Berserkir

Pedestrians and the Autonomous Delivery Robots

MSc PDE Major Project

Design Process Journal
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Executive Summary

The design of the autonomous delivery robot Berserkir is aimed at improving pedestrian interactions through an approach of understanding artificial intelligence and its perception by humans that determines acceptance of such robots.

Robots pervading our landscape is still an uncomfortable and unfamiliar thing in the minds of many. Apart from the visual discomfort, psychological risks, physical hazards, the core idea of Artificial Intelligence (AI) is relatively an alien concept. However, a multi-disciplinary literature study on cognitive science, anthropomorphism and designing AI agents points to some positive outlooks. Besides, technological leaps and the idea of ‘sci-fi’ in popular culture has furthered the idea of AI as ‘friendly and reliable’. There is an array of expectations that users have when it comes to AI interaction, and the aim of this project is not just to empathise with those, but also create an emotional design that facilitates efficient amicable operation, sharing space in a pedestrian friendly zone.

The design starts with the core idea of ‘how to design an AI agent which is NOT threatening and unfamiliar’. Based on the ‘Uncanny Valley’ graph of familiarity vs human likeness, there is a very precarious area of an AI being considered ‘friendly’, something that triggers a positive emotional response and protective instincts in humans- something that's life like, an animal, a cute one. This design takes that as a core concept and aims to create something ‘cute’ , ‘approachable’ and ‘familiar’. At the same time, functionality of the robot is maintained through bringing a little ambiguity or neutrality to the ‘cuteness’ so that negative interactions with miscreant humans or pets can be avoided. Thus, the form of a ‘baby rhino or warthog (of Timon and Pumbaa cartoon fame)’ is used to create an image of a functional but friendly robot. The other aspects which are kept in mind are the movements, interactions- like light indicators and back scales, stumpy legs, and a grounded form- making it practical yet retaining animal like familiarity. Lastly, the materials and manufacturing processes are expected to be biodegradable and recyclable to keep carbon footprint low. The usage is also expected to be long term with lesser replacements, and the AI adapting and improving its interactions as it ages, making it sustainable.

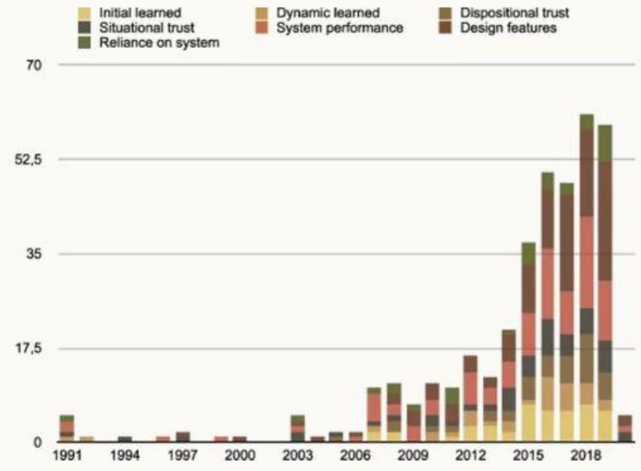
Need Identification and Problem Analysis

Autonomous vehicles are considered as the future of mobility with projections of having fully automated (level 5) vehicles common on the roads by 2040. One such subset is the autonomous delivery robots, a cost-effective and sustainable way to deliver daily consumer goods which got popular in certain parts of the world during the pandemic. [1][28]

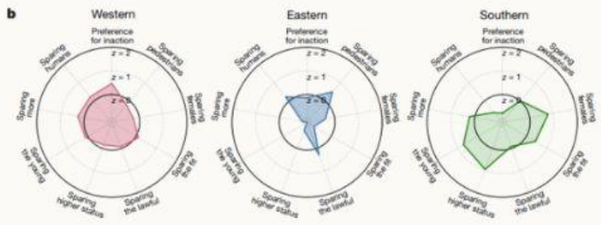
However, the penetration of such solutions in mass market and its success depends on consumer acceptance. The pandemic led boom of such robots also exposed issues of human interactions, particularly pedestrians, which can either delay or help the robot completing its delivery. Instances of robots stuck on curb sides or falling down stairs garnered social media attention with some people helping it out. While there are also examples of robots been rage-kicked by angry pedestrians, peed on by dogs, whacked by heavy glass doors, pranked and blocked with mischievously placed barricades. [4][27]

To mitigate this, some companies' models have LED screens that can display messages and emoji (like shocking pink heart eyes); some are able to talk to pedestrians to offer free samples or ask for help pressing a traffic signal's push button. But it's evident that consumers are not yet sold on autonomous delivery, and the fluctuation point for when people want it versus being afraid of it in their neighbourhood is still far away. It affects the market standing and creates a barrier in introducing sustainable autonomous innovations. For adding an unaccompanied machine to a space that is intended for pedestrians, that is supposed to be designed for accessibility, it will need to have conversational systems that are not just embedded but embodied. [3]

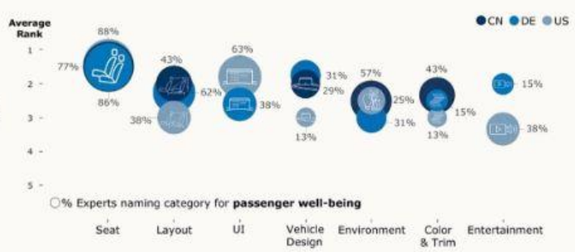
People assume that the robot is more likely to experience emotion when it experiences an adverse event, such as a barrier to executing its task, and even in some cases make mistakes, acting human. This project aims to identify the issues associated with pedestrian disdain for operating autonomous delivery robots, and design a solution that improves the psychological interactions between the two.



Aspects of trust in Autonomous being studied and how they distribute yearly.



The three cultural categories and the variation in responses.



Research Methods

Research methods classified stage wise as below:

Discover and Define
Literature Study-
History of autonomous vehicles/robots and design, pedestrian psychology and hazards associated with physical contact

Identified design and interaction aspects (form, language, semantics, affordances, AI persona)

Market Study-
Latest developments and delivery operation problems

Develop
Site Visit to Milton Keynes to interact with starship delivery robot–
Identified opportunities of conflicts with respect to interactions, movements, contact etc.

Mock-up models of scale 1:4- Form exploration

Interviews with potential users–
Understood preferences and concerns for delivery robots using the prototype models, a semi-structured conversation captured qualitative feedback

Deliver
Technical report-
Integration of cognitive science with design

·Model of scale 1:2-
Form finalised

Design Journal–
Design Specifications, research methods

Design Opportunities

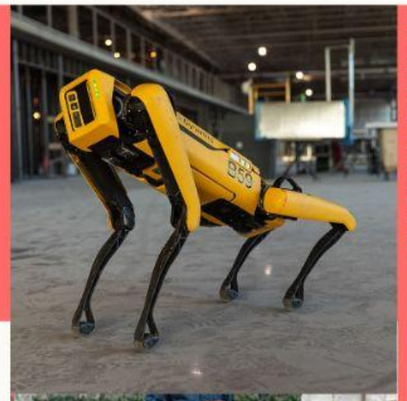
Aesthetic
Ecological
Temporal
Ergonomic
Technological

Looks like driving printer
Doesn't say what it does
Dose not go outside
Looks unpredictable

Market Study

Cultural preferences
Studies have found that while there are universal shared preferences for machine ethics, there are also differences in the individualistic or collectivistic tendencies of cultural clusters. These create serious impediments for machine ethics preference once there is a change in geography.

Other robots
The global market for delivery robots is estimated to grow at a compound annual growth rate (CAGR) of 30.3% from now until 2030. They are inevitably going to be a part of our urban lives. People experiencing them today, have opinions regarding their interaction with them.



Looks scary
Looks like robot/monster
Too human
Here to kill us
Movement not predictable
Spider/dog
Draws attention
Package can be stolen

Fun like roller suitcase
Weird but modern
Unpredictable
What is it looking
Needs to prove itself
Not calm enough
Not interesting looking

Fun, calm, cute
Like mars rover
Clean design
Too small
You expect it too talk
Probably has a beam with sensor
No color

Like a fridge
Not for sidewalk
Not beautiful
Too intimidating
Professional
Probably not talk

Intimidating
Too large
Good size
Not for sidewalk
Looks efficient, neat and professional
No idea about front or back
Might hit you
Not trustworthy

Remote controlled NS train
Tires off road?
Angry?
Not business like
Fun

Cute, fun
Eyes friendly, like a child wagon
Clumsy
Eyes too obvious
You expect it to say
Size good
But obstacle on sidewalk

The project deals with the interactions between a delivery robot and pedestrians with focus on user experience and design basing it on the science behind human behaviour and cognitive artificial intelligence. The evolution of design through literature is summarised below:

Artificial Cognitive Intelligence

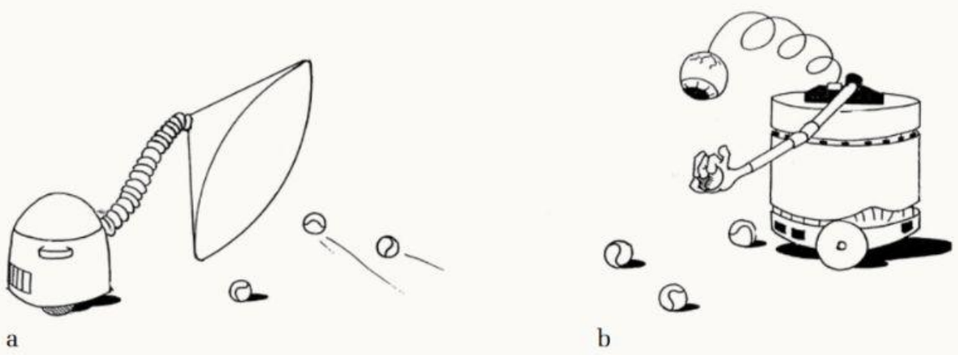
The cognitive science literature uses the approach of 'understanding by building' in exploring the principles of intelligence. The focus is not on the 'brain processing speed' as classical science had earlier theorised, but the ability to apply and learn. Thus, the 'intelligence' in AI can be better understood as a behaviour which can build on based on the new knowledge received and adapt to the circumstances. [3][5]
A delivery robot can learn from its interaction and improve/adapt over time. Thus, the design interventions would not be static for one period of time, but dynamic and adaptive as and when the robot is made functional(refer pg 6, Technical Report).[2]

The idea of the 'other'

The form of an AI has evolved with its perceptions among human society over time - from the unfamiliar 'other' to a more familiar 'robot'. Used earlier as a theoretical tool for colonialism, the 'other' today refers to the Outgroup that represents everything other than the familiar, or the self. [8]

Its also been used to denote 'aliens' in modern movies and sci-fi literature. Starting with designing the most dangerous, and frightening looking 'others' on screen, the efforts gradually turned into creating elements which had strange physicalities and human body language, even characteristics proportioned to babies and familiar abstractions. [9]

This leads to a progression in conceptualising of 'other' from threatening to something around interaction, social influence and emotions. (refer pg 14, Technical Report)



Collecting ping-pong balls. (a) engineering solution, (b) cognitive science solution. The solution in (a) requires no behavioral diversity, whereas the one in (b) does.

Autonomous agent design

The design of an agent includes the form (modularity, body and motions), interface and semantics, and behavior with task environment. Design is the continuous communication between the functional paradigms and the physical elements.

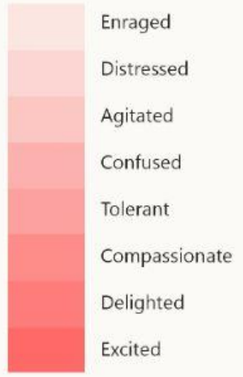
The philosophy behind designing is to 'design for emergence' (Luc Steels) which leads to a design approach that initiates from desired behaviours, and not to design behaviours which is harder to achieve. [6]

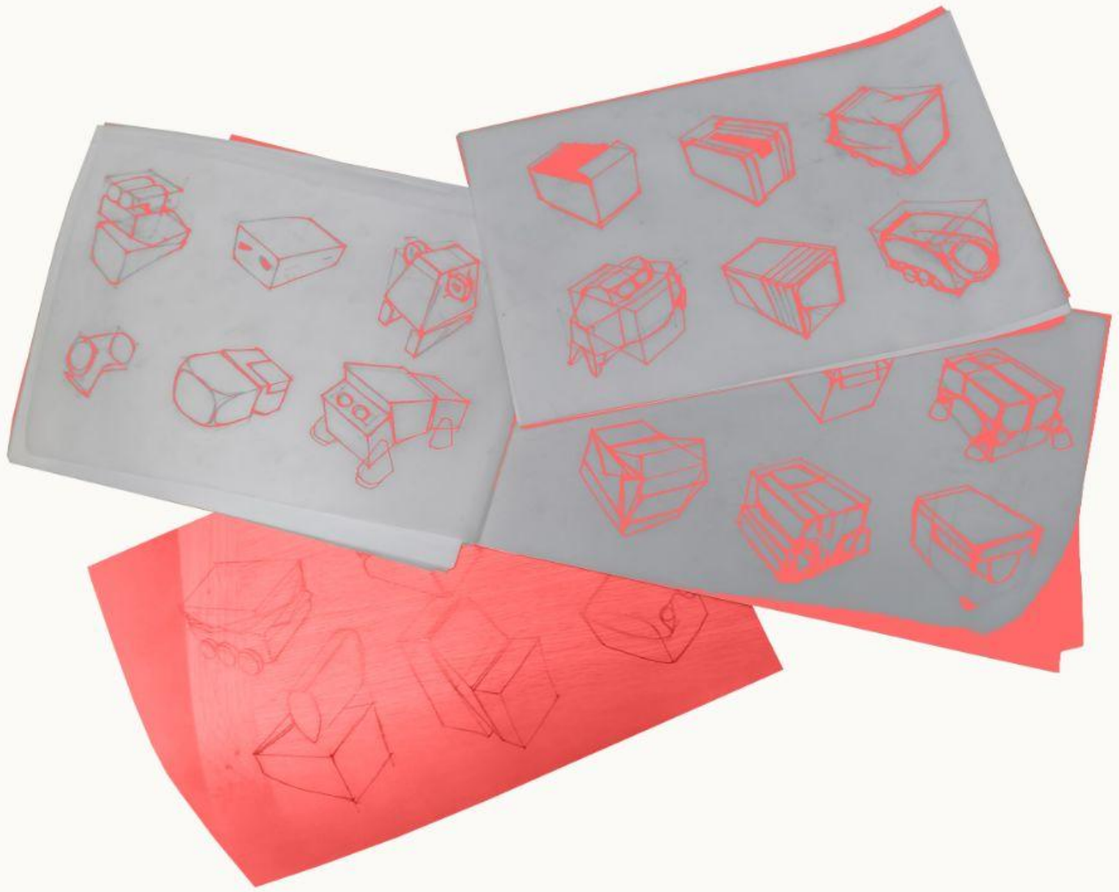
Research done by TU Delft states that pedestrians and other street users would like the robot to display emotions and their perception of the world through communication, or even mood, intent, personality and intelligent responses. People also were in favour of the robot acting up in troubling circumstances. The uncanny valley graph is a popular theory associated with the aesthetics of a robot, and clearly steers us away from highly realistic humanoids. [13]

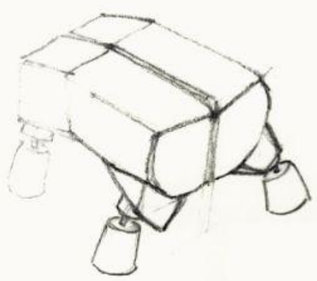
Literature on anthropomorphism and associated experiences indicate that while interacting with a robot, the user finds it most comforting if the robot resembles familiar like an animal. But there are also particular characteristics that construe in our minds as familiar and induce parental instincts in humans- Big, fuzzy eyes, soft fur-coated features, baby-sized body, human-like behaviour, slower speeds and playful tumbling type movements. It all boils down to 'what would make a human user at ease with talking to a robot' and 'what would be the limits to such interactions'. But due must also be given to the existence of cuteness aggression, which would turn out to be a major obstacle in the process of delivery and that needs to be balanced in the design. (refer pg 13-18, Technical Report)[11][26]

Thus in this scenario, the logical step in selecting a starting point for the tangible and intangible aspects of the robot, was to get feedback for the preferences of users in Glasgow, UK. Facilitated by a series of sketches, each highlighting a particular kind of shape and form, based on various aspirational, psychological and social requirements of users in relation to the perspective of robots in general, a questionnaire was set up to allow acceptance or rejection of design concepts in terms of their appearance, perceptions and associations, and in turn feasibility.

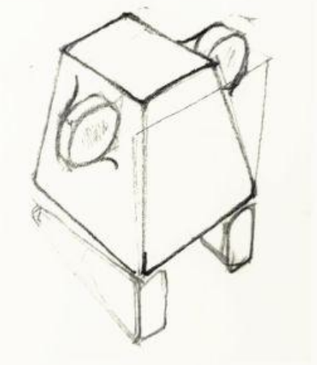
The emotional vocabulary accessible to the users included a complete range from Excited to Enraged, covering the emotions of Delight, Compassion, Tolerance, Confusion, Agitation, Distress. Three designs among all scored the maximum for the favourable emotions of Tolerance and Delight, and were taken forward in terms of Low fidelity mockups, in order to obtain further feedback during interfacing. The users selected here were Glasgow locals, but with varying cultural and professional backgrounds.



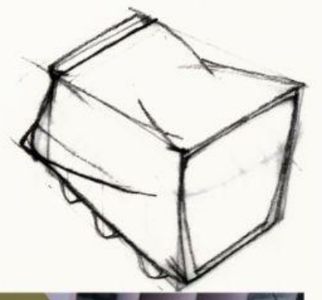




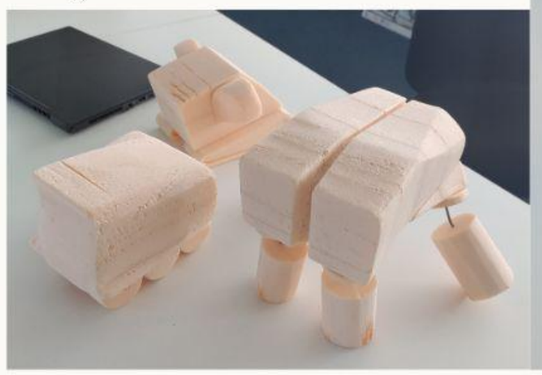
-Move away
-Looks scary/ breakable
-See from far, looks interesting especially movement
-Might fall off
-Looks like robot
-People won't disturb it
-Divided shape interesting
-Thick legs like baymax
-Curious mechanism

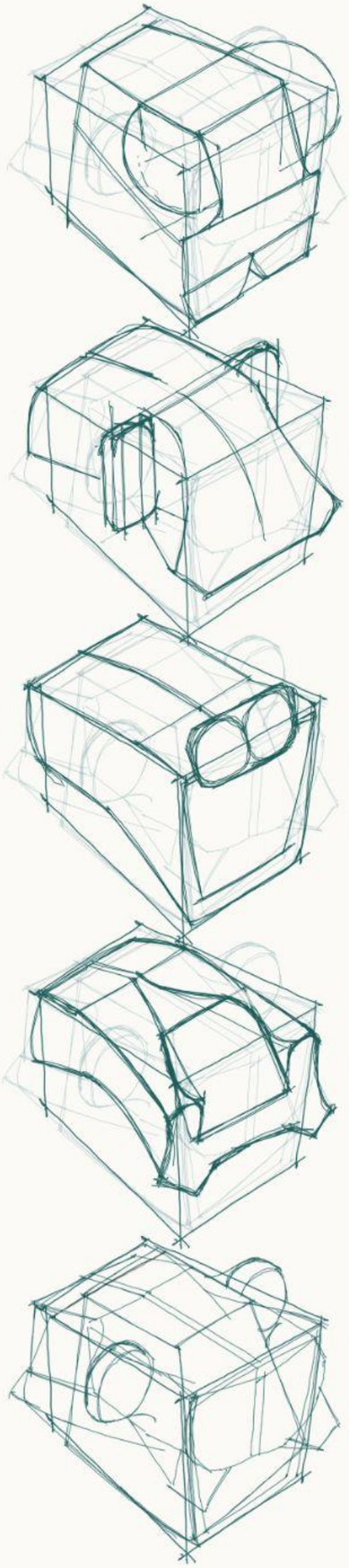


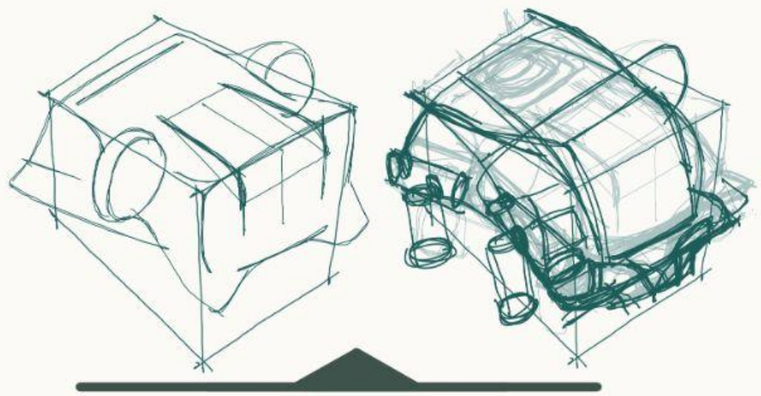
-Self wound rat
-Eyes expressive, looks cute
-Try to interact
-Bob the builder character
-Only for kids
-Sounds?
-like R2D2
-Bring out phone and record
-Too animated
-Can stop with hand



-Looks speedy
-No connection- Hi on screen?
-Looks like govt. watching
-Need a face
-Ignore and continue walk
-Looks modern
-Adults might be used to
-Sleek





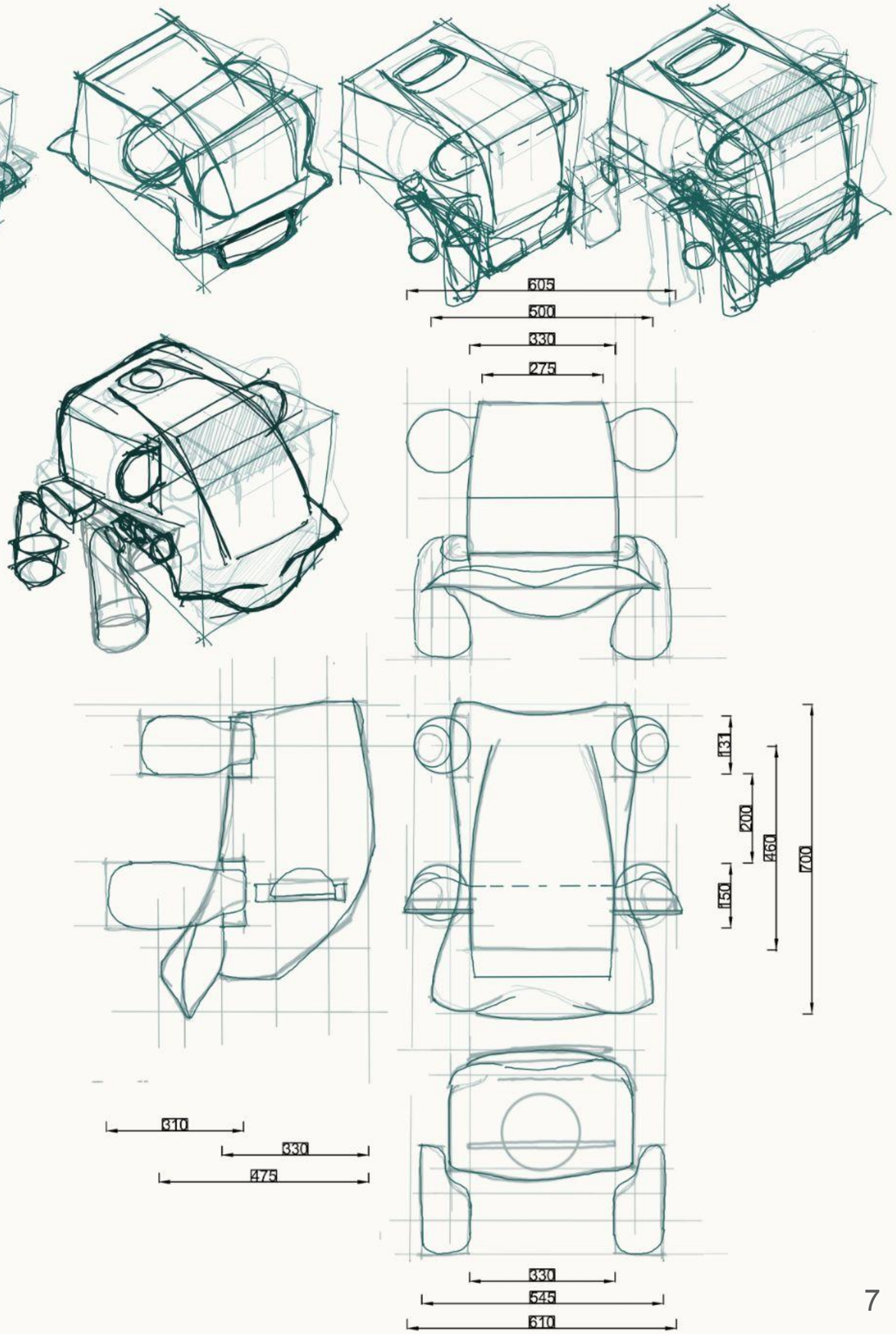


Form considerations

Affordances in robots should enable passersby to understand the robot's intentions, while the robot is doing the same for them. These might range from signs of disturbance and impatience to users being distracted, and the robot should be able to communicate its response via the modes of light, noise or even movement, as opposed to buttons and touch interfaces done traditionally. The solution in the end should come across as natural, interpretable and easily accessible to people, and should take use of well known mental models.

Design directions

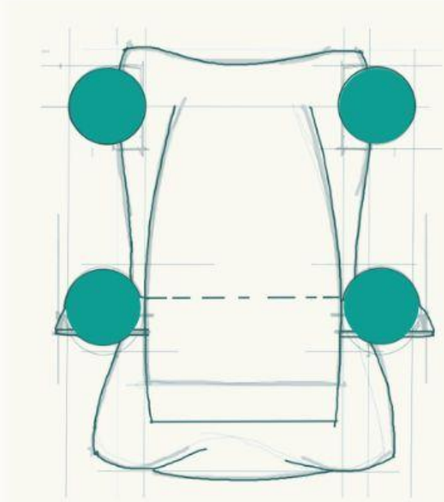
Form and sizing

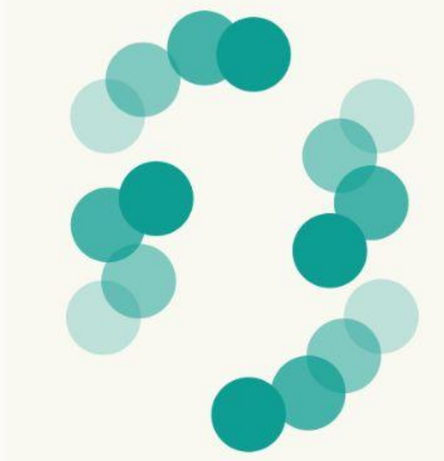


Movement considerations (unidirectional and rotational)

The requirement for delivery robots in the current world is to travel at approximately 6 km/hr, on a considerably flat (might not be smooth) terrain, but with the possibility of level differences and steps. Currently solved by the means of six wheels or off-road wheels, delivery robots in the market today claim the ability of climbing curbs. But this could easily be solved with the use of 'legged' robots, the only problem being that robots with limb mechanisms aren't the most friendly looking robots. One-legged, six or more legged, or linkage robots are too turbulent in their motion to be part of a pedestrian ecosystem. Two-legged exhibiting bipedal motion risk the idea of slipping into the uncanny valley with their resemblance to human beings. And the four-legged ones in the market today majorly exhibit an aggressive pouncing stance that in spite of enabling complex movements, will be frowned upon by users. [16][17]

The project thus manifests a very gentle and much safer affordance in its movement, and still is able to traverse omnidirectionally with a collected horse trot.





Form development

Form and movement

The Design

Form 'less threatening' and animal like familiarity
The form has majority of the bulk at the back for storage of delivery goods and insulation to take care of the functional components. The design incorporates features of an animal with an interface equipped for needed interactions without being threatening to passing pedestrians. The shape profile is a 'body' form that settles rather than launches, sticks to the ground rather than flying. This avoids 'sudden surprise' to passer-bys as a drone may have.

Friendly but on a mission
The idea has been to make it friendly enough but not too much so that it can focus on its main function of efficient delivery. That's why the structure imitates a baby rhino or warthog- familiar, friendly but on a mission. The seamless LED screen emotes according to the situation. A portion of the top comes out like a 'horn' if strong reactions need to be shown in case of pedestrians mistreat the robot much like an animal reacting to a threat.

'Eyes' and 'Tail' indicators
The indicators at the front 'eyes' and the back 'tail' have lights for signaling presence and movement, more recognisable at night. The 'eye' change direction with movement imitating an organism turning and leaving. The 'tail' lights up in red circle when the robot slows down/stops and blue line when it speeds up/moves.

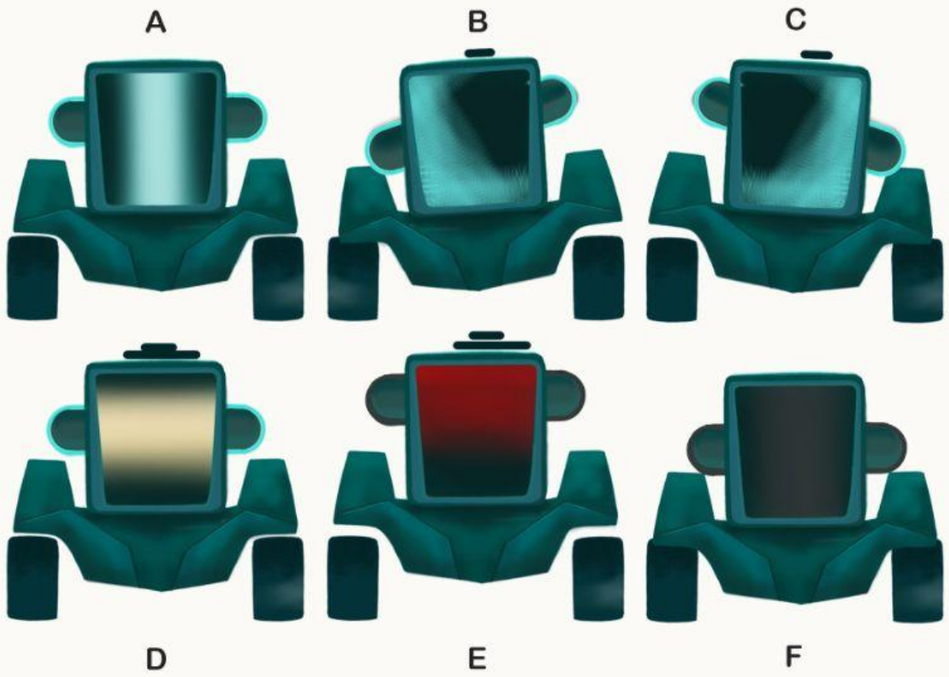
Stumpy legs
The design of the 'legs' has been a key research focus for giving a form and feel to the robot. The stumpy legs (pounded at the ends) have been chosen over thin and pointy due to two reasons- requirement of medium speed of movement and to create the less threatening 'baby rhino/warthog likeness'. The legs help the robot to raise and lower different parts of the body form. The legs bend inwards to not look scary or dominating.

Materials and manufacture

Adding to the factor of last mile delivery via robots being environmentally friendly, the robot uses a very Repair and Reuse concept of sustainability. This is made possible by allowing the same robot to stay in the usage cycle for as long as possible, by repairing/replacing the individual faulty parts whenever necessary.
The inner electronics consisting of the sensor suit, cameras and radar are grouped together, and following the norms of soft robotics are manufactured with appropriate biodegradable polymers and related low cost biomaterials. The majority of the structure and shell are made modular and formed with highly recyclable materials of Aluminium and PET, while the insulation for the storage from the eco friendly Cellulose.
This adoption of a Life-cycle thinking for the delivery robot, helps reduce environmental damage during excessive extraction and processing, and pollution and toxic emissions caused due to disposal of non degradable materials.

Aesthetics

In terms of visual and sensory characteristics, the robot is finished in a combination of two colours; Pastel turquoise being the primary, interspersed with bits of dark grey. These are colour shades usually associated with the relaxed and pleasant emotions, and would fit better in the usually overcast weather and stone streetscapes of Glasgow. The tactile experience of the robot needs to be discouraged and hence a very jagged texture would discourage pedestrians from going out of their way to physically contact the robot.

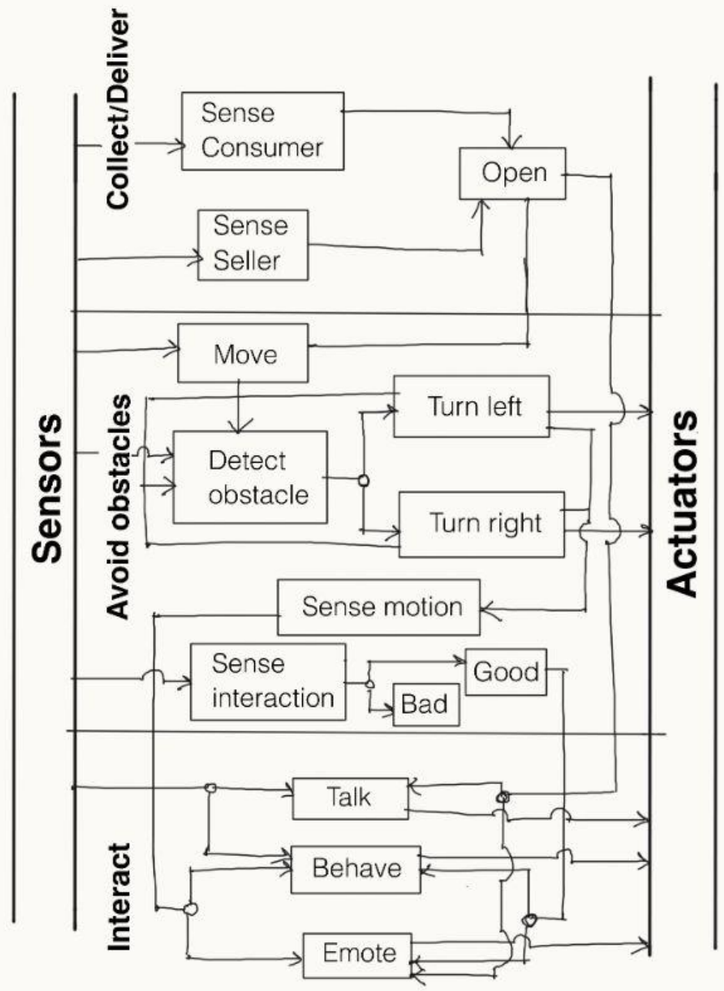


Emotional vocabulary

The vocabulary of emotional interactions between the pedestrian and the robot.
A-Neutral, B-Lean left, C- Lean right, D- Curious, E- Frowning, F- Inactive

Behaviour and Control Architecture

Subsumption Architecture was necessary to create a set of rules for the robot to follow multiple objectives for multiple paradigms, using several sensors and their extension into other modules. [18]



User Scenario

Users and possible interactions with delivery robots mapped based on chances of interaction (✓ - Low to none, ✓✓- Medium, ✓✓✓- High)

Users/ Interactions	Talking (greet, instruct, help)	Looking friendly (acknowledgement)	Navigating crowds/ multiple users	Unexpected interaction (being licked/ touched/ kicked etc)	Asking for help/ apologise	Idle / Wait
Owner & Caretaker	✓✓✓	✓✓✓	✓	✓	✓✓	✓✓✓
Seller	✓✓✓	✓✓✓	✓	✓	✓	✓✓✓
Consumer	✓✓✓	✓✓✓	✓	✓	✓	✓✓✓
Strangers (pedestrians/cyclists/skateboarders/motorists/people in wheelchairs/scooterprams)	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Animals (like dogs)	✓	✓	✓✓	✓✓✓	✓	✓✓
Inanimate (like parked vehicles, obstructions etc)	✓	✓	✓✓	✓	✓	✓
Other robots	✓	✓	✓	✓	✓	✓✓

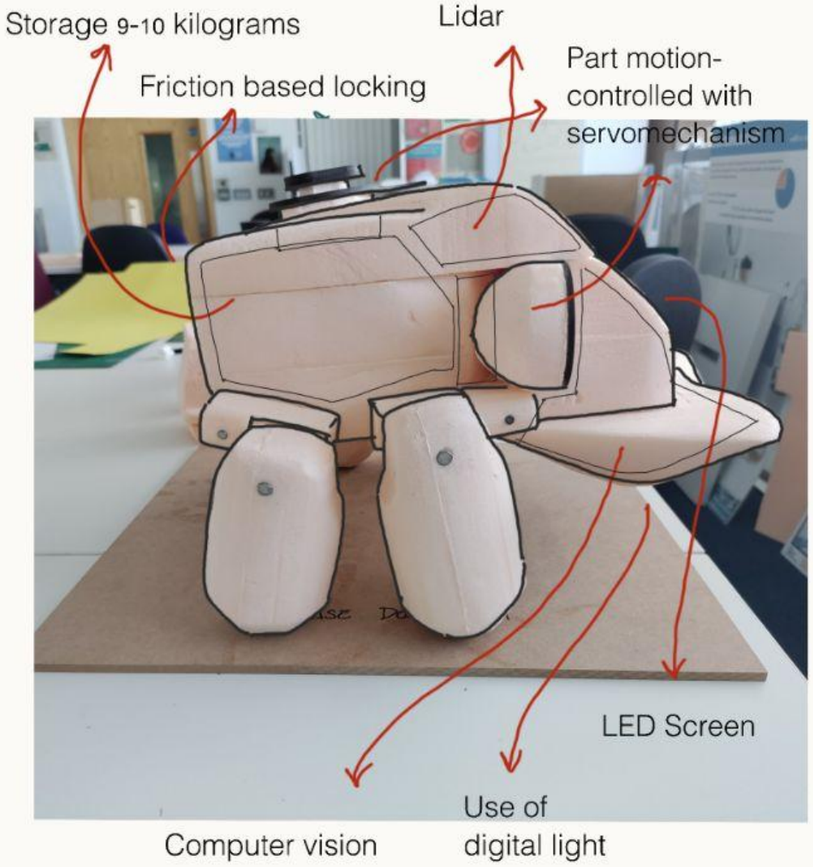
Environmental Factors

The use of autonomous delivery robots contribute to lowering transportation costs and freight emissions in the world of urban congestion, lack of parking spaces for loading and unloading commercial vehicles, and local regulations. Adding to the factor of last mile delivery via robots being environmentally friendly, the Berserkir robot uses a very Repair and Reuse concept of sustainability. This is made possible by allowing the same robot to stay in the usage cycle for as long as possible, by repairing/replacing the individual faulty parts whenever necessary. [19]

The Berserkir is based on a life-cycle thinking reducing and recycling waste. The biomaterials and recycled components used for various parts of the robot helps reduce environmental damage usually caused during excessive extraction and processing of metals/minerals for such technologies, and pollution and toxic emissions caused due to disposal of non degradable materials.

Tech, Materials and manufacturing

Parts of robot	Components	Manufacturing	Sustainability
Inner electronics	sensor suit, cameras and radar	Following the norms of soft robotics are manufactured with appropriate biodegradable polymers and related low cost biomaterials.	Biodegradable polymers ensure waste to landfill is reduced and decomposed timely as opposed to 500-1000 of years it takes to decompose conventional polymers Also economically sustainable to use low-cost biomaterials
Outer shell	Structural parts & shell, storage space	The structure & shell would be modular, and formed with highly recyclable materials of Aluminium and PET. Insulation for the storage would be made from the eco-friendly cellulose.	Recycling materials to ensure zero waste and less pressure on landfills. Cellulose, usually made of recycled newsprint, is a sustainable option for insulation.



Conclusion

Initial feedback from local users showed a very positive response to the potential of the prototype. Users were very excited about the idea of non-verbal communication, especially the use of legs and eyes to lean in a particular direction. The design considerations were appreciated; the robot, in spite of looking appealing, was an entity that could move through pedestrian paths without attracting obstacles and unnecessary interactions.
There were also particular expectations which came forward, the validity of which could be measured with a bigger test group;

Similarity to a robot form.
Play with sounds that accompany reactions.
The possibility of information being displayed on the screen.
The scope of asking for help.
Maintenance and cleaning.

Future

Going ahead, there are some important criteria the delivery agent must be evaluated on. These include a trial run for measuring the task performance, design compliance, and cost comparisons. There would be a significant amount of work dedicated to the compatibility of the platform with the interface.
There is a need for a neural level network connection of the model's behaviour and language in relation to the real world communication and assumptions.
With the exponential rate of technological progress, a forecast needs to be done for the point beyond which it'll be learning capabilities of AI that take the front seat, and selection of the appropriate paradigms then.
Differences exist in the Western, Eastern and Southern cultures when it comes to the ethical preference of autonomous systems. The delivery agent going ahead could try to address these variations

Image References

Slide 4

10 Delivery Robot Companies to Watch in 2022 - Robotics 24/7. (n.d.). Retrieved August 15, 2022, from https://www.robotics247.com/article/10_delivery_robot_companies_worth_watching_2022
Alibaba's Driverless Robots Just Made Their One Millionth E-commerce Delivery | Alizila. (n.d.). Retrieved August 15, 2022, from https://www.alizila.com/alibaba-driverless-robots-one-millionth-ecommerce-delivery/
As COVID-19 persists, Japan looks to send in the robots | The Japan Times. (n.d.). Retrieved August 8, 2022, from https://www.japantimes.co.jp/news/2020/09/19/business/coronavirus-japanese-robots/
BEST Robot Delivery Fails Tik Tok Compilations - YouTube. (n.d.). Retrieved August 13, 2022, from https://www.youtube.com/watch?v=Dbzxshp573Q
Japanese delivery robots closer to hitting the roads as pandemic puts damper on human contact | The Japan Times. (n.d.). Retrieved August 13, 2022, from https://www.japantimes.co.jp/news/2020/07/26/business/tech/japan-delivery-robots-coronavirus/
Package delivery robots' environmental impacts: Automation matters less than vehicle type. (n.d.). Retrieved August 13, 2022, from https://seas.umich.edu/news/package-delivery-robots-environmental-impacts-automation-matters-less-vehicle-type
Softbank Invests $1B in Robo-Delivery Startup Nuro | WIRED. (n.d.). Retrieved August 13, 2022, from https://www.wired.com/story/softbank-nuro-self-driving-investment/
Top 6 Delivery Robots - Self Driving (Autonomous) Delivery Robots - YouTube. (n.d.). Retrieved August 13, 2022, from https://www.youtube.com/watch?v=dagjQW_jgtE

Slide 5

Boston Dynamics' Spot isn't quite the terrifying robot hunter you think it is - The Verge. (n.d.). Retrieved August 13, 2022, from https://www.theverge.com/2020/2/19/21144648/boston-dynamics-spot-robot-mass-state-police-trial-issues
FedEx's autonomous robot SameDay Bot delivers packages to your doorstep - YouTube. (n.d.). Retrieved August 13, 2022, from https://www.youtube.com/watch?v=rYRLU1b-A2Q
Kiwibot brings in $7.5 million in Pre-Series A funding - The Robot Report. (n.d.). Retrieved August 13, 2022, from https://www.therobotreport.com/kiwibot-brings-in-7-5-million-in-pre-series-a-funding/
Maxmen, A. (2018). Self-driving car dilemmas reveal that moral choices are not universal. Nature, 562(7728), 469–470. https://doi.org/10.1038/D41586-018-07135-0
Pedestrian acceptance of delivery robots Appearance, interaction and intelligence design. (n.d.). www.stefdegroot.com
segway delivery robot. (n.d.). Retrieved August 13, 2022, from https://www.dulnvxiers.tk/products.aspx?cname=segway+delivery+robot&cid=10
Starship Technologies, Aramark launch contactless robot food-delivery service at ASU | ASU News. (n.d.). Retrieved August 13, 2022, from https://news.asu.edu/20200904-asu-news-starship-aramark-launch-contactless-robot-food-delivery
The Sidewalk's Getting Crowded As Marble & Yelp Launch Starship Robot Delivery Competitor. (n.d.). Retrieved August 13, 2022, from https://thespoon.tech/the-sidewalks-getting-crowded-as-yelp-launches-starship-robot-delivery-competitor/
Uber Eats partners with Postmate's Serve Robotics to offer self-driving AI delivery services - Food Matters Live. (n.d.). Retrieved August 13, 2022, from https://foodmatterslive.com/article/uber-eats-postmates-serve-robotics-self-driving-ai-delivery-services/
Why Piaggio built Gita, a cargo-carrying robot, to follow in your footsteps | TechCrunch. (n.d.). Retrieved August 13, 2022, from https://techcrunch.com/2017/01/31/why-piaggio-built-gita-a-cargo-carrying-robot-to-follow-in-your-footsteps/

[1] “Nuro - On a mission to better everyday life through robotics. | Nuro.” https://www.nuro.ai/ (accessed Aug. 08, 2022).
[2] R. Pfeifer and Christian. Scheier, “Understanding intelligence,” p. 697, 1999.
[3] “What challenges are last mile autonomous delivery manufacturers facing? | Thought Leadership.” https://blogs.sw.siemens.com/thought-leadership/2020/04/16/autonomous-last-mile-delivery/ (accessed Aug. 08, 2022).
[4] “How Starship, Coco food delivery robots try to survive - Los Angeles Times.” https://www.latimes.com/business/story/2022-03-17/starship-coco-kiwibot-food-delivery-bots-obstacles (accessed Aug. 08, 2022).
[5] “A day in the life of a delivery robot | by Molly Davis | UX Collective.” https://uxdesign.cc/day-in-the-life-of-a-delivery-robot-fd895476f927 (accessed Aug. 08, 2022).
[6] B. Galantucci and L. Steels, “The emergence of embodied communication in artificial agents and humans,” Embodied Communication in Humans and Machines, Mar. 2008, doi: 10.1093/ACPROF:OSO/9780199231751.003.0011.
[7] “(PDF) Semantic Triangle and Linguistic Sign.” https://www.researchgate.net/publication/317344889_Semantic_Triangle_and_Linguistic_Sign (accessed Aug. 08, 2022).
[8] L. D. Riek, A. Adams, and P. Robinson, “Exposure to Cinematic Depictions of Robots and Attitudes Towards Them,” 2011, doi: 10.1007/s00146-006-0052-7.
[9] “Designing the Other: Aliens on Film - YouTube.” https://www.youtube.com/watch?v=srul5Xd2kT4 (accessed Aug. 08, 2022).
[10] “Designing Unique Emotions for Autonomous Delivery Robots | TU Delft Repositories.” https://repository.tudelft.nl/islandora/object/uuid%3Aea65c153-7d25-4783-960b-f2197511cb57 (accessed Aug. 08, 2022).
[11] “Why do we find some animals cute and others creepy? Scientists explain | Daily Sabah.” https://www.dailysabah.com/science/2019/04/29/why-do-we-find-some-animals-cute-and-others-creepy-scientists-explain (accessed Aug. 08, 2022).
[12] “Delivery robots: a revolutionary step or sidewalk-clogging nightmare? | Robots | The Guardian.” https://www.theguardian.com/technology/2017/apr/12/delivery-robots-doordash-yelp-sidewalk-problems (accessed Aug. 08, 2022).
[13] “Designing Agentive Technology: AI That Works for People | Christopher Noessel | Talks at Google - YouTube.” https://www.youtube.com/watch?v=cciGZ3BsLwA&t=21s (accessed Aug. 08, 2022).
[14] “Creating Robots that are Emotionally Engaging — Miro-E.” https://www.miro-e.com/blog/2020/5/7/creating-robots-that-are-emotionally-engaging (accessed Aug. 08, 2022).
[15] “ANYmal - Autonomous Legged Robot - ANYbotics.” https://www.anybotics.com/anymal-autonomous-legged-robot/ (accessed Aug. 04, 2022).
[16] “The Most Amazing Four-Legged Robots | Top Four-Legged Robots - YouTube.” https://www.youtube.com/watch?v=a7eqvg5rnus (accessed Aug. 08, 2022).
[17] “Legged robot - Wikipedia.” https://en.wikipedia.org/wiki/Legged_robot (accessed Aug. 08, 2022).
[18] “(PDF) Subsumption Architecture for the Control of Robots.” https://www.researchgate.net/publication/244321030_Subsumption_Architecture_for_the_Control_of_Robots (accessed Aug. 08, 2022).
[19] “Eco-friendly insulation: Materials, properties & Prices.” https://www.insulation-info.co.uk/eco-friendly-insulation (accessed Aug. 08, 2022).
[20] A. Maxmen, “Self-driving car dilemmas reveal that moral choices are not universal,” Nature, vol. 562, no. 7728, pp. 469–470, Oct. 2018, doi: 10.1038/D41586-018-07135-0.
[21] “The Prime Challenges for Scout, Amazon’s New Delivery Robot | WIRED.” https://www.wired.com/story/amazon-new-delivery-robot-scout/ (accessed Aug. 08, 2022).
[22] “Could Uber Drivers Benefit From Self-Driving Cars?” https://therideshareguy.com/could-uber-drivers-actually-benefit-from-self-driving-cars/ (accessed Aug. 08, 2022).
[23] “As COVID-19 persists, Japan looks to send in the robots | The Japan Times.” https://www.japantimes.co.jp/news/2020/09/19/business/coronavirus-japanese-robots/ (accessed Aug. 08, 2022).
[24] “Uncanny valley - Wikipedia.” https://en.wikipedia.org/wiki/Uncanny_valley (accessed Aug. 08, 2022).
[25] M. Plooij, G. Mathijssen, P. Cherelle, D. Lefeber, and B. Vanderborght, “Lock your robot: A review of locking devices in robotics,” IEEE Robotics and Automation Magazine, vol. 22, no. 1, pp. 106–117, Mar. 2015, doi: 10.1109/MRA.2014.2381368.
[26] “How Modeling Machines on Animals Can Improve Robotic Design.” https://www.azorobotics.com/Article.aspx?ArticleID=400 (accessed Aug. 08, 2022).
[27] “Out of the Way, Human! Delivery Robots Want a Share of Your Sidewalk - Scientific American.” https://www.scientificamerican.com/article/out-of-the-way-human-delivery-robots-want-a-share-of-your-sidewalk/# (accessed Aug. 08, 2022).
[28] M. Figliozzi and D. Jennings, “Autonomous delivery robots and their potential impacts on urban freight energy consumption and emissions,” Transportation Research Procedia, vol. 46, pp. 21–28, Jan. 2020, doi: 10.1016/J.TRPRO.2020.03.159.

Interaction with the the Starship Delivery Robot in Milton Keynes, UK