Robomart
Safety Guide

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PART 1:

Robomart Overview

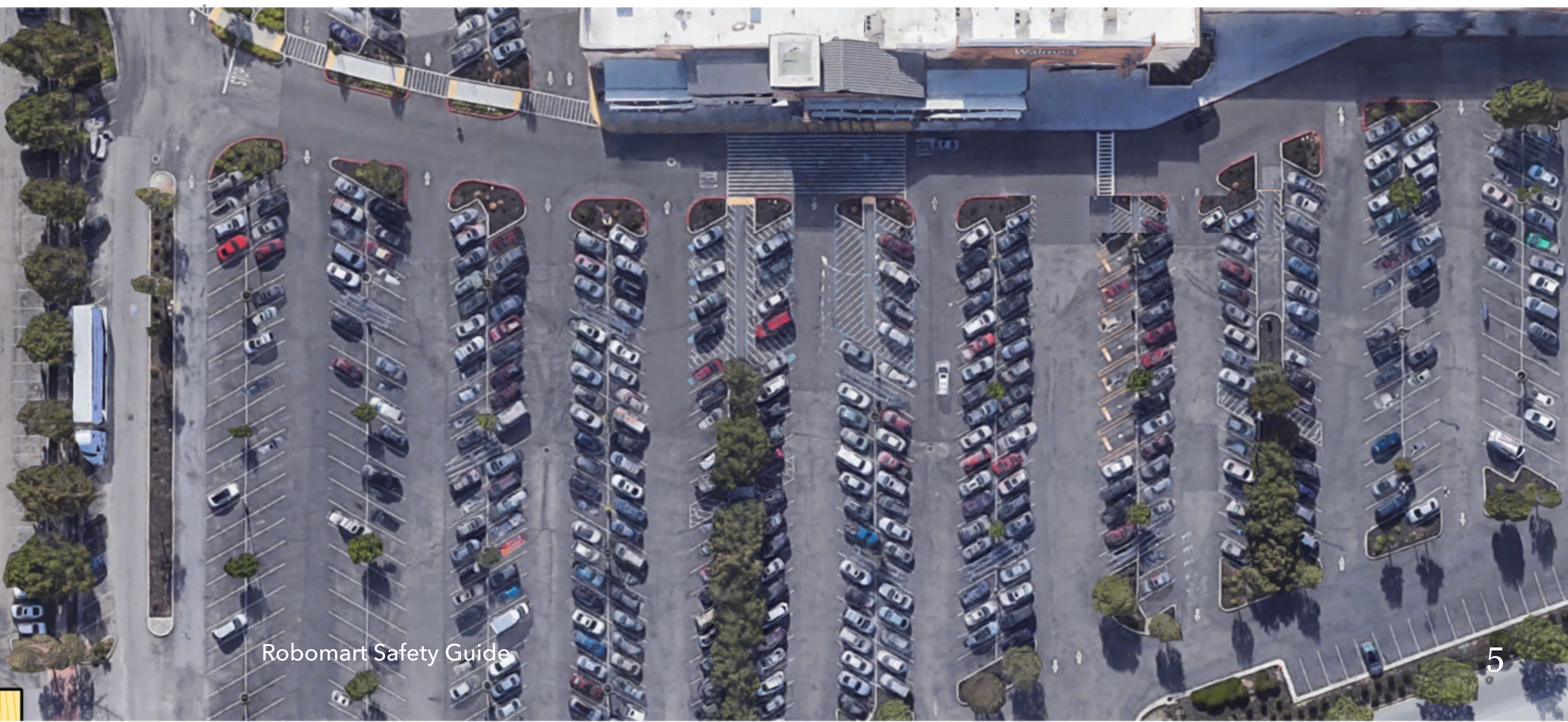
Introduction

We need fewer people in vehicles making grocery trips.

An estimated 39,141 people lost their lives on all modes of the US transportation system in 2017. The vast majority—37,133 deaths—were from motor vehicle crashes.[1]

Over 33 million Americans make a trip to the grocery store every day.[2] Many of these trips lead to accidents due to human driving errors, and a significant number of these trips are avoidable.

At Robomart we have created a better way to shop for goods, without needing to drive a two-ton vehicle to get a bag of groceries, and we are outlining our holistic approach to safety via this voluntary safety self-assessment report.



About Robomart

Based in Milpitas, California, Robomart, Inc. is a full-stack robotics company that has created the world's first self-driving store. Robomarts are fully electric road vehicles engineered with cutting-edge tech, including self-driving technology, teleoperations for safety, a checkout-free system for convenience, and purpose-built refrigeration for cooling.

Founded in 2017 by serial entrepreneurs with deep domain expertise in autonomous vehicles, on-demand delivery, and retail operations, the company has assembled a world-class team of leading industry experts to further its mission of creating time.

To learn more about Robomart, visit robomart.co

Business Overview

There are two ways to buy goods today. Shoppers can physically go to the store and buy products or order them online and have them delivered. On a typical day over 33 million Americans make trips to the grocery store, and on average 68% of those trips are single person journeys to buy 10 items or fewer.[3] This collectively amounts to 29 million hours spent, or over three thousand years wasted on grocery runs every day.

Delivery through e-commerce promised to give consumers a better option by being more convenient. Yet less than 3% of groceries in the U.S. are sold online.[4] The category has never translated over e-commerce. One reason is that delivery is expensive, but more importantly shoppers don't trust someone else picking fruits, vegetables, meats and other perishables for them.[5]

Although there have been advancements in autonomous delivery robots, these are incremental improvements that only save labor cost - they don't save time. Consumers still have to order goods online, create a basket, check-out, and wait for it to be delivered. It takes the same amount of time for a robot to make a delivery as a human - if not longer - and shoppers still don’t get to pick and choose goods when it arrives.

In three decades, since the advent of e-commerce, there has not been a better way to buy products. Until now.

Robomart has created the first new retail channel since e-commerce. Our autonomous mobile stores allow consumers to pick and buy their own goods right at home, while shopping in the fastest possible way, within minutes rather than wasting hours going to the store or waiting for delivery.

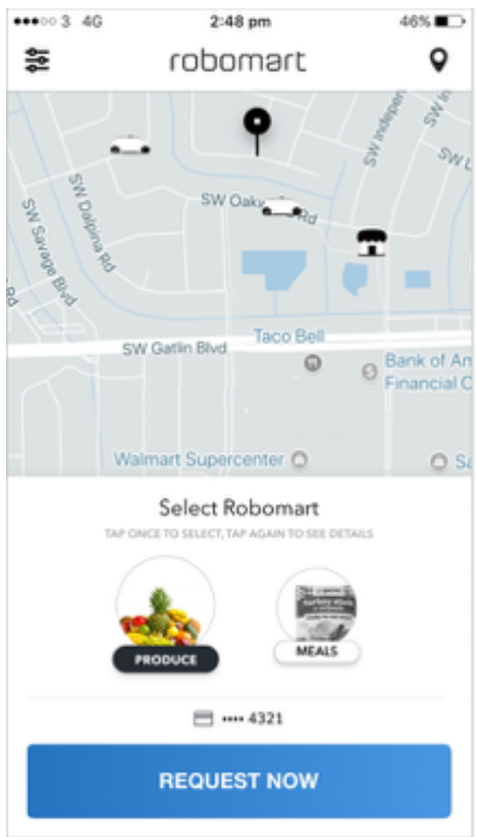
Product Snapshot

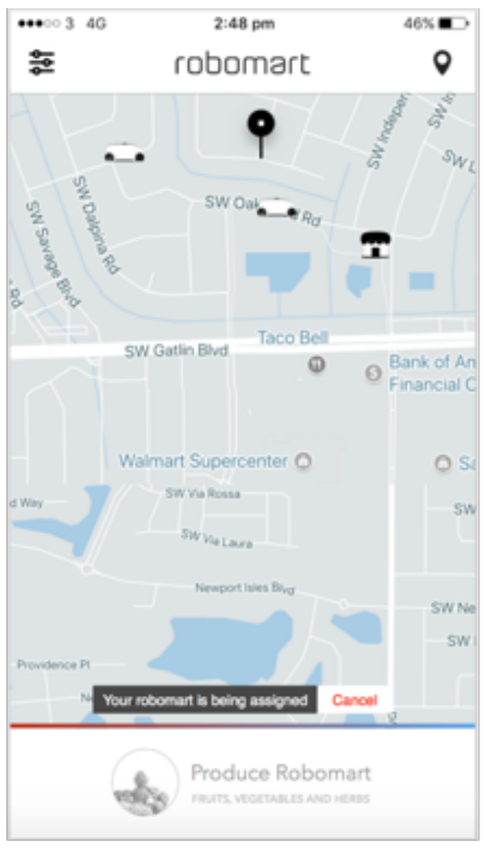
Value Proposition

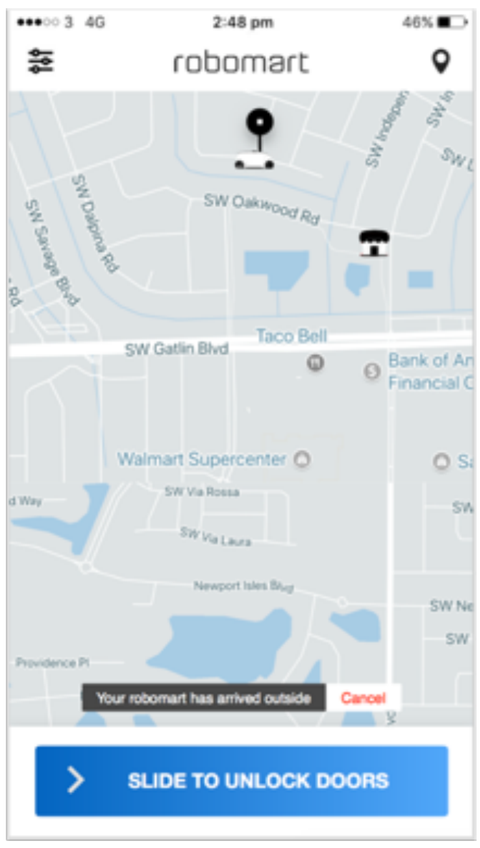
We have invented the fastest way to get groceries on demand with a single tap, by making the store autonomous.

How it works

A consumer simply taps ‘Request Now’ on the Robomart app. They are then allocated the closest robomart which they track on a map.







When it arrives outside they are notified, and all they need to do is walk up to the robomart, open the doors, take the items they need and that’s it. Our checkout-free grab and go technology lets us know which products they have taken. In this way consumers can order, pick out, pay for and receive products without having to check out, all with a single tap in the most seamless way possible.

Afterwards, the app displays a full breakdown of the products taken and provides a receipt of purchase. Based on the total cost we then charge the consumer’s saved card accordingly.

Seamless Experience

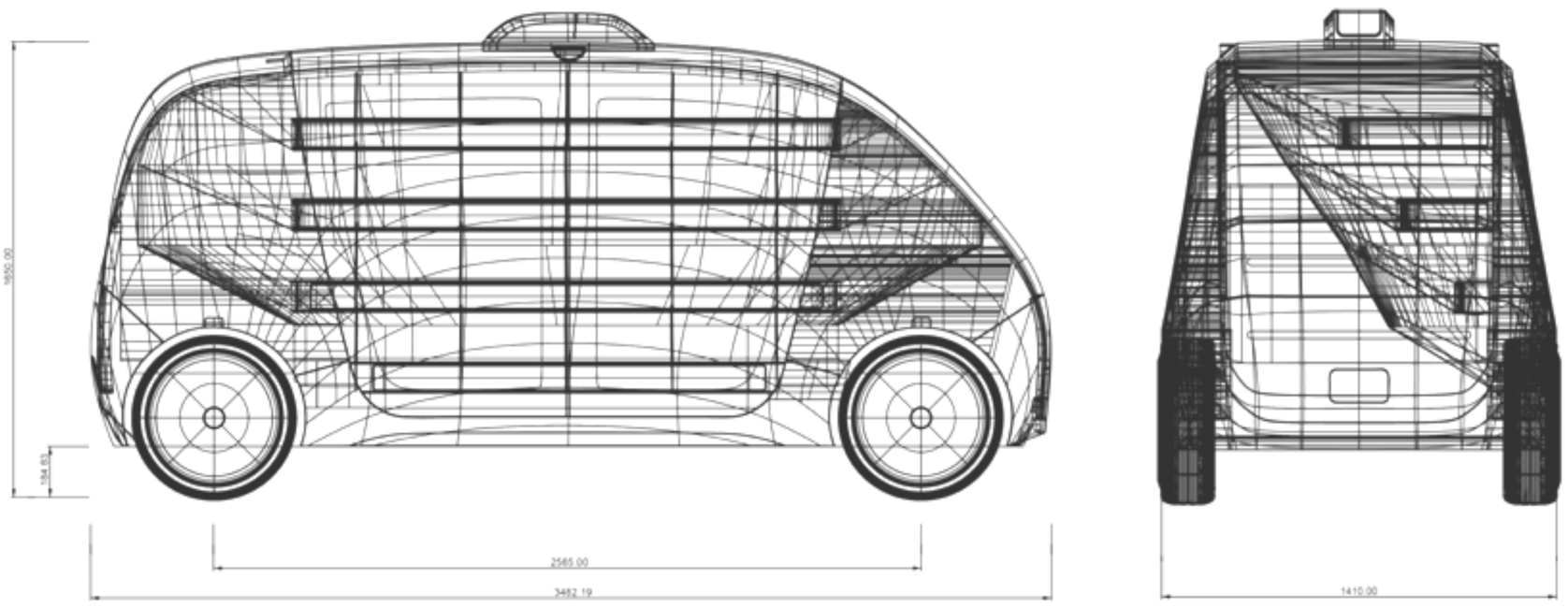
Our patent pending, state-of-the-art checkout-free mobile retailing system allows us to track everything that is taken from the robomart. This way we offer consumers a completely frictionless experience.

As robomarts are not delivery vehicles, there’s no need to create a basket, no need to wait for a retailer to accept the order, stock up and send out the delivery, and no need to pay a delivery fee. If there’s a robomart close by, consumers can shop in just a few minutes instead of waiting for hours.

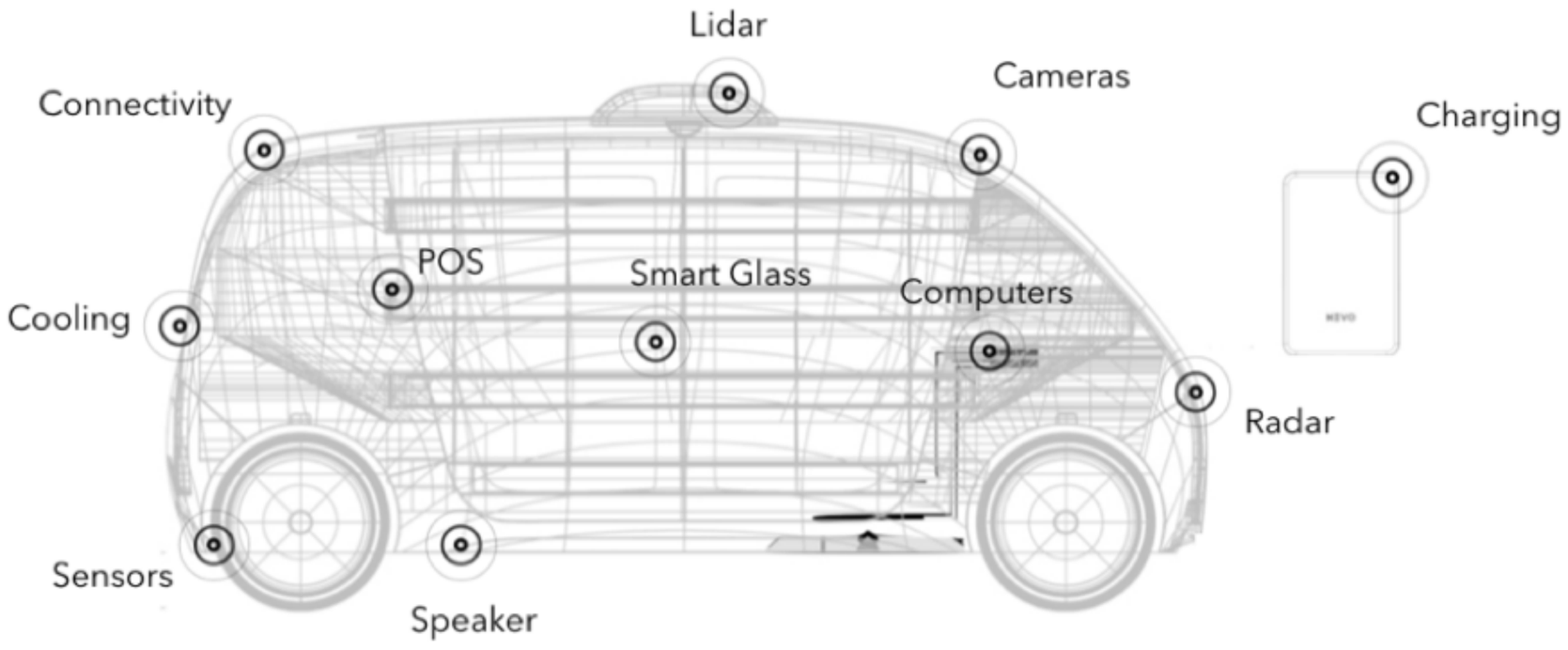
For decades, consumers had the convenience of their local greengrocer and milkman coming door to door. By leveraging driverless technology we can now recreate that level of convenience and accessibility.

Technical Specifications

Robomarts measure 11 ft 5 in long, 5 ft 5 in high and 4 ft 7 in wide.
A fully stocked robomart holds up to half a ton of goods.



Robomarts are fully electric road vehicles engineered with cutting-edge tech, including self-driving technology, teleoperations for safety, a checkout-free system for convenience, and purpose-built refrigeration for cooling.

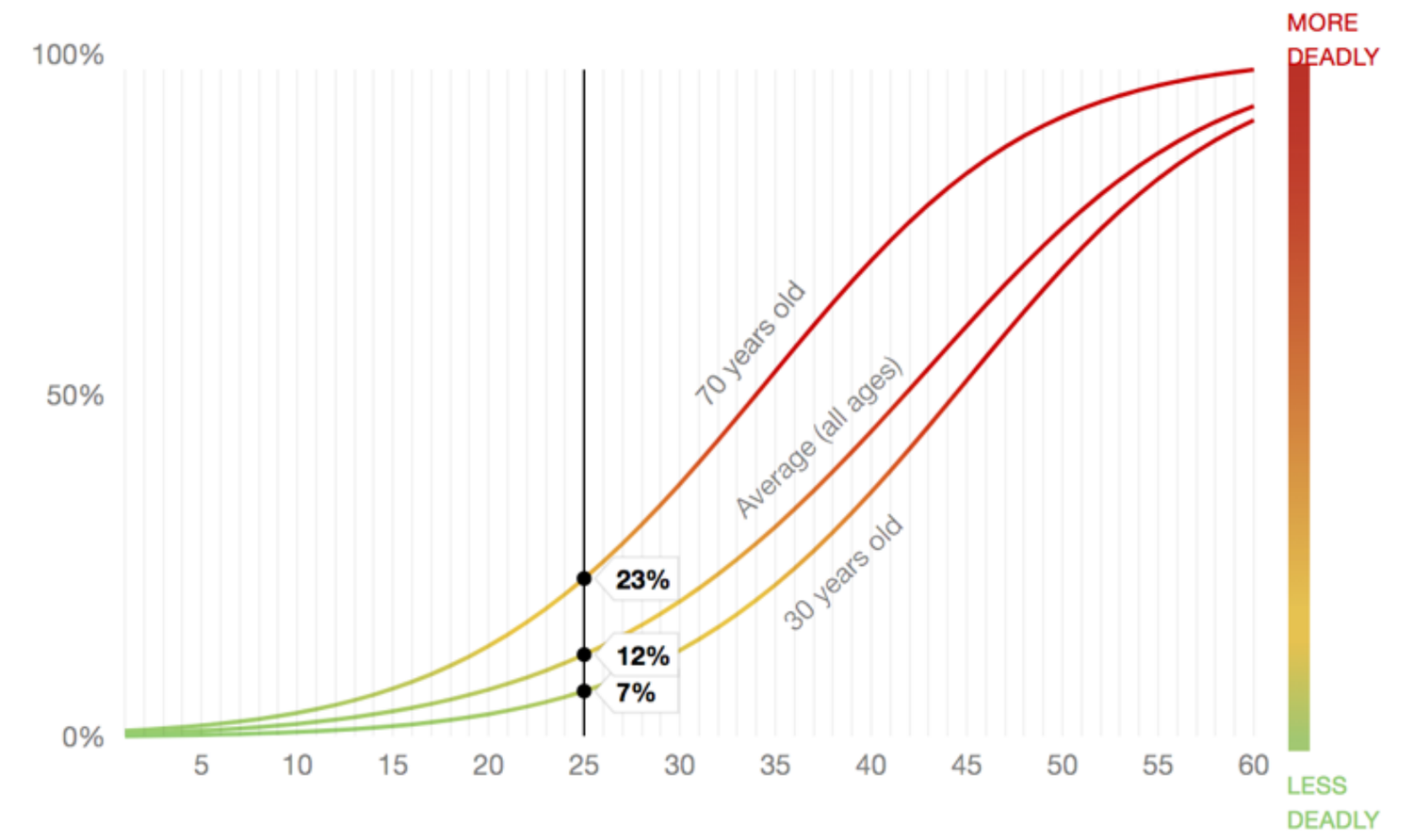


Holistic Safety Approach

Robomarts are low-speed vehicles (LSVs) with a top speed of 25mph. They operate in geofenced areas, never go on highways, and as they never carry a driver or passengers, they always prioritize the safety of pedestrians, cyclists and other vehicles.

By building a custom, fully driverless vehicle, we have created an inherently safer vehicle than any other on the roads today. By design we do not ever have to compromise the safety of passengers vs. pedestrians. Additionally, as our vehicles are battery-powered we are able to significantly reduce carbon emissions over time.

Extensive research from the AAA foundation for traffic safety has shown that vehicles going at lower speeds greatly reduce the chances of injury or casualty. By limiting the speed to under 25mph we hugely improve the chances of survival and safety for pedestrians, cyclists and other vehicle passengers in the unlikely event of an accident.[6]



Risk of casualty for pedestrians struck by a car or light truck traveling at 25mph. Source: AAA

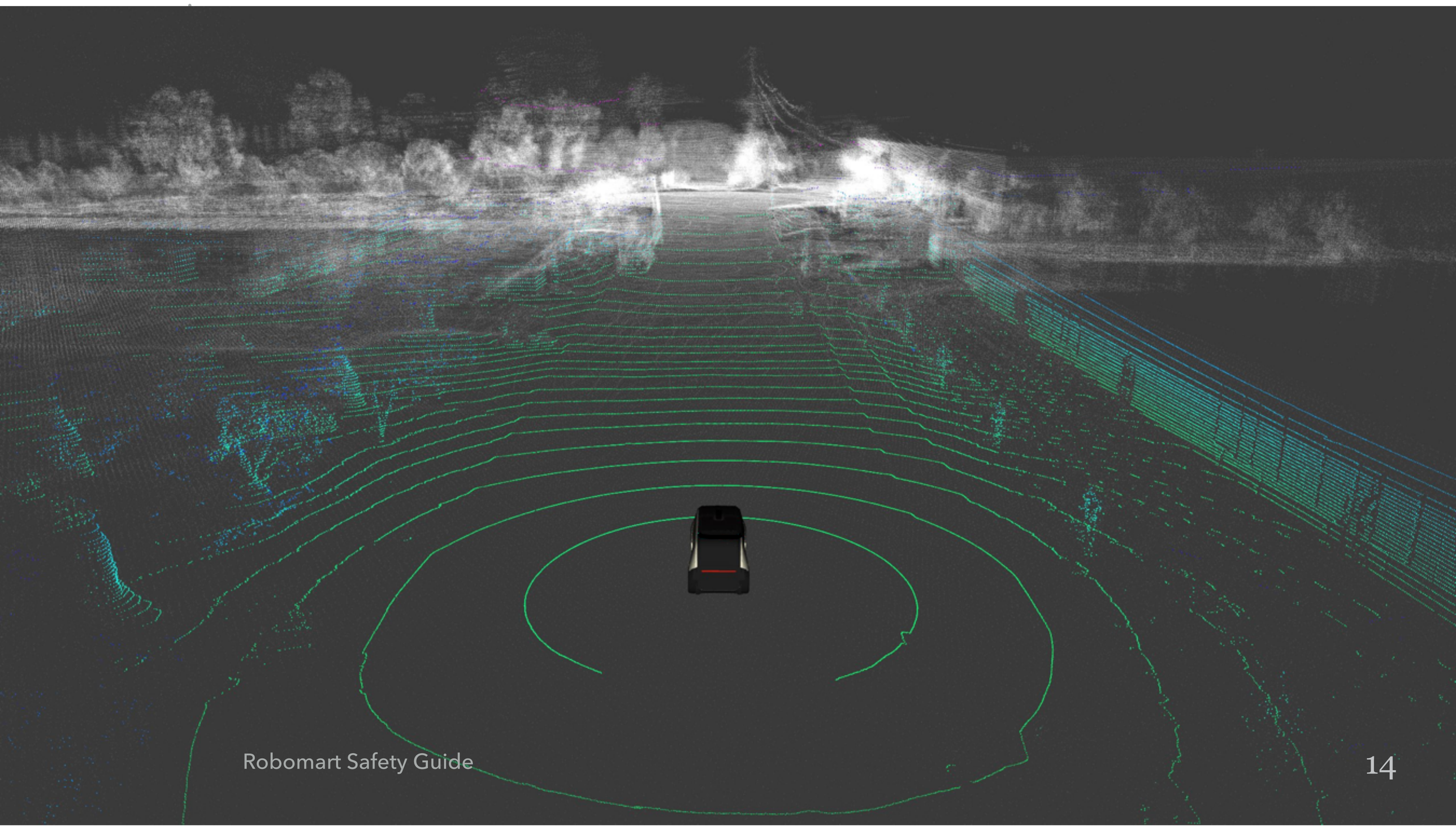
PART 2:

Operating Procedures

Autonomy

At Robomart we are building the hardware and software stack for fully driverless autonomous operation. As a result robomarts rely on our advanced self-driving system for safe, reliable operations.

Our self-driving system relies on multiple sensors including LiDARs, cameras and radars to be able to ‘see’ its surroundings, obstacles and road markings. It then ‘plans’ what to do based on its sensor data, high fidelity map and view of its environment, and then ‘acts’ based on safety considerations and route plan. It is constantly sensing its environment to make real-time decisions safely and reliably.



Teleoperations

At Robomart we have also built a state-of-the-art teleoperation system allowing us to always have a safety backup for our autonomy. This means that remote drivers (teleoperators) at our facility can take full control of robomarts at any time.

The driver station is the console that our teleoperators use to remotely drive robomarts, even from miles away. The monitors display the videofeed from the robomart's cameras in real-time, and the steering wheel and pedals are used to drive the robomart.

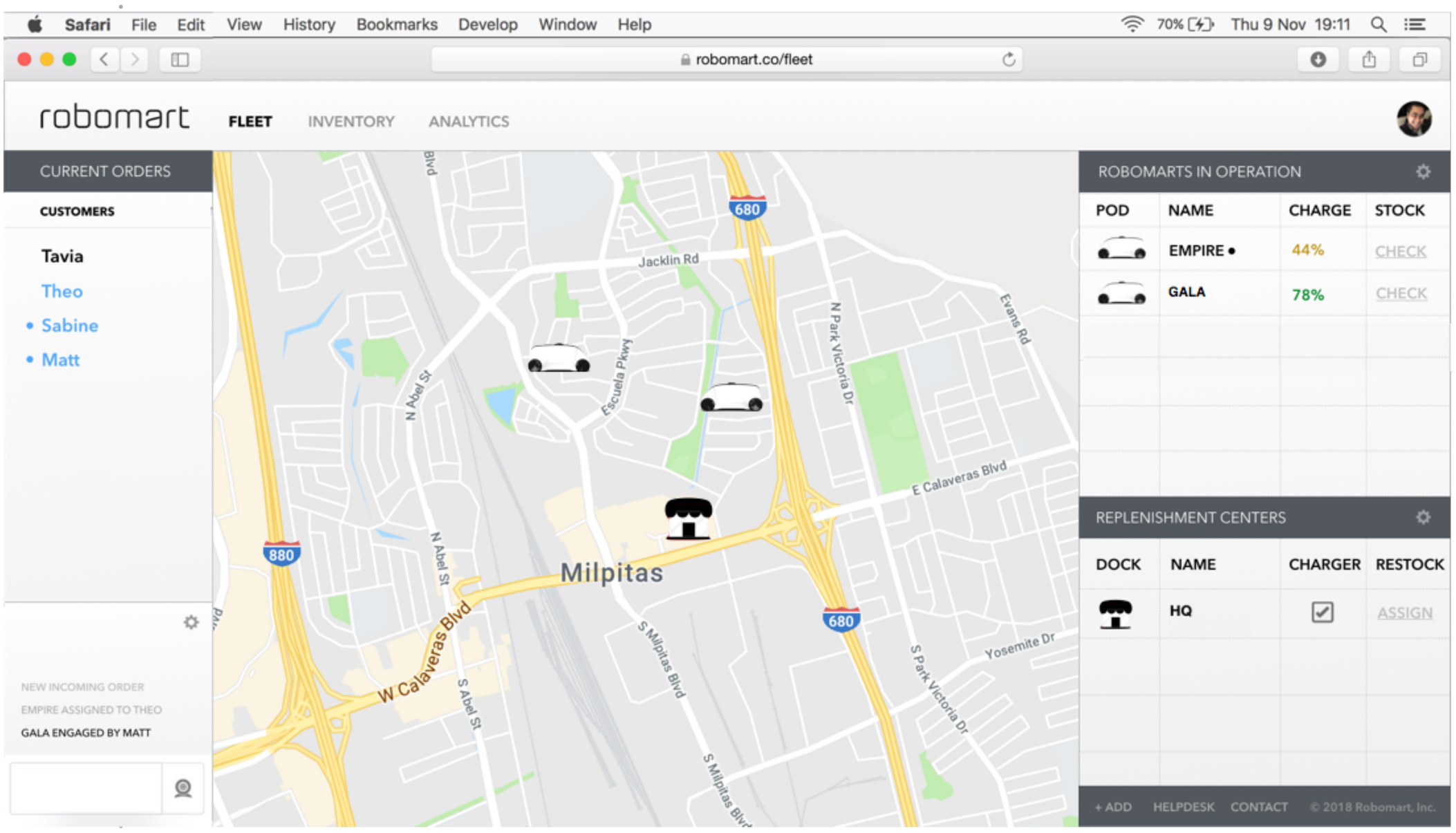
Our teleoperation system uses advanced cellular bonding technology to ensure that the control and video stream is constantly operating, and that the latency of the video and control signal transmission is kept below an acceptable threshold. In teleoperation mode our system constantly checks the health of the connection and in case of high latency or loss of connection the fallback systems kick in, bringing the robomart to a safe stop.

Command Center

Our command center is where we monitor our fleet and all real-time data. It is also where we house our driver stations, and from where teleoperators are able to control the robomarts.

We set up a command center in each city we operate, so that our fleet supervisors and teleoperators can rely on local knowledge and familiarity with the operating zone and surrounding areas.

Robomart continuously monitors its fleet in operation at all times. Highly trained fleet supervisors are monitoring both the fleet as well as the team of teleoperators when they control the robomarts in operation. Fleet supervisors are available at all times to respond to critical situations and assist teleoperators while communicating with third parties.



Operator Training

Robomarts have no driver's seat, but as we are able to remotely operate them via teleoperations, we ensure our drivers are extensively prepared. Our training program for teleoperators includes a 5-stage testing process and continuous best practice training.

Robomart's Teleoperator Testing & Training Program

1. We test a teleoperator's normal driving experience and capabilities through a standard automobile driving test.
2. We then test their capabilities through our teleoperator test, in which they need to remotely operate and drive a robomart on private roads.
3. If they pass both tests we then train them extensively via classroom style instruction on failsafe procedures, safety protocols, law enforcement interaction, and communication with consumers.
4. We then test them on procedures along with their local knowledge of the operating zone, and planned routes.
5. Finally we prepare them for road deployment via a week long dress rehearsal prior to deployment.

We also conduct background checks on all drivers, ensure they are properly licensed and insured, and follow a policy of continuous improvement and learning. We incorporate feedback into learning sessions held monthly for all teleoperators.

Quality Assurance

We follow best practices for quality assurance. As robomarts are fully electric road vehicles that carry goods we need to ensure the quality of our vehicles as well as the quality of goods stocked in them. This is incredibly important as we must uphold the reputation and trust of our retail and brand partners.

Vehicle Quality Assurance

Robomart's vehicle quality assurance is based on a framework derived from the Automotive Spice framework. Our maintenance policy follows a model of proactive diagnosis. Real-time checks are conducted for our safety critical components to identify any issues before they cause incident.

Goods Quality Assurance

We have the following best practice initiatives to ensure the quality of goods stocked in robomarts:

- All products in robomarts are packaged
- Our internal cameras track and monitor the inventory at all times
- Robomarts come back to the replenishment center store every few hours
- Our refrigeration system keeps the temperature at a set level as required
- We have standalone sensors to track the temperature in real-time
- We have a maintenance crew that can meet the robomart if required

At Robomart we regularly report performance, deviations, and trends of our quality assurance activities to internal and external stakeholders, so that issues are proactively found, analyzed, tracked, corrected, and further prevented.

Unexpected Scenarios

We have a detailed manual of SOPs (standard operations procedures) to deal with unexpected scenarios, a summarized section of which is shown below.

Theft, Vandalism and Damage

In the event a third party bad actor decides to steal goods or vandalize the robomart, we will record them and share the footage with the authorities.

Robomarts display a message: “Cameras in operation" to serve as a deterrent. The external facing cameras cover a full view of the surrounding area around the robomart doors, and are engaged and recording when the doors open.

In the event of third party theft, the consumer who is shopping at the robomart can log the event via the app, or the fleet supervisor or teleoperator who witnesses the event will log the theft. We will then review the footage and decide, at our discretion, to forward the footage to law enforcement, our retail customer, and our insurance agency.

In the event any hardware on the robomart gets physically damaged, depending on the severity of the event, the self-driving system or teleoperator will bring the robomart to a safe stop, and a maintenance crew will be dispatched to repair the issue.

PART 3:

Safety Policies

System Safety Overview

Our system safety architecture encompasses every aspect of our design, production and operations. Our goal has been to develop the safest road vehicles which is why robomarts have been engineered with safety as our foremost priority - safety by design. Robomarts are low-speed vehicles (LSVs) with a top speed of 25mph. They operate in geofenced areas, never go on highways, never carry passengers, and always prioritize the safety of everyone around them rather than the goods being transported.

Our safety innovations include:

1. Low-speed driving

Robomarts are classified as low-speed vehicles (LSVs). This means that they operate at a top speed of 25mph, never go on highways and stay within the neighborhoods they serve.

2. No passengers

Robomarts have no seats, no cabin, and no way to carry a driver or passengers. This means that we can always prioritize the safety of pedestrians, cyclists and other vehicles at all times.

3. Lighter & safer body

Robomarts are manufactured with thin fiberglass and softer materials such as foam. This allows us to create a rigid road-worthy body, while having a higher safety threshold in cases of impacts as the body is designed to crumple in cases of a collision.

4. Advanced teleoperations

Our state-of-the-art teleoperation system utilizes the latest in cellular bonding technology. This means that if the robomart drives through an area with bad reception, leading to high latency, our system switches to an alternate network in real-time, without packet loss. Simply put, we use up to eight SIM cards on board to ensure a robust cellular connection for the upkeep of the video stream and driver control.

5. Geofenced operating zones

Robomarts are always contained within their operating zones, which never include highways or roadways with speed limits higher than 35mph. This creates a safer area of deployment as robomarts are always driving within their defined, small geofenced areas that are mapped in advance.

Safety by Design

We have made all safety-critical systems redundant, including power, computing, sensors, steering, braking, and throttle that ensures the permanent operation of our system. This backup design ensures that robomarts come to a safe stop in the case of failure of one or more of the primary control units.

Independent power sources support the operation of safety-critical systems. All possible single-point faults and failures that may arise from power failures are avoided by this redundant design.

Our safety process is a combination of the best practices provided by the latest standards in automotive and autonomy safety. The basis of this is the Automotive Spice Reference Model which is based on proven-in-use internationally recognized ISO 330XX series standards combined with key activities established in ISO 26262 ‘Road Vehicles - Functional Safety’ and ISO 21448 ‘Road Vehicles - Safety of the Intended Functionality’ to achieve the highest level of functional and behavioral safety.

Operational Design Domain

The operational design domain refers to the conditions under which robomarts can safely operate. Robomart's domain includes geographies, roadway types, speed ranges, weather, time of operation, and state and local traffic laws and regulations.

We’ve designed robomarts for low speed operation, with a maximum speed of 25mph. That gives them more time to react to other drivers, cyclists, and pedestrians, shortens the stopping distance, and reduces the probability of collision and the impact of any potential collision.

Vehicle Type

Robomarts are classified as low-speed vehicles (LSVs) which can operate on public roads.

Roadways

Robomarts operate on neighborhood roads within cities with posted speed limits of 35mph or less and never on highways.

Geographic Area

Our first deployments are in neighborhoods that fall within our geofenced operating zones. Robomart maps these areas in advance of testing and deployment.

Speed Range

Robomarts' top speed is 25mph, and the average operating speed falls under 18mph.

Time of Day

Robomarts operate during the day for up to 12 hours, during the hours of daylight.

Weather Conditions

Robomarts are deployed during sunny weather and light rain. Adverse weather limits our safe operations and as such we will initially not operate during heavy rain, thunderstorms, severe snow, and other adverse conditions.

Expanding the Operating Design Domain

As our technology advances we expect to expand our operational design domain over time. When we do we will ensure that we have extensively tested all variables and conditions via simulation and on private roads before deploying on public roads, to ensure the highest level of safety at all times.

Object Detection and Response

Robomarts utilize a full suite of sensors to detect objects and take action. We use over a dozen cameras, multiple LiDARs, radars and other sensors to detect road objects. We use these sensors to identify moving and stationary objects including other road vehicles, pedestrians, cyclists, road signs, traffic signals, construction cones, and other objects.

Our sensors afford a full 360 degree view of the surrounding environment, which allows our self-driving system to not only see and recognize objects, but formulate an accurate and timely response.

We develop cutting-edge computer vision software for our perception system based on advanced machine learning and are continuously improving its capabilities. Our system is able to understand the behavior and movement of road objects so that it can safely navigate around them or stop if needed.

For our backup teleoperation system, our remote driver is also able to see what the robomart sees as we transmit a real-time video and data feed from the cameras and other sensors on board so that they are able to safely take control if necessary.

Fallback (Minimal Risk Condition)

Robomarts have been designed with safety foremost in mind. If a robomart faces a situation where it cannot proceed as planned for any reason, it will come to a safe stop. Our self-driving system is designed to detect these situations at all times.

We have built redundancies in every safety-critical component of our system, including a secondary braking system. Additionally, our software constantly checks the health of all critical systems.

Although our self-driving system does not require network connectivity for safe operations, during testing and initial deployment our system continuously monitors the health of the connection between the vehicle and the driver station, in order to make sure that the remote driver can take control when required. If the latency of the video and control signal transmission goes above the acceptable threshold, the fallback systems will kick in, bringing the robomart to a safe stop.

Validation Methods

Robomarts are tested at every stage of development, manufacturing, and deployment. A series of activities are undertaken to ensure validation targets are met and provide evidence that the safety and functionality objectives are achieved.

We constantly validate the performance of our self-driving software, teleoperation system, and vehicle hardware, following industry best practices and quality assurance principles. We work with leading automakers and suppliers and ensure that robust safety testing procedures are followed to meet our stringent requirements.

We also utilize multiple methods of testing to ensure we are keeping safety at the forefront of everything we do. We test our vehicles first in simulation, then on private roads, then in limited geofenced areas before deploying them publicly.

We also use different validation methods to evaluate the residual risk arising from real-world situations. One method is to deploy chase vehicles which would drive closely behind robomarts to monitor and evaluate their safe operation.

Finally, we analyze testing and deployment data and process it through a feedback loop that informs our continued development and manufacturing.

Human Machine Interface

Because robomarts never carry human passengers, we have designed them to be visually similar to other road vehicles while still maintaining a unique shape and design form. The front and rear of the robomart are clearly discernible due to its shape and similarity to traditional cars, and while it is a roving grocery store with doors only on one side it is instantly recognizable by pedestrians, cyclists and other vehicle passengers as a road-going automobile.

Robomarts are equipped with on-board speakers and a two-way communication system. This enables the fleet supervisor or teleoperator to speak with consumers, first responders, law enforcement, bystanders, retail partner staff, and maintenance service crews. We are also designing additional systems based on sound and visual cues to notify other road users, particularly pedestrians, of the presence and behavior of our vehicle.

Consumers will interact with robomarts when they arrive to shop for goods. They open the doors, take the items they want and then close the doors and send it on its way. We have designed and built robomarts to be extremely simple and user-friendly by design.

Vehicle Cybersecurity

At Robomart we have an extremely robust cybersecurity framework in place. We foster a cybersecurity culture, manage cybersecurity risks, adapt to a continually changing threat landscape and institute a cybersecurity management system.

Our risk management strategy includes plans and methods to determine the extent to which road users are threatened by a potential circumstance or event. We define cybersecurity goals, resulting from a threat analysis and risk assessment and base all our product development decisions around them. During production, operation and maintenance we also ensure that the cybersecurity specifications put in place during the design process are implemented and that our vehicles in the field are secure.

Robomarts communicate with our server via encrypted channels and this enables secure remote teleoperation. At the same time we also use cybersecurity techniques to protect robomarts from malicious software injections. For this purpose we use networks isolation, checksum control, whitelisting and other proven-in-use methods outlined in the SAE J3061 standard. Maximum cybersecurity attention has been paid to our self-driving software. Its operation and updates are permanently logged and analyzed to proactively prevent cybersecurity violations. In addition Robomart uses best practices from NIST's Cybersecurity Framework.

Crashworthiness

One of our most crucial advantages is that as robomarts don't have a driver or passengers, they will always be safer than traditional cars.

Robomarts are manufactured with thin fiberglass and softer materials such as foam. This allows us to create a rigid road-worthy body, while having a higher safety threshold in cases of impacts. The body is designed to crumple in cases of accidents so as to ensure the highest level of safety for all external actors, such as pedestrians, cyclists, and other vehicles.

Additionally, by design our passenger-less vehicles are less likely to lead to an injury or casualty. Extensive research from the AAA foundation for traffic safety has shown that vehicles going at lower speeds greatly reduce the chances of injury or casualty. By limiting the speed to under 25mph we hugely improve safety for pedestrians, cyclists and other vehicle passengers.

Post-Crash Behavior

In the unlikely event of a collision, the fleet supervisor or teleoperator will immediately initiate the incident logging protocol. They will then proceed to communicate using the on-board speakers with any third parties involved in the accident to ensure everyone's safety.

They will then immediately contact the relevant law enforcement authorities to inform of the accident. Additionally, they will communicate with first responders on scene.

Depending on the situation, and once the fleet supervisor or teleoperator is no longer needed 'on the scene', they will review the camera feed leading up to the accident, and log the events in our incident logging system. This will be done as soon after the accident as possible, and no later than 24 hours after the incident.

The incident log will contain footage of the accident along with the previous five minutes of footage, any images from the scene, the teleoperator's statement (if required), the fleet supervisor's log along with other sensor data. This log can then be shared with law enforcement, retail partners, insurance companies, and other authorities subject to requirements.

Data Recording

We record almost all events involving the operation of robomarts. We use this data to power the machine learning that improves our autonomous driving software, as well as our operational and safety best practices.

We gather all data from sensors, analyze it extensively, and then use the data to enhance both our simulation and real-world testing.

We also record all video data that is logged as part of our incident logging protocols. This is done to ensure that all incidents are logged in a timely, secure and standard fashion.

Additionally, as robomarts are roving stores on wheels, we gather a significant amount of consumer shopping data. We ensure all this data is anonymized before we derive insights to share with our retail partners. We also have a robust data privacy policy which ensures that all personal consumer information is protected.

Consumer Education and Training

We have designed the experience of interacting with robomarts to be intuitive and familiar. The app is very similar to ride-hailing apps in that consumers simply tap a button to call the closest robomart. This familiarity allows them to feel a certain level of comfort with our self-driving vehicles.

We partner with supermarket chains, retailers and brands and it is their branding on the outside of robomarts. These retailers are trusted brands that consumers use regularly while expecting a high level of quality. We ensure that we provide our customers (the retailers) with the highest level of quality and safety, to ensure that their reputation and brand remain trusted with consumers.

As we deploy robomarts, we will further engage in consumer education, marketing activities and training programs that familiarize consumers with interacting with robomarts and ensure we always employ best practices at every step of the engagement.

Federal, State, and Local Laws

We consider all state, municipal and local regulators along with first responders and law enforcement as key stakeholders and ensure that all our key stakeholders are fully informed about robomarts, our safety guidelines, and have green-lit our approach prior to deploying in any market. We also ensure that we comply with all federal, state and local laws.

Even though robomarts are custom-built vehicles that have been designed to be driverless and passenger-less, we have designed them to meet all guidelines and existing standards. Robomarts meets all the requirements of the Federal Motor Vehicle Safety Standards. They meet the definition of and are classified as low-speed vehicles (LSVs).

We continue to engage with all key stakeholders, legislators and community leaders to educate them about robomarts, their unique design, safety principles, and value-add to consumers.

PART 4:

Conclusion

Conclusion

Robomart has built the first new retail channel since e-commerce that will have profound effects on the way we shop, eat and live. Although we see massive improvements to our way of life over the coming years and decades, it all starts with building the safest possible product. Our commitment to safety starts with the approaches outlined in this voluntary self-assessment guide and will continue to inform every part of our product design, development, and deployment as we scale.

We're excited to drive retail forward.

Endnotes

Sources:

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2. "Who Does the Grocery Shopping, and When Do They Do It?" The Time Use Institute, April 2016

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