ECE491: Senior Design I
Mar.io
Technical Progress Report

Jared Balakrishnan, Sarthak Babbar, Akshar Amin
Sai Talla, Arjun Sachdeva, Abhiroop Verma

Advisor: Dr.Matthew Stamm

Department of Electrical and Computer Engineering
Drexel University

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1   Executive Summary

With the meteoric rise of research activity in the area of Computer Vision, numerous applications have surfaced in the world, ultimately leading to a burgeoning multi-billion dollar market. The number of problems being solved in this area, ranging from simple handwriting recognition to autonomous driving has brought to our attention the extent to which human life could be simplified with the help of such technology, thereby helping us eliminate costs as well as leave a smaller carbon footprint.

Mar.io aims to solve a segment of the problems in the path detection area for autonomous system by building a small-scale version of a computer vision system which when iterated in large scale can be used in the areas of robots used for autonomous delivery as well as wheelchair assistance for the disabled.

The project aims to build technology that is committed to improving the quality of life, whilst respecting the communities in which it would be used by striving to make computer vision more simpler and accessible.

Mar.io is designed to detect traversable areas on sidewalks in addition to attempting pathway recognition by building a machine learning model that is trained upon sidewalk images fed through a microcontroller. The machine learning model is intricately composed of components that specialize in collecting, cleaning and analyzing the data prior to using it for the purposes of training and inference. Once this task of inference is successfully achieved, the microcontroller system would be able to perform this detection in real-time. This can then be viewed live on a web application. The entire model is slated to be built using the Python programming language and the libraries associated with it, whereas the web application is slated to be built using a mix of JavaScript and React.

The prototype of *Mar.io* is also designed to be extremely cost-efficient, with the bare bones prototype costing less than $600 and the large-scale business prototype projected to cost a little less than 2 million dollars over a period of two years.

2   Technical Design Changes

As of now, the technical design of *Mar.io* is not projected to change in any way. The project is currently undergoing the process of collection of data which involves the use of a microcontroller-based camera system mounted on a toy car that can be controlled with a computer over WiFi. The project expects to collect over 12 hours of training data, with over 3 hours of data having been collected already.

3   Other Updates

3.1   Stakeholders

Previously, it was mentioned that the stakeholders for the *Mar.io* project were limited to:

- **Drexel University**
- ***Mar.io* Team**
- **The University City Community**

It was realized that the team had overlooked potential stakeholders, because of which it was decided that the list of stakeholders be expanded to have the following entities:

- **Venture Capital Firms** : Every successful large scale technology product in the market usually tends to be externally funded by a venture capital firm. This is a part and parcel of the entrepreneurial cycle where ideas are vetted and invested in by firms which enable the development of technology in the first place. In return, these firms that are ready to invest in *Mar.io* are entitled to a given, pre-determined share of the profits accrued by *Mar.io*.

- **Small and Large Businesses**: Businesses, large scale and small scale alike stand to benefit a lot from *Mar.io* given the fact that the technology used will enable them to be more fiscally efficient, cutting costs in the areas of employing people and shipping or transportation. In addition, it will also enable them to leave a smaller carbon footprint.

- **The General Public**: The public stands to benefit from the development of *Mar.io* the most, given the fact that it is focused on making the lives of mankind easier. *Mar.io* desires to change the very picture of package delivery and path detection in a way it can be incorporated into any system, thereby allowing people to be more fiscally as well as environmentally efficient.

3.2   Update on Deliverables

When the initial idea for *Mar.io* was pitched to the review committee, there were confusions regarding what the real deliverable was going to resemble. This is owing to the fact that the microcontroller-based data collection system was mistakenly presented as what the deliverable would look like: a fully autonomous system of its own that is capable of controlling itself on sidewalks as well as be able to carry a small payload which would be delivered over a given distance.
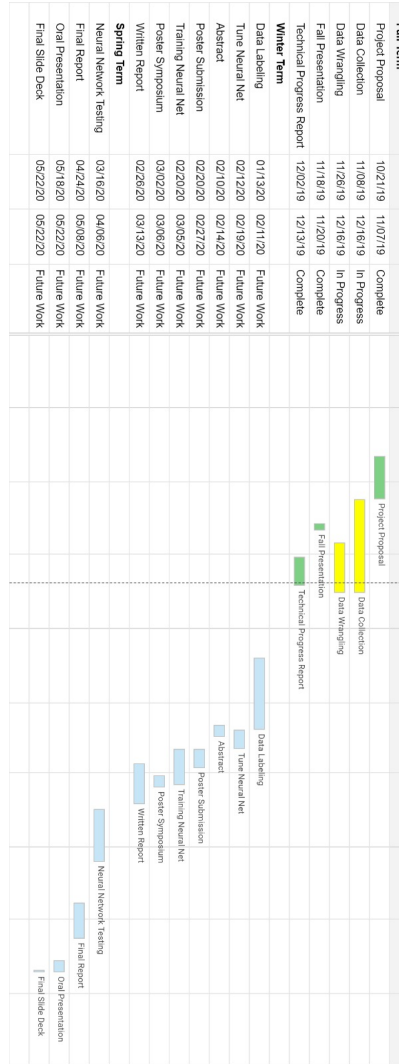
However, it should be realized that *Mar.io* serves as a **subsystem** which when incorporated into a system, giving it the capability to predict paths and dodge objects. This is so because implementing a full fledged system that would be able to do everything on its own including movement is infeasible, given the fact that there would need to be implementation of control systems for the autonomous movement. Because of the constraint of time, this cannot be accomplished.

That is, the capabilities implemented by *Mar.io* could be used in a variety of systems to primarily be capable of detecting the paths that it needs to traverse, by dodging obstacles present in the way in an autonomous fashion. In addition, it is also planned that *Mar.io* would be able to predict the path it takes in advance.

Path Prediction and Navigation is a very technologically complex project which involves the application of complex concepts from the areas of Machine Learning and Artificial Intelligence because of which it needs sufficient manpower to develop. The rational behind having a six-member team is so as to break down the development into sizable chunks, thereby simplifying the development process.

4   Gantt Chart

The Gantt Chart for the project, to reflect the updates as of now, is as shown below:

Fall Term			
Project Proposal	10/21/19	11/07/19	Complete
Data Collection	11/08/19	12/16/19	In Progress
Data Wrangling	11/26/19	12/16/19	In Progress
Fall Presentation	11/18/19	11/20/19	Complete
Technical Progress Report	12/02/19	12/13/19	Complete
Winter Term			
Data Labeling	01/13/20	02/11/20	Future Work
Tune Neural Net	02/12/20	02/19/20	Future Work
Abstract	02/10/20	02/14/20	Future Work
Poster Submission	02/20/20	02/27/20	Future Work
Training Neural Net	02/20/20	03/05/20	Future Work
Poster Symposium	03/02/20	03/06/20	Future Work
Written Report	02/26/20	03/13/20	Future Work
Spring Term			
Neural Network Testing	03/16/20	04/06/20	Future Work
Final Report	04/24/20	05/08/20	Future Work
Oral Presentation	05/18/20	05/22/20	Future Work
Final Slide Deck	05/22/20	05/22/20	Future Work

Figure 1: Updated Gantt Chart for *Mar.io*

5   Bill of Materials and Proof of Ordering

The implementation of *Mar.io* requires certain components, which need to be purchased from external vendors. The items that have been purchased as of now can be seen from the below shown table:

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Vendor	Item Description	Amount	Cost Per Unit	Total Cost
Amazon	NVIDIA Jetson Nano	1	$ 104.89	$104.89
Amazon	Acrylic Case For Nano	1	$ 15.89	$ 15.89
Amazon	Intel WiFi Card	1	$ 21.19	$ 21.19
Amazon	WiFi Antenna	1	$ 9.53	$ 9.53
Amazon	L298N Stepper Motor Driver Dual H-Bridge	1	$ 7.30	$ 7.30
Amazon	Remote Controlled Toy Car	1	$ 49.99	$ 49.99
Amazon	Portable Charger	1	$ 32.19	$ 32.19
Amazon	Batteries and Charger	1	$ 16.99	$ 16.99
Sum Total				$ 274.97

Table 1: Bill of Materials for the Equipment involved in the implementation of *Mar.io*

The below shown invoices amount as proof for having ordered some of the above listed equipment:

amazon.com

Final Details for Order #113-9372104-4747439
Print this page for your records.

Order Placed: November 8, 2019
Amazon.com order number: 113-9372104-4747439
Order Total: $104.89

Shipped on November 9, 2019

Items Ordered	Price
1 of: *NVIDIA Jetson Nano Developer Kit* Sold by: Betts store (seller profile) Condition: New	$98.95

Shipping Address:
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Shipping Speed:
One-Day Shipping

Payment information

Payment Method:
Amazon.com Store Card | Last digits: 6890

Billing address
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Item(s) Subtotal:	$98.95
Shipping & Handling:	$0.00

Total before tax:	$98.95
Estimated tax to be collected:	$5.94

Grand Total:	**$104.89**

Credit Card transactions   AmazonPLCC ending in 6890: November 9, 2019: $104.89

To view the status of your order, return to Order Summary.

Figure 2: Invoice for the NVIDIA Jetson Nano

amazon.com

Final Details for Order #113-5501129-7827414
Print this page for your records.

Order Placed: November 8, 2019
Amazon.com order number: 113-5501129-7827414
Order Total: $15.89

Shipped on November 9, 2019

Items Ordered	Price
1 of: *Yahboom Acrylic Case for NVIDIA Jetson Nano with Cooling Fan and Camera Case* Sold by: Yahboom (seller profile) Condition: New	$14.99

Shipping Address:
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Shipping Speed:
One-Day Shipping

Payment information

Payment Method:
Amazon.com Store Card | Last digits: 6890

Billing address
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Item(s) Subtotal: $14.99
Shipping & Handling: $0.00

Total before tax: $14.99
Estimated tax to be collected: $0.90

Grand Total:$15.89

Credit Card transactions   AmazonPLCC ending in 6890: November 9, 2019: $15.89

To view the status of your order, return to Order Summary.

Figure 3: Invoice for the Acrylic Case for the Nano

amazon.com

Final Details for Order #113-1538751-3467433
Print this page for your records.

Order Placed: November 8, 2019
Amazon.com order number: 113-1538751-3467433
Order Total: $21.19

Shipped on November 9, 2019

Items Ordered	Price
1 of: *OKN Wi-Fi 6 11AX WiFi Module Intel AX200NGW 2 x 2 MU-MIMO Laptop WiFi Card Bluetooth 5.0 Support Windows 10 64bit/ Google Chrome OS/Linux Gigabit and Low Latency Built for Gaming M.2/NGFF (Gig+)* Sold by: UFON (seller profile) Condition: New	$19.99

Shipping Address:
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Shipping Speed:
One-Day Shipping

Payment information

Payment Method:
Amazon.com Store Card | Last digits: 6890

Billing address
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Item(s) Subtotal:	$19.99
Shipping & Handling:	$0.00

Total before tax:	$19.99
Estimated tax to be collected:	$1.20

Grand Total:	**$21.19**

Credit Card transactions   AmazonPLCC ending in 6890: November 9, 2019: $21.19

To view the status of your order, return to Order Summary.

Figure 4: Invoice for the Intel WiFi Card

12/13/2019   Amazon.com - Order 113-0337069-2800261

amazon.com

Final Details for Order #113-0337069-2800261
Print this page for your records.

Order Placed: November 8, 2019
Amazon.com order number: 113-0337069-2800261
Order Total: $9.53

Shipped on November 9, 2019

Items Ordered	Price
1 of: *2 x 6dBi 2.4GHz 5GHz Dual Band WiFi RP-SMA Male Antenna+2 x 35CM RP-SMA IPEX MHF4 Pigtail Cable for M.2 NGFF WiFi WLAN Card* Sold by: Highfine (seller profile) Condition: New	$8.99

Shipping Address:
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Shipping Speed:
Standard Shipping

Payment information

Payment Method:
Amazon.com Store Card | Last digits: 6890

Billing address
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Item(s) Subtotal: $8.99
Shipping & Handling: $0.00

Total before tax: $8.99
Estimated tax to be collected: $0.54

Grand Total:$9.53

Credit Card transactions   AmazonPLCC ending in 6890: November 9, 2019:$9.53

Figure 5: Invoice for the WiFi Antenna

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amazon.com

Final Details for Order #113-8654614-0997830
Print this page for your records.

Order Placed: October 21, 2019
Amazon.com order number: 113-8654614-0997830
Order Total: $7.30

Shipped on October 23, 2019

Items Ordered	Price
1 of: *Qunqi L298N Motor Drive Controller Board Module Dual H Bridge DC Stepper For Arduino* Sold by: Qunqi C (seller profile) Condition: New	$6.89

Shipping Address:
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Shipping Speed:
Two-Day Shipping

Payment information

Payment Method:
Amazon.com Store Card | Last digits: 6890

Billing address
Arjun Sachdeva
326 N SLOAN ST APT 2
PHILADELPHIA, PA 19104-5392
United States

Item(s) Subtotal: $6.89
Shipping & Handling: $0.00

Total before tax: $6.89
Estimated tax to be collected: $0.41

Grand Total: $7.30

Credit Card transactions   AmazonPLCC ending in 6890: October 23, 2019: $7.30

To view the status of your order, return to Order Summary.

Figure 6: Invoice for the L298N Stepper Motor Driver Dual H-Bridge