You've Arrived at Your Destination
Quintin Carlson & Jeffrey Hsu
Nease Robotics - Ontic Development Group Team 10-0055
me@quintincarlson.com, hsus@msn.com
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You've Arrived at Your Destination

Throughout the past three years, the Ontic Development Group has strived to push the boundaries of science, technology and innovation. Whether on the moon, in a biomedical lab, or on the open road, Ontic has worked to change the way you think about life. During this presentation, lead designer Quintin Carlson and lead engineer Jeffrey Hsu will explore what it takes to exist in a fictional organization.

2010 ODG Public Project: Autonomous Vehicles

Late in 2009, Ontic Development Group subsidiary, Ontic Transport, endeavored to change our daily commute. During this project, the ODG Team addressed the current technologies and future goals in concert with their own autonomous vehicle system.

1 Current Technologies:
"Jesus had a Honda, John 12:49: For I did not speak of my own Accord." — Jeremy Clarkson.

We have been told, from the first years of the commercially available cars, that in the future these vehicles would be able to drive themselves. Where is this future? According to Professor Schmidhuber, the first autonomous car was able to navigate the streets of Paris in 1994. The car was able to make turns, follow traffic laws and monitor 12 nearby cars at once. Shortly there after, advancements were made to allow cars to travel on the Autobahn at speeds of up to 180km/h, for stretches of 150km. [7]

Unbeknownst to many drivers, in most cars-at least those made in the past decade-there is already autonomous technology instated. For instance, Anti-Lock Brakes and Cruise Control. When you are racing to the important meeting at the local Starbucks, and all of a sudden a penguin jumps in front of your vehicle and you slam the brakes, the ABS (Anti-Lock Brake System) will engage. In this process, it will check your speed of the tires (front two tires, and back two via the differential) and pump the brake accordingly- preventing the brakes from locking. Cruise Control uses the onboard computer and aims at keeping you at the same speed at all times. This is done by accelerating the car on inclines and releasing the accelerator when on slopes. However to allow for manual overriding, should the driver tap the brakes or press the Cancel button, the system will disengage.

In recent times, the DARPA Grand Challenges have been a hotspot for state of the art autonomous vehicles. Taking place in 2004, 2005, and 2007, the competition involves teams creating an entirely autonomous vehicle that can follow a route consisting of GPS coordinates and avoid any obstacles along the way. [10] The 2004 and 2005 Grand Challenge consisted of traversing a desert environment and overcoming its tortuous terrain. [3] The 2007 Urban Challenge required the vehicles to navigate through an urban environment, following streets, obeying signs, and avoiding traffic. [5]

Higher end luxury car makers have implemented a form of autonomous driving, more aptly put: autonomous parking. Lexus has made available their automated parking system; this system removes the need for manual control while parallel parking. Volvo has also introduced a system that can prevent “fender-benders” by stopping the car before rear-ending someone while under 18 miles per hour.

2 Future Goals

Ultimately, vehicles will be entirely autonomous and will require no human assistance to complete set objectives, like taking us to the mall, movies or grocery store. The car will be able to provide safe and consistent transportation, similar to something you might see out of a movie (like *Minority Report* or *I, Robot*).

2.a Elimination of accidents

Ideally, with a system that has optimal control and knowledge of the environment, it is theoretically possible to completely eliminate vehicle related accidents. For example, cars would never crash on the highway because each car is capable of detecting, evaluating, and diverting away from danger. This system also removes a human’s direct influence from the car. This has the potential of eliminating all crashes and deaths related to human error, blood alcohol levels, fatigue, distractions, and physical limitations. The potential of preventing 6 million car accidents and 45,000 deaths a year. [2] [6]

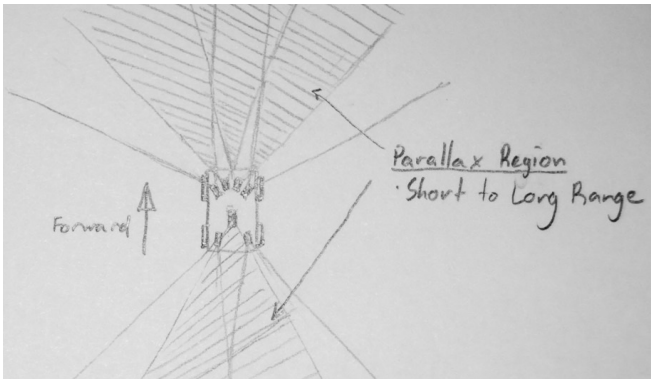
2.b Optimal routing

Expanding on the previous topic, with a system that accounts for safety, speed limits and road rules can be modified on a case by case basis. Highways speed limits can be much higher as the computer coordinates vehicles. The speed limit can also vary based on local factors, such as road congestion, nearby buildings, or type of road.

Similar to most technologies, advancements are made on a minute by minute basis. Autonomous vehicle development is no different, so prepare for a wild ride, as technology advances and changes.

3 The ODG Autonomous Initiative

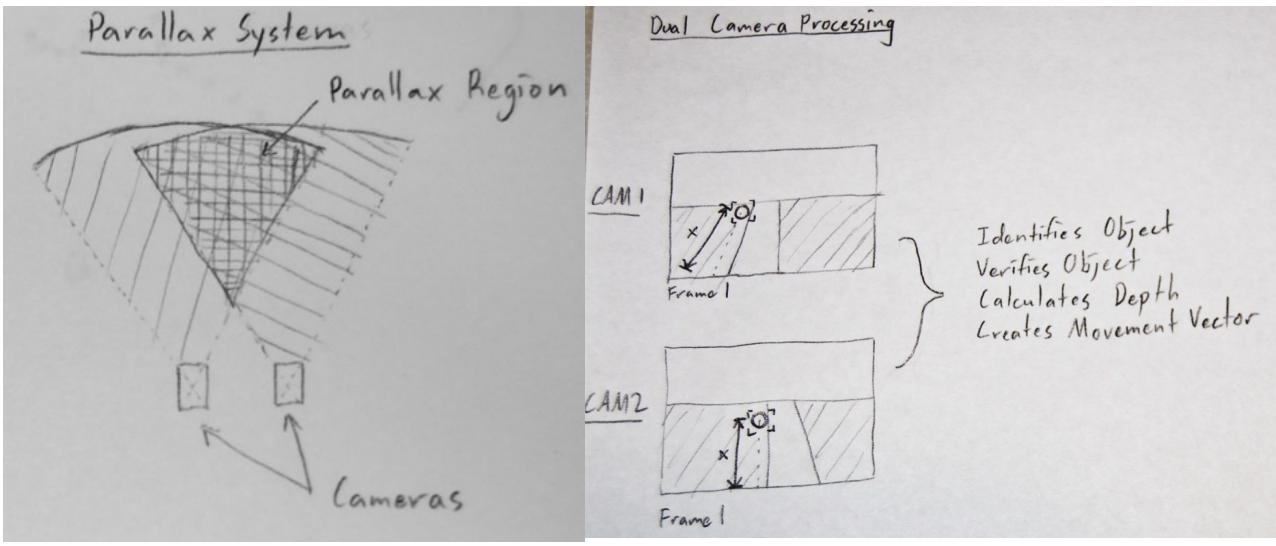
The Ontic Autonomous Vehicle System consists of three operating levels: Standalone, Local Adhoc, and the upper Evolve Network.



parallax regions in front of and behind the vehicle.

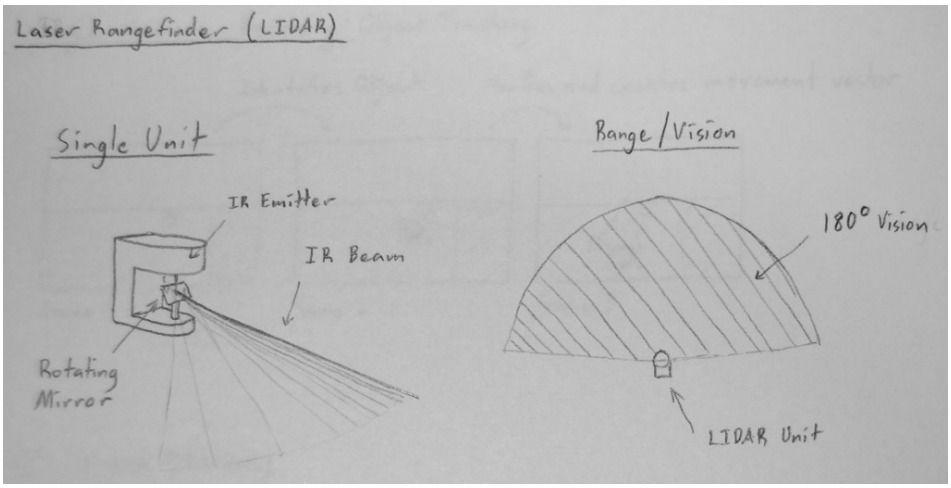
3.a Standalone Level

This level consists of detection and avoidance behaviors controlled by onboard equipment. Mounted on the vehicle, four high definition cameras allow for parallax camera processing. This system utilizes overlapping images from the camera system to create depth perception, similar to how our brain determines depth from our eyes. Two sets of cameras are positioned forwards and backwards, creating two



A separate sonar unit will also be capable of detecting items as far as 50 meters away. A medium range sensor system consists of LIDAR units: Laser Rangefinders. [4]

Lastly, the vehicle has a close proximity sensory system mainly consisting of laser rangefinders meant for shorter distances. The close range system provides a full 360º range of detection near the vehicle and covers the blind spots of other sensors. This system is crucial when entering a crowded highway, or parking in a tight space. [4]



The Standalone Level is able to provide accurate routing that closely resembles current day geo-location (GPS) systems. Input is given through vocal commands or via the touch screen input- eliminating frustration due to poor interaction design. The user can set parameters like fastest route, shortest distance, or alternate speed restrictions. The Standalone Level, while receiving frequent 'Map-Patches' or map updates from a central dispatch, is able to act without any external guidance.

When on the road, the AI employs a series of heuristics in its decision making. The absolute priority is the collective safety of the car, its passenger, and any people in its local environment. The second priority is to maintain control of the vehicle, in terms of its influence on the road and knowledge of its surroundings. The third priority is to remain on the road, with a parallel heading. The fourth priority is to achieve the trip's objectives. The car will also make predictions of the world around it based on its sensory data. The software utilizes Kalman filters to remove uncertainty and noise from the sensors, while applying Bayesian probability to predict events of success or failure in maneuvering and monitor chances of danger or instability. Through all these processes, the car is able to work without outside input from central towers or other autonomous vehicles. Since this level does not require external information, the Standalone Level acts as the primary system. No higher level systems can interfere with its goals and actions.

3.b Local / Ad Hoc Level

This level consists of the vehicle operating with other autonomous vehicles. This level mainly consists of the intercommunication between cars; assisting and providing more information than the Standalone Level. The vehicle is capable of establishing a connection and communicating with other autonomous vehicles within a set range of the communications system.

Through this communication, cars can exchange information they have accumulated. This is especially useful for obstacle detection. When driving on the road, other cars create blind spots for a vehicle's onboard sensors. The other car would be able to detect objects in that blind spot. By coordinating between the two cars, they can each broaden their total knowledge of the area by combining the sensory data. With multiple cars on the road, a single car's knowledge will increase as more cars join the local ad hoc network, to the point that the car can have complete awareness of the road, to the extent that onboard memory will allow.

Inevitably, routes and roads will change, but stored maps are not aware immediately. Instead of requiring an outside source to re-evaluate the land, cars can exchange their routes and detours to update the internal maps. For example, in the case of a two way construction zone, cars leaving the site will transmit the paths and obstacles of the site to incoming cars. This prevents new cars from having to heavily monitor the new route. This path change can also be stored in the local GPS map, as a temporary road. As more cars pass over the path, it can become a permanent road.

The communications equipment on the car releases an active beacon when in use. This beacon is used to determine the angle, heading, and distance to other cars in a local area. This is done in tandem with our sensory data, correcting for error.

3.c Evolve Level

Prior to active traffic information from Google Maps, MSN Direct or XM Traffic, mapping services would send everyone on the same route based on the minimum amount of time it would take to get there. This is a major issue when it comes to traffic flow and more importantly, keeping the vehicles moving!

"The Director"

This is one of the roles taken on by the higher level network, codenamed: Evolve. Evolve provides generalized traffic management, to prevent congestion in urban areas, interstates, construction zones and other problematic areas. This feature, known as "The Director" is initiated when needed- generally at times of heavy congestion. "The Director" is also capable of planning longer routes for road trips. For instance, if you were traveling from New Orleans to Atlanta, "The Director" would be able to expect your arrival into Atlanta, and plan the fastest and most efficient route for you to travel on. To organize the freeways, "The Director" will put cars in the left lanes when they have far distances to travel. When the vehicle approaches its exit, it will move to the right lanes. The Director provides broader and more general driving instructions, allowing the car to react to its environment while still maintaining traffic control and flow.

Connecting

The Evolve network would be based across several high speed data connection types. In more rural areas, satellite based networking would be preferred. However in more urban and metropolitan areas a combination of 3G cellular service and LTE based 4G service will provide a stronger and more stable connection.

Internet Everywhere

Evolve is also able to provide other technology services. We plan to enable internet connectivity services. This effectively makes each Evolve enabled vehicle act as a WiFi hotspot, allowing all onboard passengers to browse the web, communicate over VOiP/video conferencing, send email and watch YouTube. Evolve would also plan to provide MobileTV solutions for onboard displays, allowing passengers to enjoy live programming, streaming media and On Demand content on their way to work, school or their in-laws. Finally, Evolve will also enable continuously updated maps, known as "Live Maps," storing active information about detours, construction zones, new roadways, traffic, and weather based route closures.

Access

All drivers with Evolve enabled vehicles would have access to Basic Direction Services, which includes traffic routing and road trip planning along with inter-car communication services. However those who pay for Premium Network Services memberships, on a yearly or lifetime basis, receive additional convenience services such as internet, "Live Maps" and all media and television services available over the network.

3.d Legal

Accidents and Technical Difficulties

Should an accident occur while the Autonomous Vehicle System (AVS) is in operation, a counsel of traffic engineers, autonomous system technicians and law enforcement personnel will ensure the accident occurred due to the AVS as opposed to human override or error.
General guidelines, recommended by the Ontic Development Group, are that the Autonomous Vehicle System will pay for all damages, should an accident occur.

However, should some hardware failure or breakdown occur, the vehicle will alert the passengers. It will then provide a grace window in which the device must be repaired (whether the device is covered by warranty or not). If the passenger does not repair the devices by the set date, the vehicle will no longer be covered should it be part of an accident. However, this insurance provided by the AVS manufacturer would be reinstated when the device is repaired by an authorized service provider.

Environmental Impact

While most automotive manufacturers strive for more environmentally friendly vehicles, using alternative energy sources (like biofuel, hydrogen fuel cells or electricity), they do not address the problem of inefficient driving. While taking a “Sunday Drive” for fun is great, it is not environmentally friendly nor is the nearly unavoidable act of getting lost. In the end, driving more cautiously, never braking hard or accelerating quickly, taking the most efficient route and preventing the cars from idling as long as possible will help ensure there is as little environmental impact as possible.

Social Considerations

Driving is a part of a lifestyle. It represents freedom and independence. It represents romanticism and the ability to control your own life. Racing is a very popular, multi-billion dollar sport. There are television channels and popular shows the feature cars, which are faster and more fun to drive. By taking away the ability to drive, you lose the freedom and independence that comes with owning your own car and being able to drive.

Safety Notes

Autonomous vehicles will remove most of the careless driving accidents, preventing accidents caused by alcohol, fatigue or distraction. It will also have a faster reaction time than most humans, able to react and predict oncoming cars that may be dangerous. However, with actual drivers out on the road, accidents may still happen.

"Autonomous driving means that someday you could do your e-mail, eat breakfast, do your makeup, and watch a video while commuting to work... in other words, you could do all the things you do now while commuting to work but do them safely." - Rick Wagon

Additional Media Content is available in at our online portal:

http://vimeo.com/album/181749

http://gallery.me.com/quintincarlson/100048

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