Research, Society and Development, v. 13, n. 10, e01131047019, 2024
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v13i10.47019

Machine learning and vision neural networks in autonomous vehicles for the aging population: A scoping review protocol

Aprendizado de máquina e redes neurais de visão em veículos autônomos para a população envelhecida: Um protocolo de revisão de escopo

Aprendizaje automático y redes neuronales de visión en vehículos autónomos para la población envejeciente: Un protocolo de revisión del alcance

Received: 09/23/2024 | Revised: 09/28/2024 | Accepted: 09/29/2024 | Published: 10/04/2024

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Abstract
This scoping review aims to systematically map the current body of literature on the role of Machine Learning (ML) and Vision Neural Networks (VNN) in enhancing the usability and accessibility of Autonomous Vehicles (AVs) for elderly and disabled users. While AV technology has advanced significantly in recent years, the solutions of how these technologies can address the unique challenges faced by these vulnerable populations still in an undeveloped or underdeveloped stage. For example, cognitive decline, physical limitations, and lower trust in automated systems. The review will investigate how ML and VNN contribute to improving safety, usability, accessibility, and trust in AVs, focusing on studies published between 2020 and 2024. A comprehensive search will be conducted across four major databases, which are PubMed, IEEE Xplore, Scopus, and Google Scholar. The language of targeting peer-reviewed empirical studies and reviews must be written in English. Data will be extracted using a standardized form and synthesized through a descriptive analytical framework to identify key themes, trends, and gaps in the literature. The findings will offer valuable insights into how AV technologies can be further optimized for elderly and disabled users. It will guide future research and informing the development of more inclusive, safe, and trustworthy AV systems. Therefore, they can promote greater mobility and independence for these populations.
Keywords: Autonomous Vehicle; Machine Learning; Vision Neural Networks; Human-Computer Interaction; Artificial Intelligence.

Resumo
Esta revisão de escopo visa mapear sistematicamente o corpo atual da literatura sobre o papel do Aprendizado de Máquina (ML) e das Redes Neurais de Visão (VNN) no aprimoramento da usabilidade e Acessibilidade de Veículos Autônomos (VAs) para usuários idosos e deficientes. Embora a tecnologia de VA tenha avançado significativamente nos últimos anos, as soluções de como essas tecnologias podem abordar os desafios únicos enfrentados por essas populações vulneráveis ainda estão em um estágio subdesenvolvido ou subdesenvolvido. Por exemplo, declínio cognitivo, limitações físicas e menor confiança em sistemas automatizados. A revisão investigará como ML e VNN contribuem para melhorar a segurança, usabilidade, acessibilidade e confiança em VAs, com foco em estudos publicados entre 2020 e 2024. Uma busca abrangente será conduzida em quatro grandes bancos de dados, que são PubMed, IEEE Xplore, Scopus e Google Scholar. O idioma de segmentação de estudos empíricos revisados por pares e revisões deve ser escrito em inglês. Os dados serão extraídos usando um formulário padronizado e sintetizados por meio de uma estrutura analítica descritiva para identificar os principais temas, tendências e lacunas na literatura. As descobertas oferecerão insights valiosos sobre como as tecnologias AV podem ser ainda mais otimizadas para usuários idosos e deficientes. Elas orientarão pesquisas futuras e informarão o desenvolvimento de sistemas AV mais inclusivos, seguros e confiáveis. Portanto, elas podem promover maior mobilidade e independência para essas populações.
Palavras-chave: Veículo Autônomo; Aprendizado de Máquina; Redes Neurais de Visão; Interação Humano-Computador; Inteligência Artificial.

Resumen
Esta revisión de alcance tiene como objetivo mapear sistemáticamente el cuerpo de literatura actual sobre el papel del Aprendizaje Automático (ML) y las Redes Neuronales de Visión (VNN) en la mejora de la usabilidad y accesibilidad de los Vehículos Autónomos (VA) para usuarios mayores y discapacitados. Si bien la tecnología de VA ha avanzado significativamente en los últimos años, las soluciones de cómo estas tecnologías pueden abordar los desafíos únicos

que enfrentan estas poblaciones vulnerables aún se encuentran en una etapa subdesarrollada o subdesarrollada. Por ejemplo, el deterioro cognitivo, las limitaciones físicas y la menor confianza en los sistemas automatizados. La revisión investigará cómo ML y VNN contribuyen a mejorar la seguridad, la usabilidad, la accesibilidad y la confianza en los VA, centrándose en estudios publicados entre 2020 y 2024. Se realizará una búsqueda exhaustiva en cuatro bases de datos principales, que son PubMed, IEEE Xplore, Scopus y Google Scholar. El idioma de los estudios empíricos y revisiones revisados por pares debe estar escrito en inglés. Los datos se extraerán utilizando un formulario estandarizado y se sintetizarán a través de un marco analítico descriptivo para identificar temas clave, tendencias y brechas en la literatura. Los hallazgos ofrecerán información valiosa sobre cómo optimizar aún más las tecnologías de vehículos autónomos para usuarios mayores y discapacitados. Orientarán las investigaciones futuras y servirán de base para el desarrollo de sistemas de vehículos autónomos más inclusivos, seguros y fiables. Por lo tanto, pueden promover una mayor movilidad e independencia para estas poblaciones.
Palabras clave: Vehículo Autónomo; Aprendizaje Automático; Redes Neuronales de Visión; Interacción Hombre-Ordenador; Inteligencia Artificial.

1. Introduction

Autonomous Vehicles (AVs) is leading the transformative innovations in transportation, It offers the potential to revolutionize mobility, safety and independence, particularly for elderly users. The elderly population, which is rapidly growing worldwide, faces cognitive and physical limitations that often impair their ability to drive safely. Approximately 16% of the population is aged 65 (and over) among all groups in Australia (Australian Institute of Health and Welfare, 2024). This proportion is expected to increase in the coming years significantly. The elderly individuals could greatly benefit from autonomous vehicles, because AVs are expected to reduce their dependence on others for mobility. Also, their quality of life will have a significant improvement. However, the widespread adoption of AVs by elderly hinges on addressing key challenges such as trust, usability, and safety (Yuen et al., 2021; Rahman et al., 2019).

Machine learning and vision neural networks are essential to the functioning of modern AVs. The vehicles will perceive their surroundings and make real-time decisions when the driver activates the program setting supported by these technologies (Sun et al., 2020). These technologies allow AVs to continuously learn and adapt to new driving conditions, enhancing safety (Ignatious & Khan, 2022). Vision neural networks process visual data from cameras and sensors. It allows AVs to detect obstacles, pedestrians and road signs with minimal human intervention (Pande & Khandelwal, 2022).

Despite these technological advancements, the researches specifically focusing on the integration of these technologies to address the unique needs of elderly users remains limited. Older adults may face cognitive decline, reduced reaction times, and other physical challenges, making the design and interface of AVs critical to their adoption (Singh & Saini, 2021). Additionally, trust in AV technology is lower among elderly individuals compared to younger users. The reason is largely due to unfamiliarity with automation and concerns about safety (Yuen et al., 2021). Several studies have highlighted the specific needs of older adults to enhance their trust and acceptance of AVs, which is the transparent decision-making processes, user-friendly interfaces and adaptive systems that can cater to the elderly's requirements (Müller, 2019; Lajunen & Sullman, 2021).

While AV technology has made significant strides, there is a critical need for further research into how machine learning and vision neural networks can be optimized to support the mobility of elderly users. The potential of AVs to improve the quality of life for the elderly is huge, and it's a worth exploring research area. Particularly in terms of how these technologies can address the specific cognitive and physical limitations of this demographic (Katalesanket, 2023). By focusing on the integration of machine learning, vision neural networks as well as HCI, this scoping review protocol aims to map the current literature and identify gaps in research that need to be addressed to make AVs more accessible, safe, and trustworthy for elderly users (Karle et al., 2023).

The objective of this scoping review protocol is to systematically map the existing literature on the role of machine learning, vision neural networks and HCI in autonomous vehicles. It also has a specific focus on how these technologies can

help the elderly and provides how future innovations can improve the usability, safety and trustworthiness for them. This review seeks to explore advancements in AV technology, identify research gaps related to elderly users. With all the tasks, this scoping review protocol aims to contribute to the development of inclusive and accessible AV systems that enhance the mobility and independence of the elderly.

Principal Review Question:

- What is the current state of research on machine learning and vision neural networks in autonomous vehicles, and how do these technologies address the unique needs of the aging population?

Sub-Questions:

1. How do machine learning algorithms in autonomous vehicles improve safety, usability, and trust for elderly users/disable users?
2. What role do vision neural networks as well as machine learning play in enhancing the driving experience and accessibility for older adults in autonomous vehicles?

2. Methodology

This scoping review will follow the methodology outlined by the Joanna Briggs Institute (JBI) for scoping reviews, ensuring a systematic and transparent approach to identifying, screening, and synthesizing evidence on Machine Learning (ML) and Vision Neural Networks (VNN) in Autonomous Vehicles (AVs) for elderly and disabled users (Silva et al., 2021; Zablocki et al., 2022).

Search Strategy

A comprehensive search of academic literature will be conducted using databases highly relevant to the fields of computer science, engineering, and human-computer interaction. The selected databases were PubMed, IEEE Xplore, Scopus and Google Scholar. These databases provide an accessible way to review a wide range of every kind of journals, conference papers, and technical reports. Thus, all of them are critical for understanding the current research on autonomous vehicle technologies (Elallid et al., 2022). The search will focus on articles published between 2020 and 2024 to capture the latest advancements in machine learning and vision neural networks applied to autonomous vehicles (Casali et al., 2022). The inclusion of high-quality and international research is indispensable. Therefore, the review language of all articles will be limited to written in English.

The search terms will be carefully developed based on key concepts relevant to the scoping review. These will include core technologies like "machine learning," "vision neural networks," and "computer vision," as well as terms related to the vehicle type, such as "autonomous vehicles" and "self-driving cars" (Mohammad-Rahimi et al., 2021). Additionally, keywords focusing on the user population will be used, including terms like "elderly users," "aging population," "disabled users," and "accessibility." To further refine the search, keywords addressing specific outcomes like "safety," "usability," "trust," and "acceptance" will also be applied (Soori et al., 2023). Boolean operators (AND, OR) will be used to create complex search strings that combine these terms. For instance, search queries may include phrases such as “autonomous vehicles AND machine learning AND elderly users” or “self-driving cars AND vision neural networks AND disabled users.”

Once the search is completed, the results from all databases will be imported into EndNote for reference management. Any duplicate entries will be removed to ensure that each study will only include once before the screening process begins (Mozaffari et al., 2020).

Next, Table 1 shows seach attibute policy:

Table 1 - Search Attribute Policy.

Search Attribute Policy	Description
TITLE-ABS-KEY	This attribute entails searching for the selected keywords within the title, abstract, and keywords of the studies.
AND	This operator ensures the presence of all selected keywords in the search (e.g., autonomous vehicles AND elderly users).
OR	This operator allows for flexibility by including studies that mention any of the specified keywords (e.g., machine learning OR vision neural networks).
NOT	This operator excludes studies that contain unwanted terms or focus areas (e.g., NOT general population).
YEAR	Limits the search results to a specific publication period, which is set between 2020 and 2024 for this review.

Source: Author.

Table 2 shows the search string criterion:

Table 2 - Search String Criterion.

Search String Criterion	Description
C1	"Autonomous vehicles AND machine learning AND elderly users OR disabled users AND vision neural networks"
C2	"Machine learning AND vision neural networks AND autonomous vehicles AND trust OR usability"
C3	"Elderly users AND autonomous vehicles AND machine learning NOT non-AV technologies"
C4	"Disabled users AND accessibility AND autonomous vehicles OR self-driving cars AND vision neural networks"

Source: Author.

Inclusion Criteria

This scoping review will include studies that focus on the role of machine learning (ML) and vision neural networks (VNN) in enhancing autonomous vehicles (AVs) for elderly, it will also mention disabled users fractionally. Specifically, studies must address how these technologies improve safety, usability, trust, or accessibility for users aged 60 and over, or individuals with disabilities. Only peer-reviewed empirical studies, literature reviews, and part of the conference proceedings will be considered to ensure the review captures the most relevant research. English will be the foremost language of all included studies, and Chinese will be used as an auxiliary language. All selected journal articles must be published within the last 4 years from 2020 to 2024. This timeframe allows for the inclusion of the latest advancements in AV technology and ensures that the research reflects current technological developments and user needs. Table 3 shows inclusion criteria:

Table 3 - Inclusion Criteria.

No.	Description
1	Studies focus on elderly users (60+) or disabled individuals in the context of autonomous vehicles.
2	Investigate the application of machine learning, vision neural networks, or both in AVs.
3	Reports on safety, usability, trust, or accessibility improvements in autonomous vehicles for elderly or disabled users.
4	Peer-reviewed empirical studies, literature reviews, and conference proceedings.
5	Articles written in English.
6	Studies published between 2020 and 2024.

Source: Author.

Exclusion Criteria

Studies that do not focus on elderly or disabled users will be excluded. The journals that explore the general population or other age groups will be excluded based on the content of the articles. Additionally, any research articles that does not involve machine learning or vision neural networks in the context of autonomous vehicles will not be considered. Non-peer-reviewed articles, such as opinion pieces, editorials will be removed, as well as studies without empirical data. This aims to maintain the quality and reliability of the review. Furthermore, studies written in languages other than English will not be included. To ensure the research is timely and relevant to the current stage of technology in AVs, studies published before 2020 will not be included. Next, Table 4 shows exclusion criteria:

Table 4 - Exclusion Criteria.

No.	Description
1	Studies focusing on non-elderly adult populations, children, or the general population.
2	Research that does not specifically involve machine learning or vision neural networks in AVs.
3	Non-peer-reviewed articles, editorials, opinion pieces, or articles lacking empirical evidence.
4	Studies written in languages other than English.
5	Studies published before 2020.

Source: Author.

Study Selection

The study selection will occur in two phases, with clear inclusion and exclusion criteria to ensure only relevant studies are considered.

Phase 1: Title and Abstract Screening – The titles and abstracts of all identified studies will be screened by computer. Studies that do not meet the inclusion criteria clearly will be excluded, such as the articles not focused on autonomous vehicles. Any

disagreements between reviewers will be resolved through discussions, the appointed researcher will be the final decision maker (Reid et al., 2019; Stewart et al., 2015).

Phase 2: Full-Text Review – Based on the inclusion and exclusion criteria, the remaining studies (full text articles) will be reviewed to check the eligibility. This phase will ensure that studies providing direct insights into the use of machine learning and vision neural networks in AVs for elderly or disabled users are included. Some studies with only machine learning and vision neural networks will also be included. A detailed log of reasons for exclusion will be kept, following the PRISMA-ScR guidelines to ensure transparency (Fayyad et al., 2020).

Data Extraction

Data will be systematically extracted using a standardized extraction form tailored to capture the essential aspects of each study. The key data fields will include study details such as the author(s), year of publication, country of origin, and the type of publication like journal article or conference paper. Additionally, population characteristics, including the age range and demographics of the elderly or disabled users studied, will be recorded (Casali et al., 2022). The extraction process will also focus on the specific technologies examined, particularly the machine learning algorithms and vision neural networks employed in autonomous vehicles. Furthermore, the outcomes measured will encompass safety improvements, usability enhancements, trust and acceptance metrics, and accessibility features (Pavel et al., 2022). The form will also capture the study design (whether qualitative, quantitative, or mixed methods) and the key findings related to the application of ML and VNN technologies for elderly or disabled users in AVs. To ensure consistency and reliability in the data extraction process, two independent reviewers will pilot the form on a small subset of studies. Any discrepancies identified during this process will be resolved through discussion and consensus between the reviewers (Bichu et al., 2021).

Data Synthesis

The extracted data will be synthesized using a descriptive analytical framework to categorize and summarize the findings from the selected studies. The synthesis will focus on identifying major trends, recurring themes, and existing gaps in the literature concerning the application of machine learning and vision neural networks in autonomous vehicles for elderly or disabled users (Sirohi et al., 2020). The findings will be organized into key thematic areas, including safety, usability, and trust. The safety theme will explore how ML and VNN technologies help reduce risks and enhance the safety of elderly and disabled passengers (Alzubaidi et al., 2021). The usability and accessibility theme will assess how these technologies improve the ease of use of AVs and ensure accessibility for individuals with physical or cognitive impairments (Zakaria et al., 2023). Finally, the trust and acceptance theme will examine the factors that influence trust in AV technologies among elderly and disabled users, such as transparency and the design of user-friendly interfaces (Fayyad et al., 2020). A narrative synthesis will accompany these themes, detailing how the studies contribute to each area, while also highlighting gaps in the research. The Key recommendations for future studies will be made based on the identified gaps to encourage further exploration in this field (Sirohi et al., 2020).

Quality Assessment

Although a formal quality assessment is not required for scoping reviews, an informal assessment of the methodological rigor of each study will be performed. Studies will be evaluated based on their clarity in reporting, sample size, relevance to the review's objectives, and the strength of their conclusions (Smith et al., 2022). This assessment will help ensure that only high-quality evidence is synthesized.

Presentation of Results

The results will be presented in tabular format and narrative formats. A PRISMA-ScR flow diagram will visually depict the study selection process. Tables will be used to summarize key information from each included study, including population characteristics, technology focus, and outcomes. A narrative synthesis will provide further explanation of the themes and trends identified in the data.

In addition, any emerging sub-themes not initially anticipated in the review will be noted and discussed, contributing to a comprehensive understanding of the current state of research on machine learning and vision neural networks in autonomous vehicles for elderly and disabled users.

3. Discussion

This scoping review protocol aims to systematically map the current state of research on the application of machine learning and vision neural networks in autonomous vehicles for elderly and disabled users. As the development of AV technologies rapidly, the requirements of ensuring these systems are safe, reliable, accessible and user-friendly is growing. The groups with specific needs, such as elderly and individuals with disabilities should also be considered. This review will provide an in-depth exploration of how current research addresses these challenges by leveraging ML and VNN technologies. The integration of ML and VNN in AVs has the potential to significantly enhance the safety and usability of these vehicles for vulnerable populations. Existing studies indicate that elderly users often struggle with the trust and acceptance of autonomous technologies due to cognitive and physical challenges. Machine learning algorithms can help drivers through predicting user behavior, adapting to individual needs, and providing personalized driving experiences. Similarly, vision neural networks can improve the vehicle's ability to detect and respond to obstacles, pedestrians, and complex driving environments, thus enhancing safety for users who may have slower reaction times or diminished mobility. Despite these advancements, a gap existing in the literature when it comes to addressing the specific needs of elderly and disabled users. That makes this scoping review timely and relevant. By synthesizing the findings from various studies, this review will identify key trends and themes, such as the role of trust in AV adoption, the usability challenges faced by elderly users, and the accessibility improvements brought about by VNN and ML technologies.

The review will highlight research gaps in the current research field, in terms of understanding how these technologies can be optimized to better serve these populations. Identifying these gaps will be crucial for guiding future research and for informing the design and development of AV systems that are inclusive and accessible for all users. The findings from this scoping review will provide valuable insights into the intersection of AV technology, machine learning, and user accessibility (HCI). It will offer a comprehensive overview of how existing research addresses the challenges faced by elderly and disabled users. While, it's also identifying areas where further investigation is needed. The results will have significant implications for researchers, designers, and policymakers, as they work towards creating AV systems that enhance the quality of life for vulnerable populations, promoting independence and mobility in an increasingly automated world.

4. Conclusion

This scoping review protocol outlines a detailed plan to systematically identify, categorize, and summarize existing research on the use of Machine Learning (ML) and Vision Neural Networks (VNN) in Autonomous Vehicles (AVs). Elderly and disabled users are the main focus objective on their usability and impact. AV technology has the potential to revolutionize mobility and improve the quality of life to those users who have physical challenges and unique cognitive. However, while advancements in AV technology are progressing rapidly, research specifically addressing how ML and VNN can be tailored to

meet the specific needs of elderly and disabled individuals remains limited. This review seeks to address this gap by identifying and synthesizing existing evidence on the safety, usability, trust, and accessibility improvements provided by ML and VNN in AVs for these vulnerable populations.

The comprehensive search strategy proposed in this protocol will ensure that relevant studies from multiple databases are identified, focusing on recent advancements in AV technology. By employing clearly defined inclusion and exclusion criteria, and using a rigorous screening and data extraction process, this review will provide a detailed analysis of how ML and VNN are being used to enhance the driving experience for elderly and disabled users. Additionally, the data synthesis will reveal key trends and recurring themes. While, the areas where further research is required will also include. It's offering insights into the practical applications of these technologies and the challenges that remain.

Finally, this scoping review will help the public to have a deeper understanding about how autonomous vehicle technology becomes more inclusive and accessible could benefit the society. It will also provide valuable information to researchers, designers, and policymakers to informing future studies. The development of AV systems that are more responsive to the needs of elderly and disabled users will be studied intensively. The findings will serve as a foundation for identifying gaps in the current research, it will offer recommendations for future work. This aims to ensure the autonomous vehicles can safely and effectively support the mobility and independence of vulnerable populations. By addressing these gaps, the review will help advance the goal of creating AV systems that are not only technologically advanced but also socially inclusive, fostering greater trust and widespread adoption among the aging and disabled communities.

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