How do cyclists interact with automated buses? An overview of research findings

Conference Paper - November 2019

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How do cyclists interact with automated buses? An overview of research findings

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Introduction
An increasing number of automated (minibus) systems is entering our roads, often driving in mixed traffic environments including cyclists. What are cyclists’ opinions and experiences when interacting with these automated vehicles and what is the impact on the behavior and safety of cyclists?
This study aimed to identify knowledge gaps on the interaction of cyclists with automated buses by making an inventory of available research. We conducted a systematic literature review by searching literature databases. In addition, we report some first results from currently running real life projects in the Netherlands and Norway where the interaction of cyclists with automated vehicles is relevant.

Method
Systematic literature review

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<th>Step</th>
<th>April 2019 Results</th>
<th>October 2019 results</th>
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Table 1. Approach of the systematic review performed in this study. The last two columns show the search results in April 2019 and October 2019, respectively.

Results: cyclist interactions with AV-shuttles
Empirical studies from interviews, focus group discussions, surveys, and (video) observations directly addressing the interactions of cyclists and AV shuttles: CityMobk2, EU [1,8]; Appelscha case study, NL [4]; GATEWAY London, UK [7]; WePods, NL [5,11,14,19]; Autobus, Norway [2]; ARIBO, USA [17].

Study on passenger opinions about cyclists interacting with AV shuttles were investigated [10].

- Basic insights:
  - The AV shuttles are not mature; they stop when any object (e.g., road users, static object, etc.) is within a certain distance from the bus [2,4]
  - Cyclists seldom force the bus to stop [2,5,8,19]
  - Buses’ speed is slow, often slower than cyclists’ speed
  - AV shuttles’ abrupt braking can cause the cyclist to perform unexpected moves [2]
  - A common observation is that cyclists ride alongside (left or ride) or overtake the AV shuttle, which can cause abrupt braking (too short distance to shuttles) [2,4,8,19]
  - Cyclists cross very short distance ahead of the AV shuttle [2,8]
  - Shuttles often drive on existing infrastructure, sharing the road with cyclists [1,2,5,8,12,14], or use the cycle track [4]
  - Cyclists’ opinions and safety perceptions become more positive after having interacted with AV shuttles [2,12,14]
  - Interactions change: cyclists give less often way to the AV shuttles over time [2]
  - Infrastructural characteristics (e.g. markings, shared or separate road) influence observed interactions, which appear to be more risky on shared narrow roads [1,2,4,8]
  - The safety of cyclists (and other road users outside the AV shuttle) is more of a concern to passengers than their own personal safety [10]

Conclusions
The interaction of cyclists with automated buses, from the cyclists’ perspective, is not a common research topic yet. Very few studies have actually observed how cyclists react to automated shuttles or have asked their opinions. And those studies having cyclists in direct contact with AV shuttles or have asked their opinions. And those studies having cyclists in direct contact with AV shuttles or have asked their opinions. And those studies having cyclists in direct contact with AV shuttles or have asked their opinions. And those studies having cyclists in direct contact with AV shuttles or have asked their opinions. And those studies having cyclists in direct contact with AV shuttles or have asked their opinions. And those studies having cyclists in direct contact with AV shuttles or have asked their opinions. And those studies having cyclists in direct contact with AV shuttles or have asked their opinions.

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There are other studies of cyclists’ decisions when approached by an automated vehicle - not being an AV shuttle bus - using photos depicting various situations [6,15], animated video clips [18] or in virtual environments [11]. Yet other studies have focussed on cyclists’ needs for dedicated cycle facilities [1], communication and design requirements for safe interactions of AVs with vulnerable road users [9, 16, 20], and a survey among cyclists on actual experiences with AVs [1]. Experience and expectations about AV behaviour influence cyclists’ decisions.

References on www.toi.no/autobus
2. Bjerkan et al. (2019, 2020)
4. Boerema et al. (2018b) Appelscha
5. Boerema et al. (2018b) WePods
8. Merigian et al. (2019)
10. Nordhoff et al. (2019)
11. Nuñez Velasco et al. (2019)
12. Nuñez Velasco et al. (2016)
13. Pernraj et al. (2019)
15. Rodríguez Palmeiro et al. (2018)
20. Van der Wilt (2017)
21. Eisma et al. (2019)