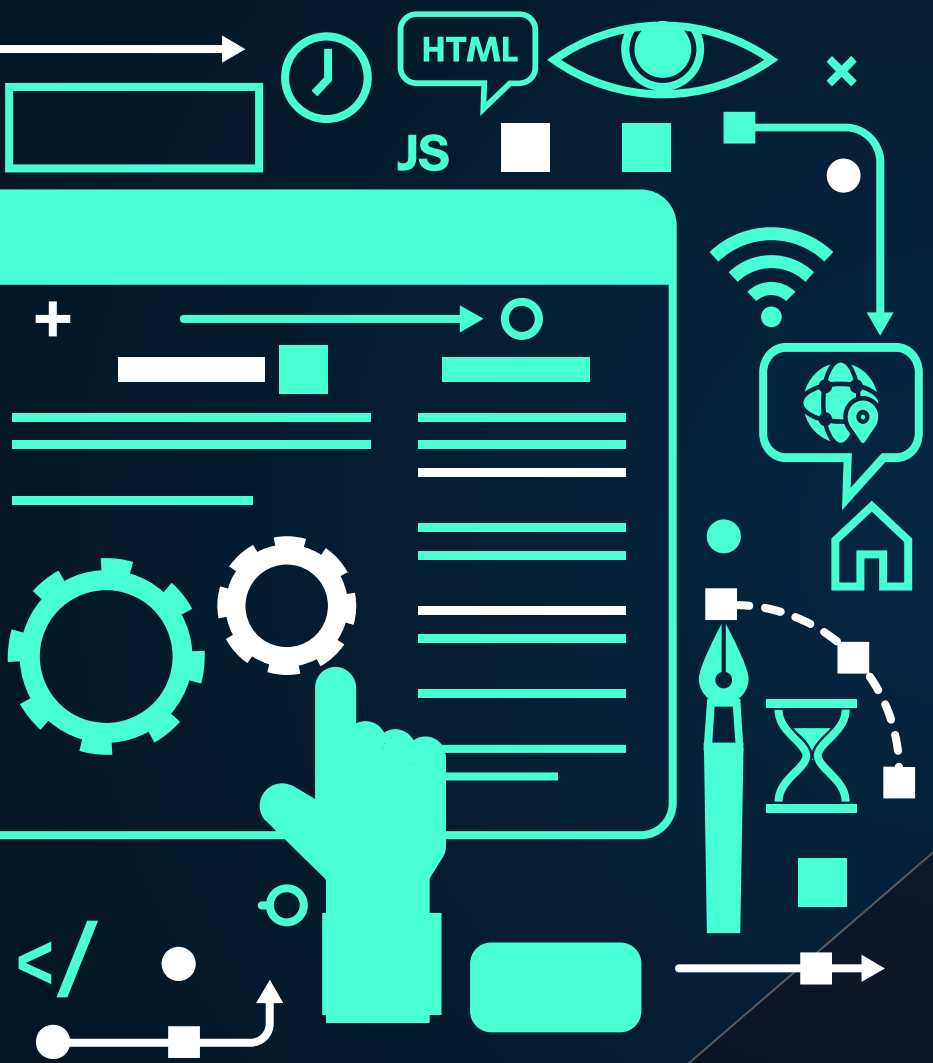

The New York Academy of Sciences

Security Reimagined

By: Vikram M., Johan J., Yash V., Rishabh J., Abhijit C.

THE TEAM

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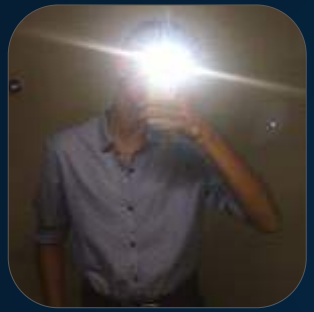

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PROBLEM

Vehicles are not Connected

01

Vehicles do not unlock the potential of communicating on the road to reduce the risk of accidents

Vehicle Maintenance

02

Car owners often neglect maintenance of their cars and this causes catastrophic incidents on the road and owners are not able to remotely monitor their car

Drivers Need A Third Eye

03

Drivers can often be distracted on the road and need warnings and methods to ensure that accidents are prevented

Security of Cars

04

With the extensive use of technology in cars, it is important to ensure data is transmitted securely and the car is immune to hackers

BACKGROUND

- More than 1,000 people are injured daily in accidents in which at least one driver was distracted
- 4,000 people were killed in crashes involving distracted drivers in 2015
- Cyber-physical systems (CPS) such as vehicles are vulnerable to cyber attacks, data breaches, malfunctions, along with other technical wear and tear issues
- In order to protect the vehicle systems and maintain the integrity of the network, trusted computing principles are necessary to bridge the gap between user and product interactions while sustaining a safe environment for transmission of data

APPROACH

PROPOSED SOLUTION

An add-on device for vehicles that monitors the vehicle and its driving behavior and alerts the driver and other drivers of possible hazards while monitoring data and analysing it on a server and presenting it to the user.

OUR HYPOTHESIS

Through the use of advanced machine learning algorithms for image processing and data security, the proposed solution will establish communication between vehicles on the road, creating an environment where drivers can be alerted from possible risks caused by other vehicles on the road.

RESEARCH TOPICS

- Hardware Design & Security
- Image Processing on the Edge
- Presenting Data
- Secure Signal transmissions

RESEARCH RESULTS

Prototype 1 based on a Raspberry Pi and SIM808 GPS/GSM module
Prototype 2 based on smartphone with inbuilt GPS and cellular
Non-invasive EEG headsets to read driver concentration levels to detect driver drowsiness.

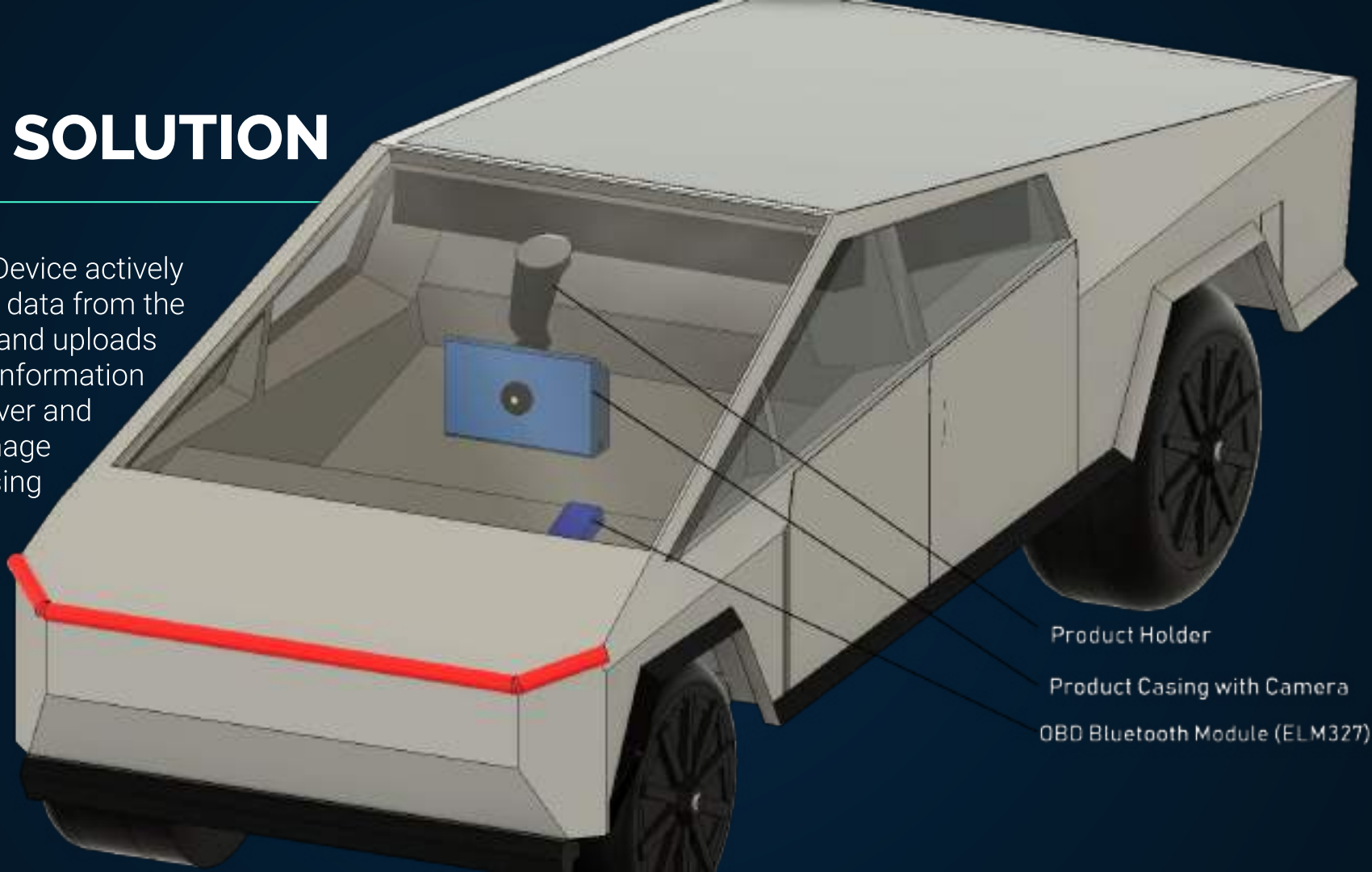
Convoluted Neural Network (CNN) approach for accident detection and Haar Cascade approach for distracted driving detection for image processing on the edge
Data retrieval and transmission requires encryption - using asymmetric encryption

Data can be uploaded to a server using the smartphone or Raspberry Pi
Frontend is developed using CSS, HTML and JS which communicates with the backend server

Secure Encryption of Data transmission through remote attestation and trusted computing principles to mitigate security breaches

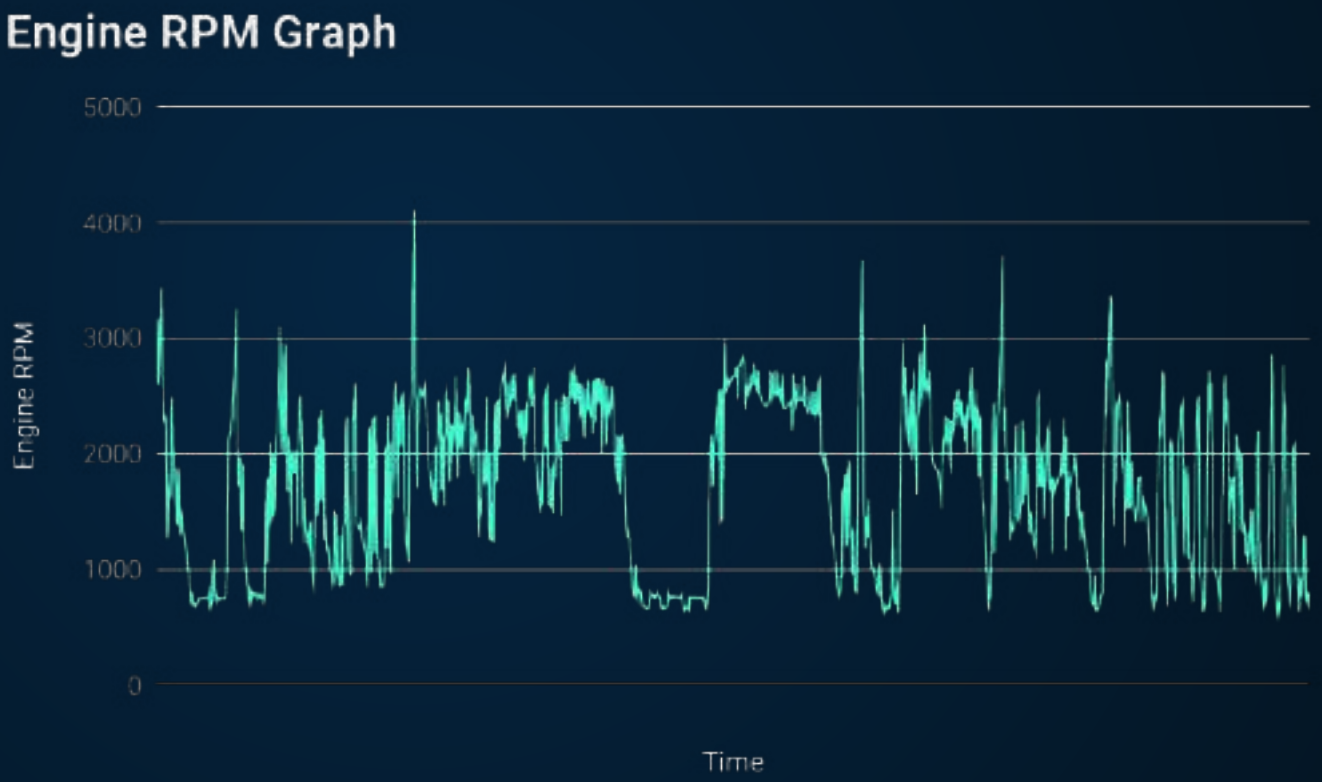
OUR SOLUTION

Part 1: Device actively collects data from the vehicle and uploads crucial information to a server and edge image processing



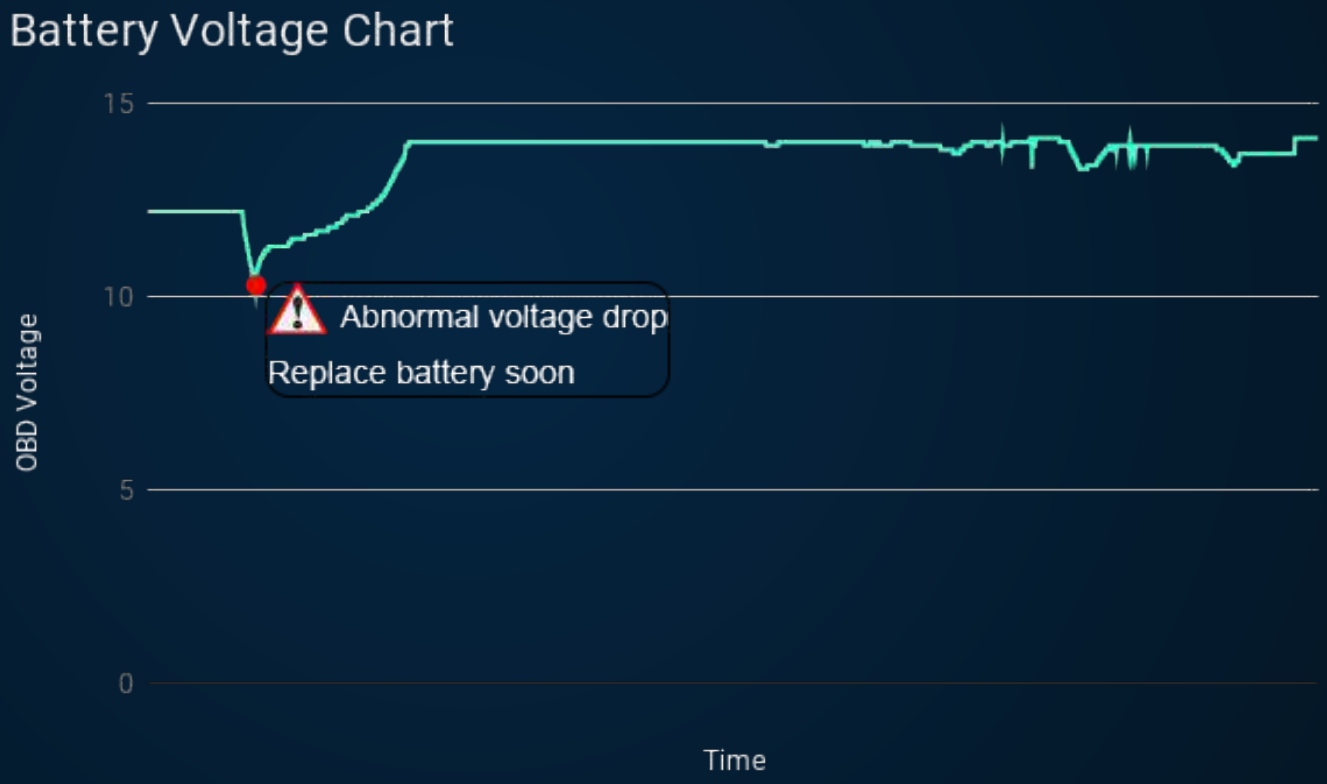
OUR SOLUTION: Data Monitoring

- Analysis of data and live tracking of vehicle parameters
- Data is analysed to predict faults in the vehicle on our server

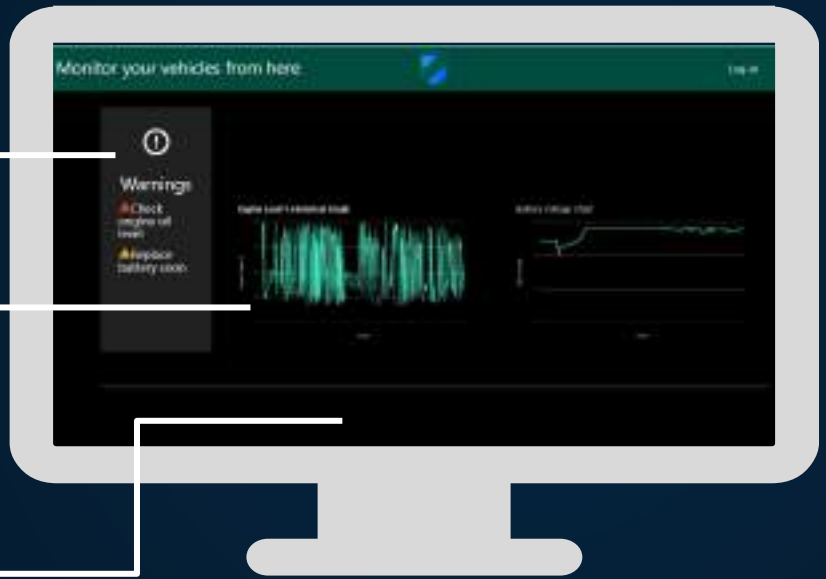


OUR SOLUTION: Fault Prediction

- Monitor possible faults and recommended solution on our online dashboard



OUR SOLUTION: User Interface



MAINTENANCE & WARNINGS

HISTORICAL GRAPHS

LIVE PARAMETERS

RESPONSIVE DESIGN

OUR SOLUTION: Accident Prediction

- Road facing camera captures video stream at 30 FPS on a Raspberry Pi running TF lite
- CNN machine learning model detects cars in the same lane and creates bounding box
- Relative size calculated in % and stored
- Relative size calculated for new frame and compared with previous relative size
- If the increase in size per unit time is greater than a set threshold value the driver is alerted through a audible alarm

OUR SOLUTION: Distracted Driving

Actual \ Predicted	Safe Driving	Text (R)	Phone (R)	Text (L)	Phone (L)	Radio	Drinking	Reaching behind	Hair	Talking to passenger
Safe Driving	**95.34**	0	0.33	0.65	0.11	0.43	0.43	0.87	0.11	1.74
Text (R)	0.31	**96.63**	1.23	0.31	0.92	0	0.31	0	0.31	0
Phone (R)	0.29	3.23	**96.48**	0	0	0	0	0	0	0
Text (L)	2.02	0.61	0	**96.15**	0.81	0	0.20	0	0	0.20
Phone (L)	0	0.33	0	4.90	**94.77**	0	0	0	0	0
Radio	4.26	0	0	0.33	0	**95.08**	0	0	0	0.33
Drinking	0.74	0	0	0.25	0	0.74	**98.01**	0.25	0	0
Reaching behind	3.65	0	0	0	0	0	0	**95.35**	0	1.00
Hair	3.79	0	0	0	0	0	1.38	0.34	**92.76**	1.72
Talking to passenger	1.40	0	0	0	0	0	0.47	0.31	0.16	**97.67**

- Using an online dataset for distracted driving we found on Kaggle, we created a Haar cascade classifier to detect for distracted driving as we felt it suited our needs better than any other image classification technique
- We divided it into 9 different scenarios that we thought covered most bases for distracted driving (mentioned in the table on the side), along with one scenario for safe driving.
- The accuracies for the detection of each scenario is highlighted in bold in the confusion matrix on the left.
- Distracted driving is a problem that plagues our society, claiming over 2,500 lives in 2018 in USA alone. As we embed our model into our system, we hope to try to curb this problem and save the lives of countless around the globe.

OUR SOLUTION: EEG Headset

Driver distraction and drop of attention while on the road can be extremely dangerous and hazardous for a driver and surrounding vehicles. Therefore, we have made an headset that connects to our smart system and uses 3 electrodes placed on the driver's forehead with minimal contact to read 9 of their brain waves. These 9 brain waves are used to calculate the driver's focus level. This focus level is weighed against a threshold and when the value is below a certain minimum value required for safe driving, our system notifies the driver. The notification is in the form of a momentary vibration of the headset. If there is persistent lack of attention, a secondary warning is issued to the driver, followed by a recommendation to halt the car on the side of the road until the driver's ability to concentrate on driving and focus retention increases.

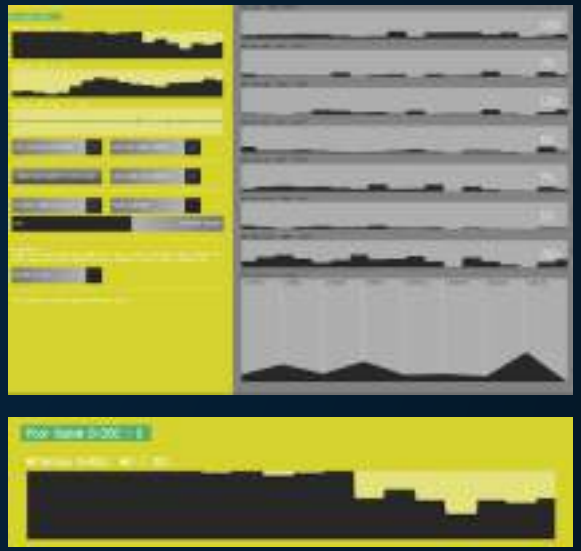


Fig. Screenshot of the application visualizing the user's brainwaves and attention level.

OUR SOLUTION: Network & Security

- The network comprises of several cell towers that rely data between the central database and the vehicle.
- For efficiency, the internal processors are built in with cryptographic accelerators that enable rapid encryption and reduce load on the systems.
- The signals travel to and from the vehicle while data remains securely encrypted to provide seamless transmission of information without any interferences or backdoor access.
- The central database where data inflow and outflow occurs, consist of a blend of static root of trust and dynamic root of trust for measurements of the data codes in order to preserve and enhance the overall system anomaly detection.
- Data analysis and remote attestation of data through verification allows for security development and better communication between vehicles and the sensory devices (cell towers, traffic lights, Radars).

LIFE CYCLE ANALYSIS

Extraction of Raw Material

The PVC housing for the electronics is manufactured through electrolysis of saltwater, combined with fossil fuels. The manufacturing process of PVC does produce hazardous wastes.
Metallic components are made of recycled iron in the form of mild carbon steel

Transportation

Raw materials are transported through locomotives and trucks directly or indirectly use fossil fuels to run and hence cause environmental disturbance through the emission of oxides of carbon and nitrogen and releasing unburnt hydrocarbons, especially in the case of trucks.

Manufacturing

The PVC housing is manufactured through vacuum forming or vacuum casting which does not have any direct hazardous waste and can be used to make volume products at affordable rates.
The manufacturing process does not require working in harsh conditions.

LIFE CYCLE ANALYSIS

Packaging

Electronics will require a coat of anti-static plastic to ensure longevity of the electronics.
The product will be shipped to the user in a 85*90*50 mm cardboard box to ensure the product is not damaged in transit.

Usage

The product is completely waterproof, it uses a PVC housing for the electronics to ensure that water does not enter the electronics enclosure.
The product will not release any harmful substances during normal use.
Power consumption of the device does not exceed 0.5W, making it energy efficient.

Disposal

Disposing of the PVC enclosure and the pipe should be disposed responsibly to type 3 plastic recycling centres who will extract the raw materials by heating the PVC.
Electronic components should be disposed to e-waste collection companies for recycling. The electronic components should last over 20 years and hence should last for the entire life of the product.

Expert and Industry Feedback

"This solution is very innovative and could be positioned to help the elderly and disabled to a great extend initially. The CNN based accident prediction will be an effective method considering that the technology has now matured enough to work with high levels of reliability "

—Gautam Mishra (Founder Tensor Digital)

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