Future Trends Written Report

Group ID: 10-28

Team Leader: Joshua Heng

Members: Jayden Low, Elkan Sim, Daelon Teo

Community Studied: Our fellow commuters

Potential Problems:

Problem #1:

Observation:

52 respondents expressed that they would feel worried if the bus were to malfunction and cause an accident.

Problem:

If the sensors of the driverless bus malfunction, the bus could not be able to detect passengers at the next station or pedestrians crossing the road, thus having a possibility of causing accidents.

Research:

According to the following article: “Lin, M. (2016, October 18). Driverless car hits lorry during test drive. Retrieved from https://www.straitstimes.com/singapore/driverless-car-hits-lorry-during-test-drive”, This accident sprouted many doubts regarding the safety of driverless vehicles.

Problem #2:

Observation:

51 respondents expressed that they felt insecure without a driver/supervisor in the bus.

Problem:

The driverless bus may not be able to handle in-bus incidents like robberies or inappropriate/unruly behaviour, therefore human intervention could be necessary.

Research:

According to “Salonen, A. O. (2017, November 06). Passenger's subjective traffic safety, in-vehicle security and emergency management in the driverless shuttle bus in Finland. Retrieved from . “...commuters in Finland are worried about their safety as there is no one in charge of the bus.

Problem #3:

Observation:

39 respondents expressed that they were concerned about the cybersecurity of the infrastructure of driverless buses

Problem:

AI software of driverless buses are linked to one another as well as the security operations centre for communication. If the infrastructure gets hacked, the buses could be frozen and thus cause malfunctions and possibly accidents.

Research:

According to “Buttice, C. (2019, February 22). Hacking Autonomous Vehicles: Is This Why We Don't Have Self-Driving Cars Yet? Retrieved from https://www.techopedia.com/hacking-autonomous-vehicles-is-this-why-we-dont-have-self-driving-cars-yet/2/33650”, commuters are afraid that the bus might break down and go haywire due to breaching of cybersecurity, which is a concern to their safety.

Problem #4:

Observation:

37 respondents expressed that they were concerned that the driverless buses cannot recognise and react immediately to the actions of other human drivers or cyclists, cannot interpret hand signals (e.g traffic police directing traffic), and they cannot assess road conditions like bumpy road.

Problem:

When commuters flag down a bus, they stretch out their hands and wave at the bus. Passer-bys and pets such as dogs and cats cross roads to travel around. If the bus is unable to detect these actions, the pets as well as the commuters might get injured, which concerns the safety of the commuters.

Research:

According to ”Solana, A. (2018, October 03). Autonomous driving: Facing dogs, pigeons, heavy rain, this driverless bus passes test. Retrieved from https://www.zdnet.com/article/autonomous-driving-facing-dogs-pigeons-heavy-rain-this-driverless-bus-passes-test/”, detection on obstacles like humans or pigeons are very important to ensure the safety of passengers as well as other commuters.

Problem #5:

Observation:

22 respondents expressed that they were concerned about the rise in bus fares with the development of driverless buses.

Problem:

To build driverless cars, much materials and facilities are needed for development. For mass production of driverless buses, lots of money has to be put in to purchase enough resources. Bus fares in Singapore are also increasing as the years go by.

Research:

According to "Hermes. (2018, December 29). Train and bus fares rise by up to 10 cents. Retrieved from https://www.straitstimes.com/singapore/transport/train-and-bus-fares-rise-by-up-to-10-cents" and "The cost of driverless buses. (n.d.). Retrieved from https://www.steergroup.com/insights/cost-driverless-buses", the cost of the development of driverless buses as well as the rise in bus fares in Singapore could cause an even greater rise of bus fares.

Underlying Problem:

With the advancement of technology in 2030 where driverless buses will be roaming on the roads of Singapore (condition and fsp), how can we improve the infrastructure of the driverless bus (key verb) so that commuters will feel safe and secure while riding in them (purpose)?

(Incorporating problems: 1, 2, 4)

Solution 1:

We thought there could be a virtual assistant in the form of a hologram for the passengers to talk to. The assistant will answer all of the passenger's queries, and will be further controlled by a human, who will have access to most of the buses' wide range of features, and appear in the hologram in the case of an emergency to guide the passengers. He will also be able to shutdown the bus in the case of emergency or malfunction. We also proposed to have gantries at the bus stops. The gantry will then deter fare evaders, and only allow only passengers who have the appropriate app on their smartphone to enter the bus stop.

Research: Condliffe, J. (2019). Holograms and smart assistants like Alexa are on the menu for the next generation of your car's dashboard. Retrieved 6 August 2019, from https://www.technologyreview.com/s/603307/holograms-and-alexa-are-coming-to-a-car-near-you/

Solution 2:

We thought of installing firewall in each driverless bus. Firewall is a program or hardware device that filters information coming through the internet connection into our private network settings. In other words, it helps to eliminate virus, thereby reducing the chances of hacking. Firewall prevents hackers from exploiting virus to assess the driverless bus systems to steal information or change the codes, which may cause harm or injury to the commuters on board and other pedestrians.

Research: Qu, J. (2019, April 09). Training Self Driving Cars using Reinforcement Learning. Retrieved from https://towardsdatascience.com/reinforcement-learning-towards-general-ai-1bd68256c72d

Solution 3:

Reinforcement learning is the key to train an AI robot. Research has shown that robots actually succeeds after countless failures. For example, a robot could not pick up a pen at first but was able to succeed after many tries. Before driverless buses are used as a form of transport, manufacturers can test run these buses several times before they can detect and analyse human movement and traffic condition. This would allow the AI system to detect commuters who want to board or alight and the bus would stop at the bus stop accordingly. The AI system would also be able to detect wheelchair bound people and would deploy a ramp for them to enter. Research: Training Self Driving Cars using Reinforcement Learning. (2019). Retrieved 6 August 2019, from https://towardsdatascience.com/reinforcement-learning-towards-general-ai-1bd68256c72d

Solution 4:

The government should set up a website about driverless buses for the public to read about it. They would then be able to keep up with the trend and familiarise themselves. The website should be easy to read and comprehensive so that everyone regardless of age can understand and learn how to use the equipment. For example, the website would be able to teach them how to board the bus, how to use their phones and how to use the hologram in of danger. This will allow them to have a safe and enjoyable ride. Research: Singapore relooking road rules to allow for self-driving vehicles. (2019). Retrieved 6 August 2019, from https://www.channelnewsasia.com/news/singapore/self-driving-cars-road-rules-sin

gapore-mot-10397586

Solution 5:

Stricter road legislation should also be implemented in the driverless city. Vehicles will be driverless and when an incident occurs, it is hard to pinpoint whose fault it is. Will it be the manufacturer's fault or the software's fault? Hence, stricter road legislation would reduce the ambiguity and it will also be easier for people to claim insurance should an accident occur. Research: Chin, M. (2019). Waymo is launching a campaign to teach people about self-driving cars. Retrieved 6 August 2019, from https://mashable.com/2017/10/09/waymo-educational-campaign/

Decision making matrix point system:

1. No points are given when the criteria has not been fulfilled.
2. One point for solution if the criteria is fulfilled poorly.
3. Two points for solution if the criteria is completed substandardly.
4. Three points for solution if the criteria is fulfilled adequately.
5. Four points for solution if the criteria is fulfilled well.
6. Five points for solution if the criteria is fulfilled perfectly.
7. The weight of each criteria is provided next to its title, in brackets

5 criteria to assess our solutions

1. Must be feasible - possible to be implemented
2. Should work the most effectively - extent to which the objectives can be achieved
3. Must be resource efficient - measure of how economically resources (like funds, expertise, time) are converted to results
4. Must have the most positive impact - the primary and secondary long-term effects produced by the intervention
5. Sustainability - continuation of benefits over a period of time

Step 3	Solution Idea	Criteria	Total

Sol'n #		1 (Weightage 2)	2 (Weightage 5)	3 (Weightage 4)	4 (Weightage 3)	5 (Weightage 2)	
#1	Virtual Assistant and gantry system	**4**	**5**	**4**	**5**	**5**	**74**
#2	Security firewall	**4**	**4**	**4**	**5**	**5**	**69**
#3	Teach AI to detect human movement and analyse road conditions	**3**	**3**	**5**	**4**	**3**	**59**
#4	Information dissemination programme	**4**	**2**	**4**	**3**	**2**	**47**
#5	Legislation to regulate driverless bus so as to ensure safety	**3**	**2**	**4**	**3**	**4**	**49**

Action plan (best solution):

What?

It will be a system that includes a virtual assistant and a gantry system at bus stop. The virtual assistant will be located in the bus, and at bus stops in the form of a hologram.

The gantry system will be installed at bus stops. The bus stops would be made into an enclosed area. Commuters who would want to enter can tap their phones on the relevant scanners if they have the appropriate application, in order to enter into the bus stop. Our group also discussed the luxury of air-conditioned bus stops, which will most likely be implemented in the design. This will make bus stops more attractive to all generations also. But this is not a must.

Who?

The solution will be implemented by bus companies and transport industries, and

be available to every person who has a phone.

How?

The virtual assistant will slowly learn what are some of the common questions that commuters ask, and will slowly become quicker and more accurate in doing so. After listening to the many accents that Singaporeans have, it will also become more skilled in detecting words, and will better understand the characteristics of our voices and the slang that we might use. It will be built in with the new fleet of driverless buses, and be included when Singapore's bus stops undergo their much needed upgrade.

Why?

It will help to improve the infrastructure of the new AI systems (KVP) as our solution involves equipment like gantries to avoid evasion of bus fares and new bus stops to keep commuters comfortable. This system of bus stops will also act as a testing bed for manufacturers, before they release their equipment to market. This will cause Singapore to be recognized as an innovation and AI friendly country also.

Where?

The virtual assistant that appears in the form of hologram can be located in the bus, at bus stops and in our phones. Gantry systems will also be installed at all bus stops for commuters to scan their phones before alighting and boarding. The gantry systems will be added slowly to only suitable locations before it is made fully-public. Control stations can be in high places to receive the best connection to

minimize connection errors.

Phase 1

The pilot testing of the virtual assistant and gantry system will take place in less populated areas like Jurong Island, Sentosa or within the universities.

Phase 2

After pilot testing, the virtual assistant and gantry system will be rolled out to the suburbs like Woodlands, Pasir Ris, Punggol, etc.

Phase 3

The virtual assistant and gantry system will be rolled out island wide.

When?

Our solutions are predicted to be fully implemented by 2030.

Phase 1: By 2022

Phase 2: By 2026

Phase 3: By 2030

Feedback from industry:

Mr Anthony's (Founder of Moovita, a company which develops self-driving

systems) **comments:**

The virtual assistant can be installed in the handphone, so it would be personalised and be able to attend to each passengers' needs.

Singapore is quite safe because people are quite civic conscious and do not have the tendency to jump over the gantry.

Enclosed bus stop with air-con is quite expensive and difficult to implement. Enclosed bus stop may not be necessary.

Need to find out how to handle bus docking into the bus stop.

Finalised version of our action plan:

The virtual assistant can be installed in the handphone, but it can also appear as a hologram on the driverless bus in emergencies to guide passengers. Passengers can push an emergency button in order to activate the system but the system can also be automatic.

Effectiveness and feasibility: Holograms and AI have already been invented and are already implemented in some cases. Gantry systems are already in place in MRT stations. Hence our action plan is feasible, as it makes use of technologies that already exist.

With the gantry system, people would have no choice but to tap in to enter the bus stop and board the bus, which prevents fare evasions. With the virtual assistant being personalised for every commuter’s needs, commuters would find taking a bus ride more convenient and easier. The public virtual assistant on the bus can also monitor the situation and control the bus in times of danger. This makes bus rides more safe for commuters as perpetrators’ actions will be watched and action

can be taken immediately.

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First Driverless vehicle accident aroused doubts in autonomous vehicles being rolled out on the road (ST article-https://www.straitstimes.com/singapore/driverless-car-hits-lorry-during-test-drive)

Experiment on driverless shuttle bus shows passenger's views being in a driverless bus (ScienceDirect article-https://www.sciencedirect.com/science/article/pii/S0967070X1730286X#bib14)

Opinions on how hacking driverless vehicles could be done and consequences (Technopedia article-https://www.techopedia.com/hacking-autonomous-vehicles-is-this-why-we-dont-have-self-driving-cars-yet/2/33650)

Picture taken from: http://www.roots-solutions.com/telematrixme/en/?portfolio=police-control-center

Picture taken from: https://images.app.goo.gl/5DF4P5WyGrsF1xe67

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