

Research Paper Outline

Mark Gameng

Introduction

- Brief overview of what smart cities is, their implications and their future
 - o Smart transportation, health care, safety, energy, etc.
- Most of the worlds population now resides in urban areas which will keep growing and growing. Cities which are high density areas are efficient in many ways such as energy, resource, etc.
- Smart cities essentially connects the physical, IT, social and business infrastructure to overall make a better and more efficient city. This is most important for environmental sustainability and the longevity of the city.
- Along with smart cities, there are 3 dimensions to it, technology, human and institutional. For a city to be smart, it needs to have the technology required for it to function and be as efficient as possible. The city's people should also be creative and knowledgeable for the city to keep learning and growing. City should be as useful and helpful to its inhabitants to keep growing. The institution, government and the community as a whole should be "smart" and act as a group to result in a better city
- Recently, transportation has been a major topic , so this paper going to focus on smart transportation and autonomous vehicles / driverless city
- **Resources:**
 - o Nam & Pardo
 - o Harrison et al.

Smart Transportation

- Overview of the approach and issues with implementation of smart cities with smart transportation
- Currently there are "automated" vehicles roaming around the streets, the question is its impact and how it will continue to grow. There's also the risks and ethics of automated vehicles and a driverless city. This paper aims to talk about the software engineering approaches of forms of smart transportation from data collection, AI, and CCI and HCI communications as well as the risk management.
 - o Estimates say 4/10 vehicles will be autonomous by 2040. Australia, Rio Tinto already using driverless trucks and is set to make 30% of them autonomous by 2019.
- Some of the challenges are the technology and the feasibility of this coming into fruition, at least the marketable and safe version. There's also the ethics and the possible push back from society from this transition. A popular example would be the trolley problem. Should a car swerve and injure one pedestrian or instead crash and injure it's many passengers. Are autonomous vehicles safer than humans driving? These issues sway the acceptance of the implementation of a high level smart transportation such as automated vehicles.
- The transition to smart transportation and automated vehicles are coming, the question is how and what can we do to support and make sure it doesn't fail or result in a more dangerous city. Rather than higher ups or the government taking charge, its society as a whole that determines

whether the push for smart transportation/driverless city/automated vehicles will happen in the near or far future

- **Resources:**
 - o Hancock et al.
 - o Porter et al.

Software

- Software engineering approaches with smart transportation / autonomous vehicle / driverless city
- Data collection via various sensors and cameras
 - o Radar, lidar, and Camera – detect cars and moving objects from quite far away and also lanes and motionless objects
 - o Ultrasonic sensors – detects nearby cars, especially useful when changing lanes.
 - o Satellite Imagery – to identify the road it's on, traffic, and possible issues
- Algorithms include using the data collected and detecting cars, people, movement, lanes etc as well as path finding.
 - o Object detection and tracking. To detect objects, moving objects, and humans as well as the speed and direction.
 - o Localization – input is image and extracts features like landmarks to pinpoint their location in a map. So the system understands its surroundings and sense of the road, lanes, and structures.
- There are various levels of automation in cars. With level 5 being full automation and the car takes full control of all driving tasks under all driving conditions. Most current autonomous vehicles today are level 1 (driver assistance), 2 (partial automation), and 3 (conditional automation). Most systems only handles driving tasks under limited driving conditions and expects the driver to be aware and respond if need be. For example, the car can only drive on highways that it has on the database and requires the human driver to have their hands on the steering wheel. In this case, HCI communication is still important and critical for the safety of the driver and everyone in the road.
- Aside from sensors and humans communicating with the system, other cars may also. In the case where each nearby cars are communicating with each other then the result is a more cohesive and unified traffic which results in higher safety and more efficiency.
- For quality assurance and testing, 3d simulations can be created or real life experiments can also take place. Currently, 3D simulations are advanced enough for these kinds of tests which will be much cheaper, but real world tests are still the most proper.
- **Resources:**
 - o Ingle & Phute
 - o Lin et al.
 - o Furda & Vlacic

Risk Management

- Autonomous vehicles have many benefits but it also has many challenges and risks
- Vehicles cost a lot, even more so, if its autonomous. So testing and experimenting with this type of technology is very expensive. Also, too expensive will result in possibly less sales as it's not available to most people. Tradeoff between really expensive autonomous vehicles with high

autonomous functions and not that expensive vehicles but with more human interaction due to having less autonomous functions

- Most importantly is the litigation and liability of autonomous vehicles. There will always be crashes in a non perfect world and system. Should an autonomous vehicle value itself more than an animal or a person. What dictates its decisions. If an accident occurs and it goes to court then the algorithms, sensors, and the decisions the vehicle makes will be put in to question. This will be more talked about in the ethics section
- There's also the importance of security. The ability to hack or disrupt the system should be top priority as it not only endangers the passengers but also endangers everyone in the vicinity.
- Since this is a recent field, there's not a lot of research, so may have to spend money on research and it may or may not pay off.
- Security and costs of making the vehicles are the most expensive and risky part of this. The design should be as complete and accurate as possible to minimize the extra costs that may come from testing.
- **Resources:**
 - o Fagnant et al.

Examples

- Tesla
 - o Uses radar, camera and ultrasonic sensors to detect cars, moving objects, humans from nearby and far. Object detection/tracking and localization. Also uses satellite imagery and GPS and algorithm to identify the road it's currently on. Traffic segment is also detected based on prior knowledge or from its sensors.
 - o Includes automatic steer, lane change, emergency steering, side collision warning, and auto park. Drivers must keep hands on steering wheel so that they are always aware in case that the car requires them to act.
 - o In this case, it seems to be conditional automation level 3. Teslas afaiik only are able to autonomously drive in some/most? highways, and rarely on cities. It depends on how much data they have on the road and location I guess. Also requires the human to always be aware in case it needs to take control. So tesla only handles driving tasks under limited driving conditions and expects the driver to be aware and respond if need be.
- Delivery drones
 - o Last mile delivery of small and light items. Prevalent in delivery companies such as Amazon, Google, UPS, DHL as well as healthcare. Reduces freight traffic and car traffic.
 - o In the future, will be essential and possibly replace trucks and have a massive impact on energy consumption, safety, privacy, pollution, etc. Depending on how advance it is and the logistics, it may be more efficient and better than trucks and cars for deliveries.
 - o In healthcare, used for blood medication, vaccines, and defibrillator deliveries
 - o Very similar to autonomous vehicles but mostly without a human controller
- **Resources:**
 - o Therese Jones
 - o Judy Scott & Carlton Scott
 - o Ingle & Phute

Ethics

- Privacy of vehicles. With these “smart” cars, everything will be recorded, at least a few minutes before a crash. The data may include routes, destinations, speed, etc. Some may not want that available and be used against them in court. That data may also be misused by people or even the government. At the same time, having this data publicly available will result in a more efficient transportation systems.
- Consequences of autonomous vehicles. Human drivers may be forgiven for making a bad split-second decision but should an autonomous car be. Who should take the blame for when an autonomous car makes a bad decision? The programmers or the company. Should they even take repercussions. When faced with situations such as the trolley problem, the right and wrong answers is not always clear. In that case, what should happen. I feel as if there is no real objective answer to this. One for sure thing is that people should be researching and talking about the ethics and morality of autonomous vehicles.
- In terms of an autonomous vehicle coming into an accident or having “bad” code and thus making an objectively bad decision. To evaluate this, programmers and ethic researchers alike should review the code and how the car was designed to figure out which part, which step in the process was the problem. This in turn will make the programmers or the company as a whole take the blame.
- Morals are a social construct, or subjective. It differs from people to people. Discussing the morality of algorithms in autonomous vehicles will probably never end and reach a consensus. The only real end is if the result far outweighs the bad. As long as autonomous vehicles are deemed to be safer than human drivers and are more efficient and better for the environment and such, then the debate on the ethics should not be a roadblock.
- Nevertheless, the ethics debate of autonomous vehicles will probably never and probably never should, as more and more debate will take us closer and closer to reaching a consensus of our morality and how we should view these types of technology.
- **Resource:**
 - o Bonnefon et al.

Future

- Technology is advancing fast and autonomous vehicles are already here, so in the future, there is no doubt that there would be more and more electric and autonomous vehicles
- In 10 years, most car companies will have an autonomous vehicle at some level and it will be more commonplace.
- 50 years and beyond, I can see the cars start communicating with each other so that the road will become even more efficient safe.
- In the far future, all vehicles of some kind, even drones, will probably be available to be autonomous at least for transportation. Laws will take place to encourage and probably require the use of autonomous vehicles for safety and efficiency. The level of autonomous will also be more advanced, it might even become fully autonomous, having no need of human interaction in all kinds of situations.

Resources

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