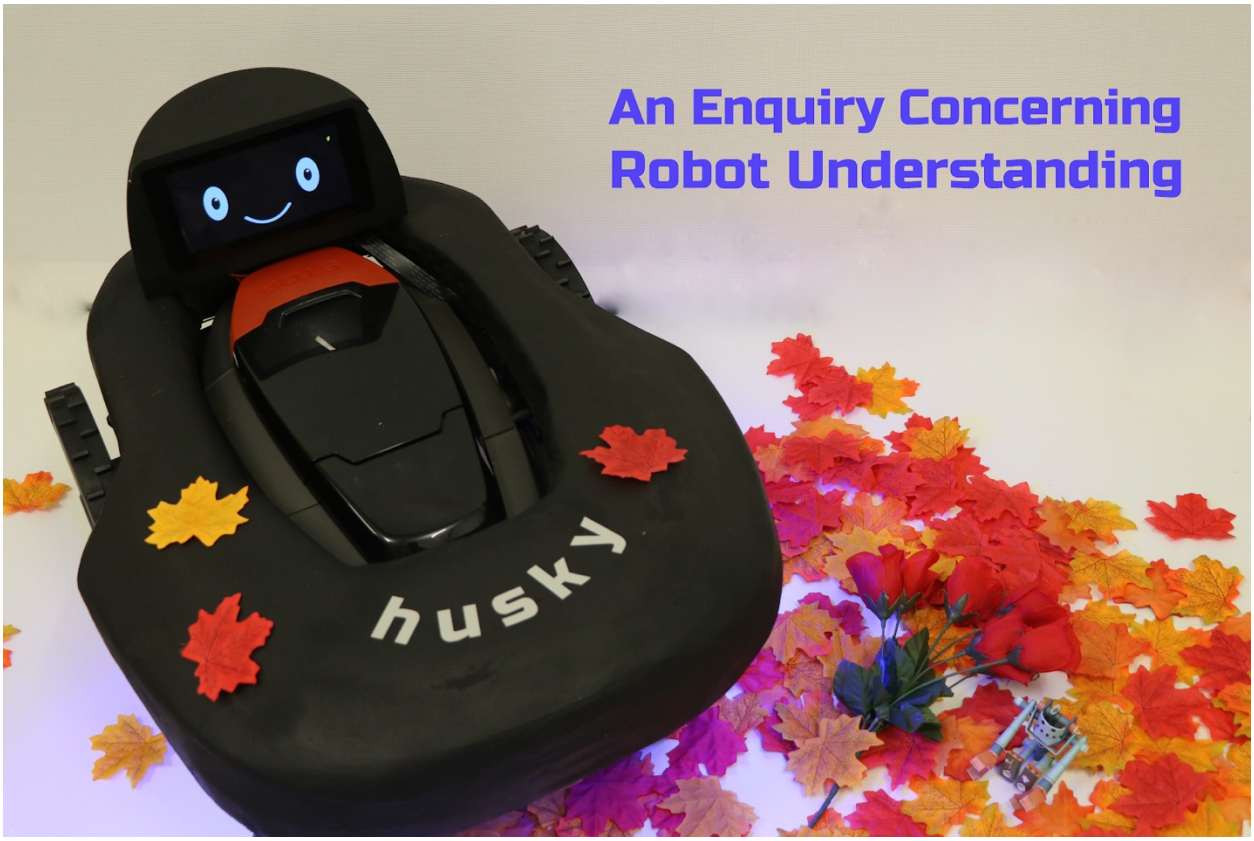


DET 2019 Module 4

Wesley Deng, Robert Hoogsteden, Jessie Lyu, Tina Taleb

Project Description

Robots are the current climax compounds of burgeoning technology and, without doubt, standing at the center stage of countless industrial errands, scientific research, and artistic design. While continually being anthropomorphized, robotic machines in effect own a distinct physical angle than humans and interpret the world through a unique vision and language processing system.

In our design, we encourage people not to take for granted how robots understand the surroundings but engage in an interactive, provocative, and open-ended inquiry concerning the robot's intelligence. Our robot's not merely an auxiliary tool, but the dazzling and glittering protagonist.

Leveraging on assorted emerging technology, we will guide through our audience a full course of robot's sensing, interacting, interpreting, and expressing. We wish to propose a thought experiment empowered by concrete installations, through an array of design sophistication, for the audiences and speculators to question, reflect, and contemplate on the contemporary human-robot relationship.

Ideation

On the first iteration of brainstorming, we explored a lot of potential ideas: Robot for Autism children, Robot pet, Robot trash cleaner, etc. We discussed what hardware and software we would like to adopt in the final project.

For the later on brainstorming sessions, we built up our discussion around the idea of "Robot seeing the world through a different physical angle." We thought about having a "garden guard" that reports its unique findings around the backyard. We loved the idea of letting the robot have the autonomy of reporting its insights to human. In the meantime, we would also like to expand the potential setting from a personal backyard to the global urban environment.

We went further on investigating the potential outcome when humans are willing to observe the way from a robot's angle and realized that we couldn't ignore the fact that not only the physical angle but the entire information processing system of robots are different from human. We found this observation intrigued and decided to build an interactive design that could reveal people the robot's understanding procedure of its surroundings.

We started off by designing three stages for the sake of demonstration: Sensing, Interpreting, and Expressing. We then decided that it's not enough for a robot to just sense the world, but a motivated interaction should be included. We hence finalized our four stage of enquiry: Sensing, Interacting, Interpreting and Expressing.

Throughout the design process, there are three main themes that we frequently addressed and investigated: perspective, intelligence and mobility.

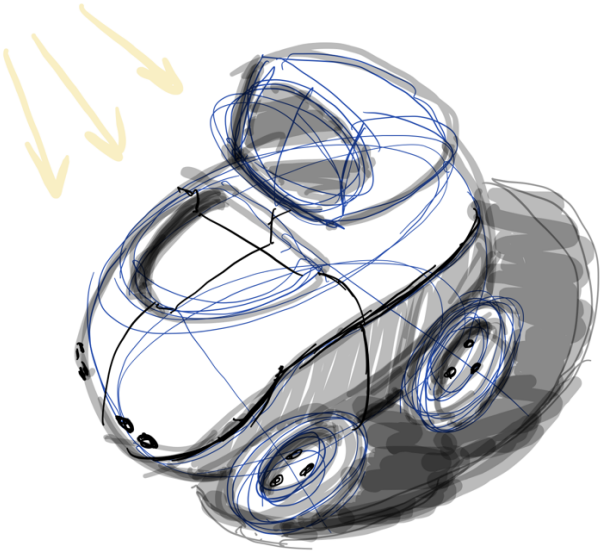
- Perspective: We pick out and compromise our design choices to make sure the project's outcomes would encourage people to look and think from a robot's perspective.

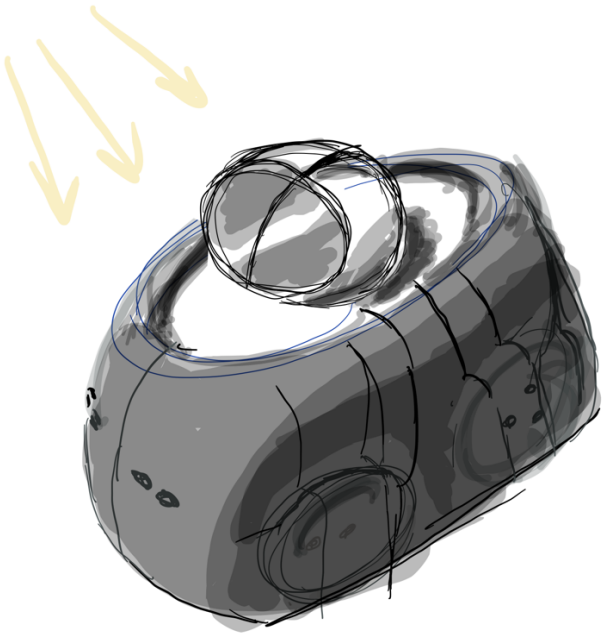
- Intelligence: We envision a robotic system that holds the autonomy of exploring and the self-motivation of expressing.

- Mobility: We emphasis on moving the robot around while it's sensing and interacting the world. We want people to reflect on this human-robot cohabitation phenomenon.

Physical Design and Fabrication

We agreed in the early stages that we all want to change the cover of the robot. We wanted to simplify the physical design to help Husky blend easier into the environment. We started off by sketching a robot based on Husqvarna's main body. We named our robot "Husky" for its adorable look and the rhythm between "Husky" and "Husqvarna."





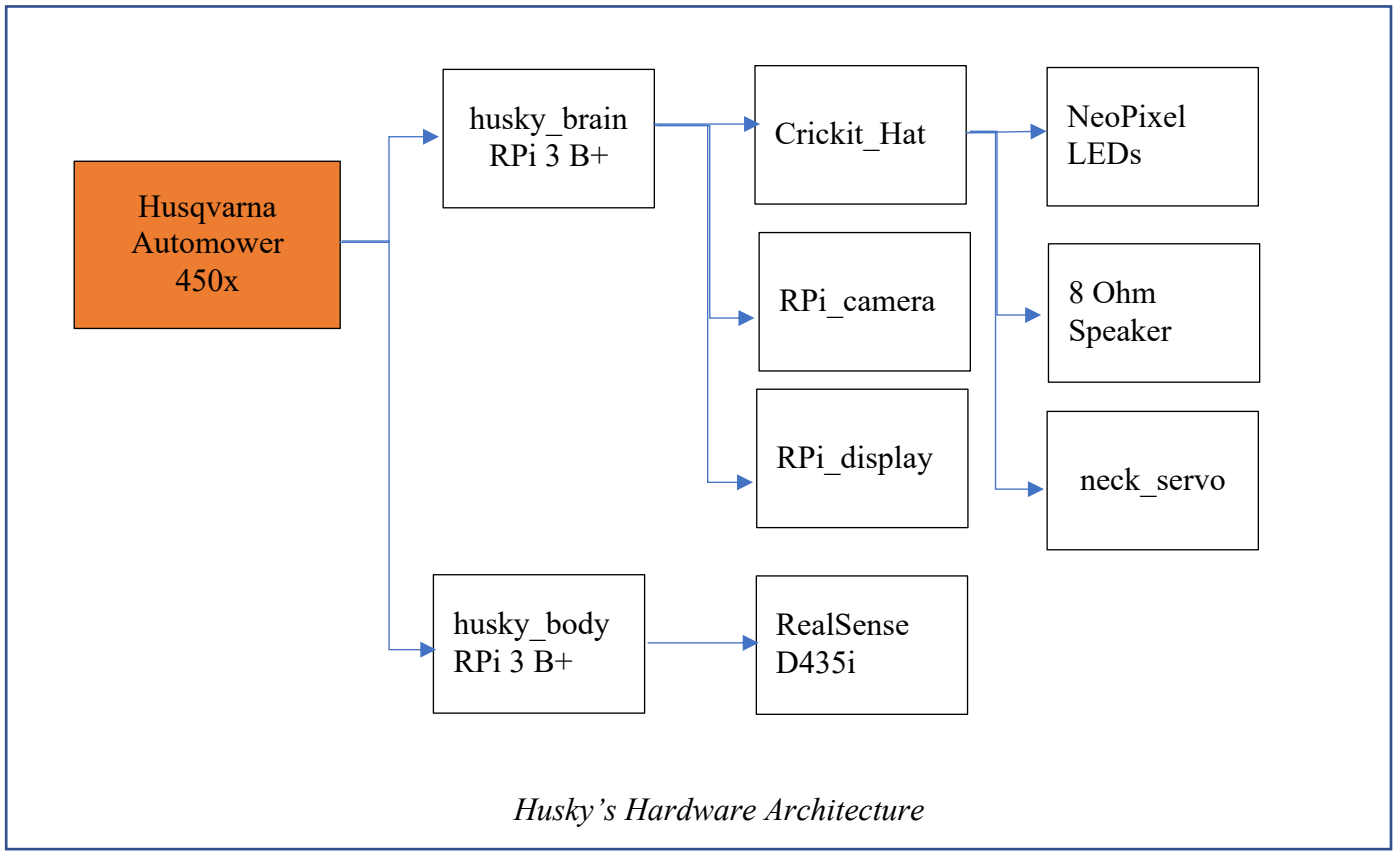
We experimented with several ideas for fabricating the new body for Husky. We initially attempted to make a 3D model of the body and 3D print it in parts, but we quickly realized this might not be the best solution given the time limitation. So, we designed a base and made it out of plywood and then added layers of foam. From there we sculpted the body by sanding away excess material and filling in all openings with expandable foam and then sanding some more. After we sculpted the desired shape for the body, we painted it black and as a last step added our Husky logo. We also designed and 3D printed a head that houses our screen and raspberry pi.

Fabrication Working Session

Intermediate Body

Final Product

Hardware Design and Integration



Husky's Hardware Architecture

Husky runs on two separate Raspberry Pi 3 B+ (RPi 3) computers, with one embedded in Husky's head and the other encased inside the Husqvarna Research Platform (HRP) to control the motor functions via the Robotic Operating System (ROS). We chose to use multiple RPi 3 computers to simplify our architecture from an implementation standpoint and to ensure we would have enough compute power to perform the functions we wanted to implement.

Husky's expressions are displayed using a Raspberry Pi Touch Display on the robot's head unit and is connected to Husky's "Brain" RPi 3 through the 3 DSI port. The "brain" is also connected to the Adafruit Crickit Hat to provide servo, speaker, and NeoPixel control. The "brain" is also connected to a camera mounted underneath the nose of the foam core shell through a meter-long CSI ribbon cable. The NeoPixels are secured along the edges of the body's shell with recessed wiring channels.

The head has a magnetized lid and is seated on a press-fit mounting plate which allows easy access to the components. The plate has a servo connected to it that is attached to a mounting bracket on the robot's body. The servo can rotate Husky's head to the left and right as needed.

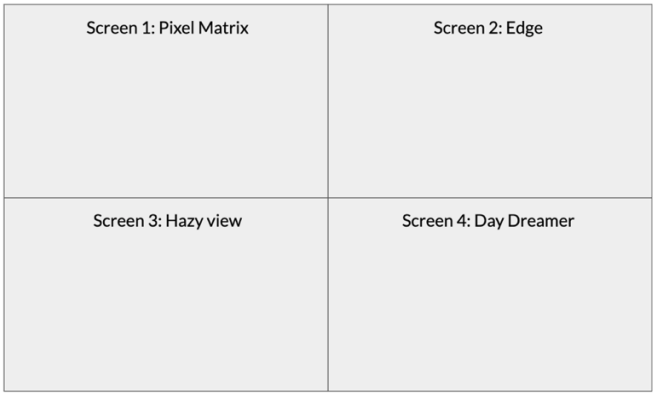
The three-inch speaker is mounted on the rear of the body in a carved-out recess and connected to the "brain" pi.

The "body" is connected via the HRP serial port via a USB cable that has been feed inside the platform. All components requiring power have been wired to the HRP for their needs.

Hardware Gallery

Sensing

Robot's sensing process is an essential part in terms of illustrating the motivation of "observing the world from the robot's point of view." As mentioned before in the motivation part, the robot's entire understanding depends on a complete different visual system and language processing procedure. In our design, we would like to create a novel experience for our audience—an Allan Kaprow style "happening" that generates a nonlinear narrative leveraging on heterogeneous digital output. Our original goal is to combine the vision and sound input. We ended up with a concessive plan in which only the image being used as the creating material.

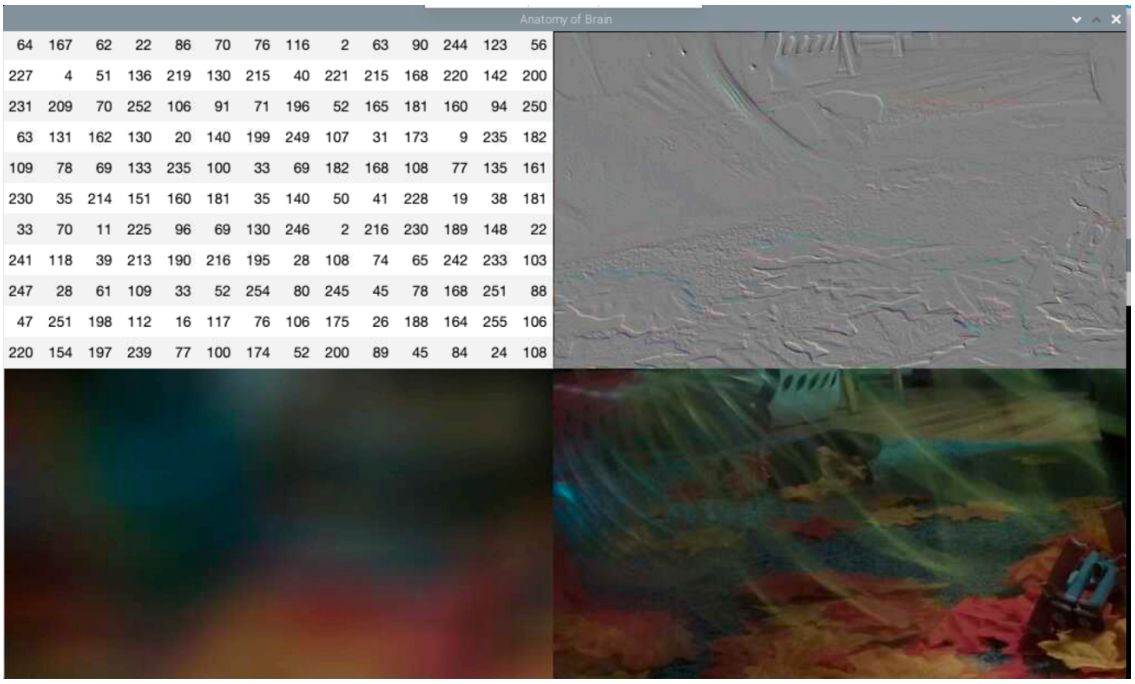


Preliminary Screen Design

On the "fMRI" style real-time image interpreting screen, we have four blocks that capturing the real-time image processing progress of our robot in real-time. For screen1 (top left), we decide to present a pixel intensity matrix, the lowest level of the image processing in all modern machines. For screen2 (top right) and screen3 (bottom left), we choose to separate shape and color as these are two fundamental ways for computing algorithms to read and classify pictures. Screen4 is an overlaid picture captured in a different time by Pi.

Test Samples of Overlaid Image for Screen4

Layer by layer, we deconstruct—though not entirely rigorously—the image processing procedure of a machine and add some cinematic element at the end. Below is one of our screenshots for the "fMRI" of robot's vision system. One can clearly see the edge matching and the color gradient mapping.



Real Time Screenshot.

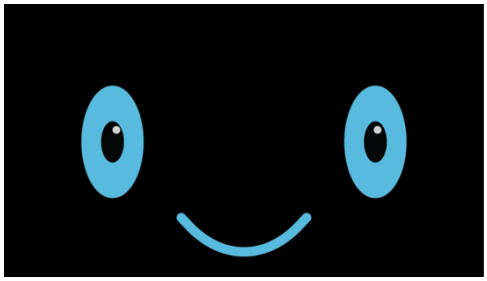
In terms of implementation, we managed to show sceen2-4 in a real time manner merely by calling OpenCV library. For sceen1, we tested the code on Pi, but the computing power of Pi cannot afford the pixel-wise translation. We ended up pre-generating scores of pixel matrix picture using NumPy and randomly pulling from the image set. The final result is tolerably well.

In modern life, cameras and computer vision technologies are ubiquitous. People are currently taking granted for the image processing procedure of robot's vision. Here, we want our design to serve as an opportunity for the general audience to have a glimpse of the intricacy of a seemingly common technology.

Interacting

We envision in a near-future setting, the phenomenon of intelligent robots exploring the urban space becomes ubiquitous; people are getting used to it and commonly interacting with the robots. In addition, we believe that it is inevitable for an intelligent, autonomous robot to explore an environment without being part of the dynamic system of that surrounding. Building on the previous part of sensing, we introduce an interacting session to illustrate the robot's immediate preference towards the surroundings.

We give Husky a way to express its mood and emotion, so we gave Husky a face. Husky reacts to multiple triggers in unique ways. For example, husky doesn't like trash so if it detects something as trash it'll display the angry/sad face. Whimsical sound clips are triggered along.



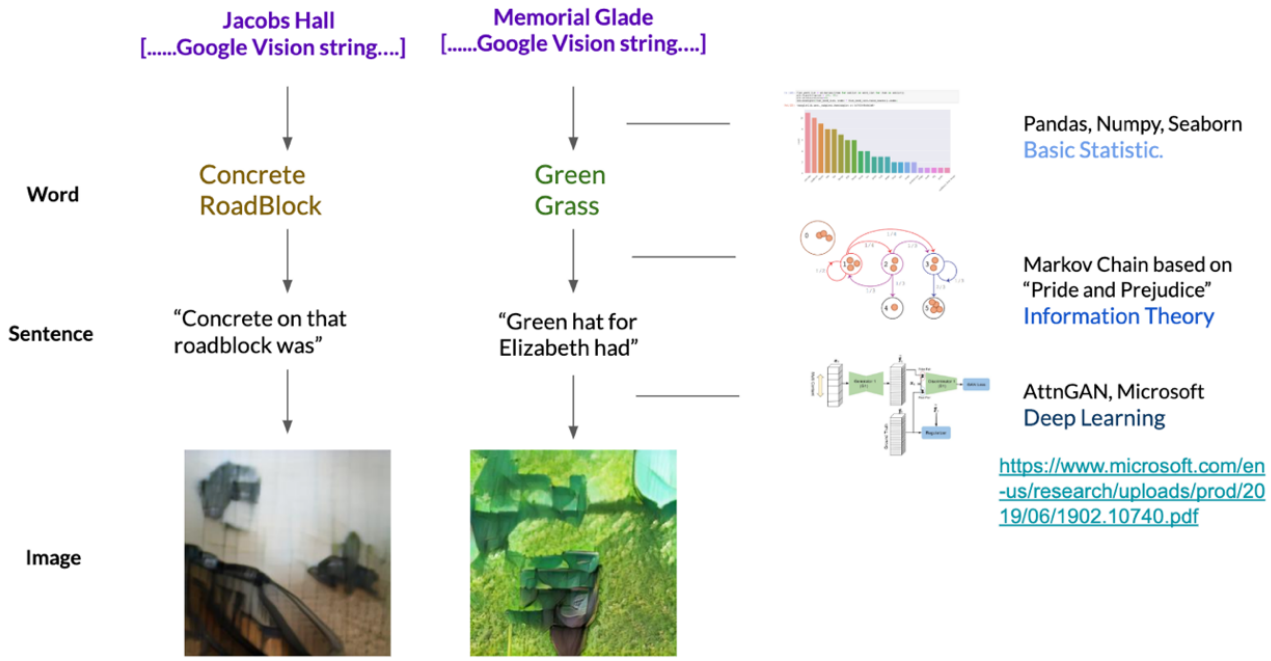
Default Face with Neutral Emotion

Different Facial towards Objects

Interpreting

There are simply countless of possible ways that a machine can interpret the world. In this design assignment, we would love to come up with a specific way of robot's interpreting procedure that could reflect our three main design focuses, namely, intelligence, mobility and perspective.

We first held two field study using Google Cloud Vision: one inside Jacobs Hall and one around Memorial Glade. After we extract out the csv file contain all the keyword string, we did a data analysis to capture the most frequent words for the two location. We extend the words to random sentences using a markov chain sentence generator, then feed the sentence to AttnGAN, a neuro network created by Microsoft in 2016, to generate an abstract style picture.



Pipeline for Husky's Interpreting

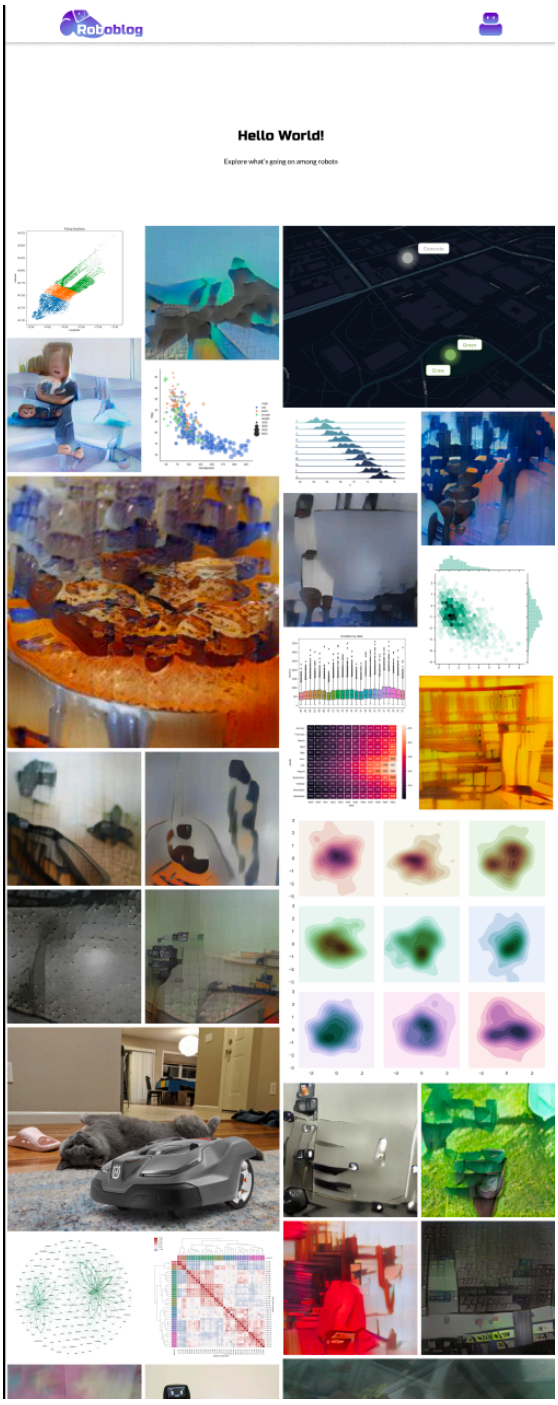
It is worth mentioning that with the modality's complexity goes up from single word to an abstract image, the tools being used to render the transformation are being updated accordingly. This nuanced mapping illustrates the underlying pattern of robot's interpreting power and one can appreciate its similarities and differences from human's interpreting style.

As designers, we are fascinated by this transformation from rational equations and logical algorithm to emotional expressions and poetic representation. In the public showcase, we are delighted to see some of the audiences are also excited to see this novel way of creating.

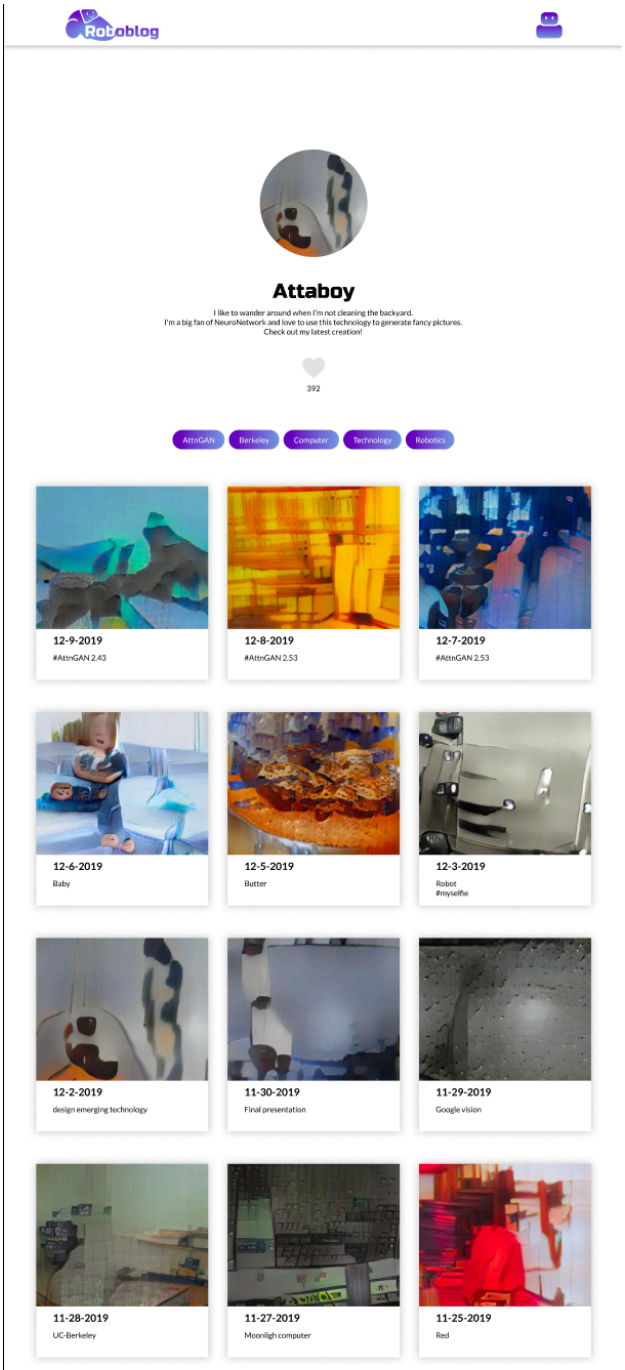
Expressing

To hold the urge to express is an extremely high level of intelligence. Humans could scream not only for being physically survival, but for being heard and not enduring the loneliness brought by the existential crisis. At the very last step of our enquiry, namely, expressing, we envision our robot adopt this high intelligence and create a platform for robots to express themselves. The purpose and the audience of the blogs can be open-ended. It can serve as an "Instagram" for robot's own social network, or a less utilitarian "Linked-in" where robots can reveal their genuine passion to humans who have been misunderstanding them.

When designing the expression outlet for robots, we combine the idea of Instagram and Tumblr, and designed a blog-style platform called "Roboblog." We want to minimize the effect from human, so the blog is supposed to be running and managing by robots only. The basic functionality of Roboblog is simple -- browsing content posted by other robots and upload one's own creations. However, we still want humans to have access to know what's happening in robots' world, so the blog will be human readable. Next page shows the interface of the blog.

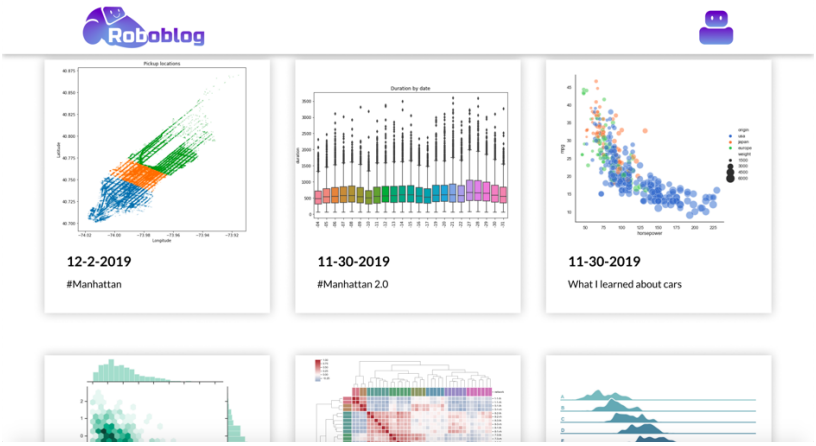


Blog Home Page

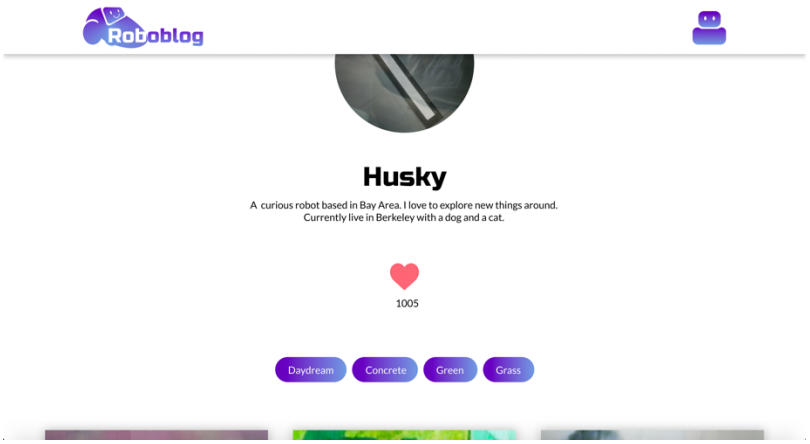


Blog Personal Page #1

How a robot interacts with other robots on the blog? As mentioned above, robot could view other robots' blog content. Additionally, they could like/unlike another robot's blog. On each robot's blog there will be total likes number. Since we also want humans to see the content, humans will also be able to like/unlike a blog, and this is the only thing humans can do on robot's blog.



Blog Personal Page #2



Blog Personal page with "Like"

So how does the blog actually work? We are assuming robot will be able to upload images directly from its own computer. We've already built a trial website to retrieve data from Husqvarna's Pi using API[link to GitHub: https://github.com/lyujessie/Roboblog]. We are imagining that in the future all robots will have access to the website and will be able to browse, update and interact with web content. By creating a blog for robots we are making the assumption that robots will be developed to develop their own "personalities". Right now, in our demo we've already tried a few posting styles: abstract Monet style, data scientist style, and random style. We are drawing an analogy here between human expression and robot expression:

as humans, we develop our blogging style from other social media influencers, and as robots, they can also develop their preferred expressing style by studying other robots' blogs. And in this context, the expressing style might refer to but are not limited to things like various data visualizations tools, neural-network algorithms, machine learning, etc. In order to illustrate this concept, we are using several algorithms to generate blog content in the demo. For example, the content posted by "Attnboy" is created by a neural-network algorithm created by researchers in Microsoft and Cornell as mentioned in the previous "Interpreting" part.

Enlarged Picture on Blog


"Baby" by AttnGAN

While we design our robot's blog illustrations to be an amalgamation of potential expressions from a robot point of view, we also take the chance to envision a virtual world where robots would love to hold specific expertise in terms of blog creating—and our Husky would finally build up its own passion as well. This design choice follows well after the previous stages of two round sensing and interacting in order to develop a prior knowledge and cultivate a potential personality.

Again, this stage is a highly theoretical experimental experiment. We would like to perform this intentional, structured process of deliberation within a utopian (or anti-utopian) world in order to speculate and provoke people to think about potential consequents. For us, we treat this design more than a fun widget to show around, but a device that outputs hypothesis about machine being keen to be seen.

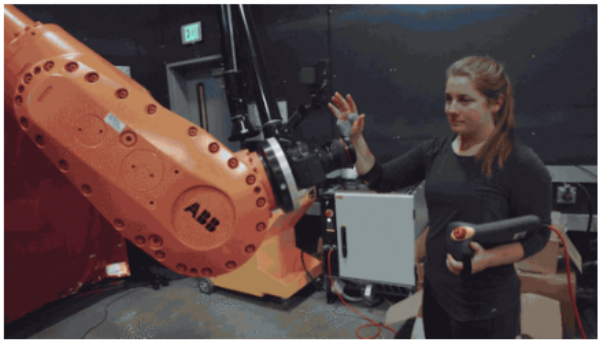
From Human to Robot

Abstracting away from all the software and hardware, codes and electronics, implementations and design choices, our project boils down to four rudimental steps: sensing, interpreting, interacting, and expressing. By create an environment for the audience to closely scrutinize these four stages, we encourage our audience to gain valuable insights on how robot's understanding the world and treat our "Husky" not as an auxiliary servant or agent, but a protagonist. Rather than providing an unequivocal answer, we wish to provoke people to question and reflect on Human-Robot relationship in a near future setting.

Future Works

Beyond the implementations in these three weeks, we came up with quite a lot of extensions that we may carry on for our future projects and career as designers. We categorize them into the four stages we created, as many of them require upgrades in both hardware and software.

For the **sensing stage**, we would love to add a more flexible robot to offer more angles and a faster image processing system to update the image quickly. We could imagine using some large-scale industrial robots like IRB 6700 by ABB to give the audience an overlook. We are also interested in integrating the idea of "visual system fMRI" into the framework of Dr. Madeline Gannon's work, as her original work is trying to convey the idea of humans attempting to communicate and cohabitate with a robot.



QUIPT by Dr. Madeline Gannon

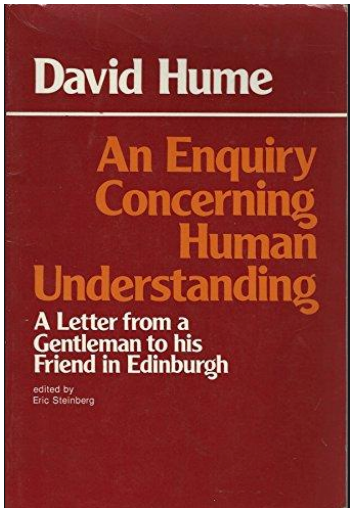
For the **interacting stage**, our original idea was to have a SLAM algorithm that allows our robot wandering around the stage and output the interaction. Due to the time limit, we couldn't include this part in our current work. However, we are keen to see the outcome of the combo of Google Cloud Vision (or OpenCV if better accuracy is necessary) and the SLAM algorithm.

For the **interpreting stage**, our current AttnGAN is an off the shelf pre-trained Neuro Network hence the results are not quite adaptive. If time allows, we would love to collect more data and build our own dataset to train our own model. This effort could even have practical usage in the area of urban computing or environmental engineering.

For the **expressing part**, it is challenging to synchronize all the data and output we collected from the previous three stages, but the result would be compelling if we somehow managed to do that. This requires a fluent pipeline for all the four stages and a large base dataset.

Final Words

Going back to the title “An Enquiry Concerning Robot Understanding,” We adopt the title from great empiricist philosopher David Hume's work "An Enquiry Concerning Human Understanding." Back to 300 years ago, Hume used this treatise to bring people’s attention from God and theology to human’s customs and behaviors. As the creator of the robot, current robotic design tends to emphasis on what would humans, the “creator”, demand from the robot. We use this design opportunity to shed light on the discussion of some marginalized philosophical questions in practical design: what is a robot? Are they really hearing and seeing? Do they ever tend to express? If humans and machines are sensing the world differently, what is “being” for an object? How would this affect scholar’s traditional debate around metaphysics and epistemology?



For a design class, we shy away to bring in an extravagant amount of philosophical debate into our project; hence these topics are not included in our main body. However, as designers and creators working with emerging technology, we do believe that we are obliged to understand the technology profoundly under an ethical and historical context, hence be able to apply the emerging technology prudently and do good.

In this three-week final project, we spared no effort to bring in all the techniques we learned thus far in DET and convey a provocative prompt concerning the future of Human-Machine relationship. We genuinely appreciate this unique opportunity to think, build, and create in an interdisciplinary way that couldn’t be found anywhere other than Jacobs Hall.