blockchain technology), she is a very proactive and assiduous student.
E-mail: vaibhavishreya2004@gmail.com

Reshma
Chandigarh University, India.
Assistant Professor-CSE in Chandigarh University from last 9.5 years and currently pursuing her doctorate in CSE from Punjabi University, Patiala. She has published more than 15 research papers at national and international conferences. Her interest is in Artificial Intelligence and Machine Learning.
E-mail: reshma.khan36@gmail.com

Aniya Kumari
Chandigarh University, India.
Pursuing her degree of bachelor's in engineering. She has experience of internship in Metacrafters (Blockchain technology), she is a very persistent and enthusiastic student.
E-mail: aniyakumari096@gmail.com

Sanskar Daksh
Chandigarh University, India.
Pursuing his degree of bachelor's in engineering. He has experience of multiple projects related to IoT and AI. He is very career oriented and skillful student.
E-mail: sanskardaksh2004@gmail.com

Приянка Бехки
Университет Чандигарха, Индия.
Доцент. Интересы включают машинное обучение, облачные вычисления, Интернет вещей, искусственный интеллект, кибербезопасность и структуры данных.
E-mail: behkipriyanka1998@gmail.com

Вайбхави Шрея
Университет Чандигарха, Индия.
Получает степень бакалавра по инженерному делу. Имеет опыт стажировки в Metacrafters (технология Blockchain), очень упорная и увлечённая студентка.
E-mail: vaibhavishreya2004@gmail.com

Решма
Университет Чандигарха, Индия.
Доцент CSE последние 9,5 лет, в настоящее время работает над докторской диссертацией в Университете Пенджаби, Патиала. Автор более 15 научных работ на национальных и международных конференциях. Ее интересуют искусственный интеллект и машинное обучение.
E-mail: reshma.khan36@gmail.com

Ания Кумари
Университет Чандигарха, Индия.
Получает степень бакалавра по инженерному делу. Имеет опыт стажировки в Metacrafters (технология Blockchain), очень упорная и увлечённая студентка.
E-mail: aniyakumari096@gmail.com

Санскар Дакш
Университет Чандигарха, Индия.
Получает степень бакалавра в области инженерии. Имеет опыт работы над проектами, связанными с IoT и AI. Очень ориентированный на карьеру и способный студент.
E-mail: sanskardaksh2004@gmail.com