ABSTRACT

In many applications of autonomous driving concepts, it becomes difficult to focus on one domain, understand it and implement it in a better way.

In this field it is quite complicated for college students to gain knowledge and make contribution to the same. Using camera images as a primary input, we will send this images via Raspberry PI and Wireless Transmitter to a machine which combines and processes data using convolutional neural network (CNN) based decision and distance estimation models. On the basis of a detected stationary object, it decides to avoid, stop or run over it.

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Chapter 1: Introduction

1.1 Problem Summary

Using camera images as a primary input, we will send this images via Raspberry PI and Wireless Transmitter to a machine which combines and processes data using convolutional neural network (CNN) based decision and distance estimation models.

It will distinguish the stationary objects on a drivable road surface and estimate their distances from a single camera's view. Classification Algorithms run on real-time images and send it back to Raspberry PI to control the speed and steering of the car. On the basis of a detected object, it decides to avoid, stop or run over it.

1.2 AIM and Objective

The main purpose of this system is to implement one of the modules of Autonomous Car Driving which motivates the people in the locality to pursue more research in the same field. When this achievable system is scaled up and implemented in a car or a drone (with some changes) it will help detect and avoid obstacles.

1.3 Problem Specifications

This bot car will be having "Forward Collision Avoidance System" which in real life is an essential part of autonomous driving cars. As a real life entity, the autonomous car has numerous other functionality of recognition, location, motion, control and many real world test cases. This system will allow the car to detect, classify and avoid stationary objects.

More specifically, it does this by capturing the front footage of the car and take decisions through neural net designed which are trained using specific algorithms and other machine learning techniques.

1.4 Prior Art search

Autonomous car driving is in trend from last 2-3 years due to the recent development of Machine Learning algorithms and computer vision techniques. Many tech giants and Google has already started a project called Waymo. They are training the data since 2009 and getting better and better. Students have tried many other techniques to improve autonomous driving by using sensors. In reality, it's really difficult to achieve 100% perfect system. Trying to implement such a system at this level would help understand the algorithms and efforts behind such amazing projects and would itself motivate students to perform research in the field itself.

Steven Northrup and Christopher Paros have already implemented Visual Navigation of an RC Vehicle using Wireless Video Feedback to a PC [1] but their vehicle was unable to detect objects and test out the algorithms which they have made in a different environment. Another project like Waymo and other project of autonomous driving industry includes the Visualize and Understand Convolutional Networks [2] on larger scale

1.5 Literature Survey

• Getting started with raspberry pi
On the official website of Raspberry Pi we referred the help videos on using raspberry pi with Raspian OS
• Raspberry Pi Robotics Essential by Richard Grimmett

• OpenCV
Official Documentation of OpenCV.
• Mastering Scikit Library.
Official Documentation of Scikit
• OReilly Hands-On Machine Learning with Scikit-Learn and TensorFlow
The author of this book is Aurelien Geron. We used this book as the reference book for referring TensorFlow.

1.6 Plan of the work

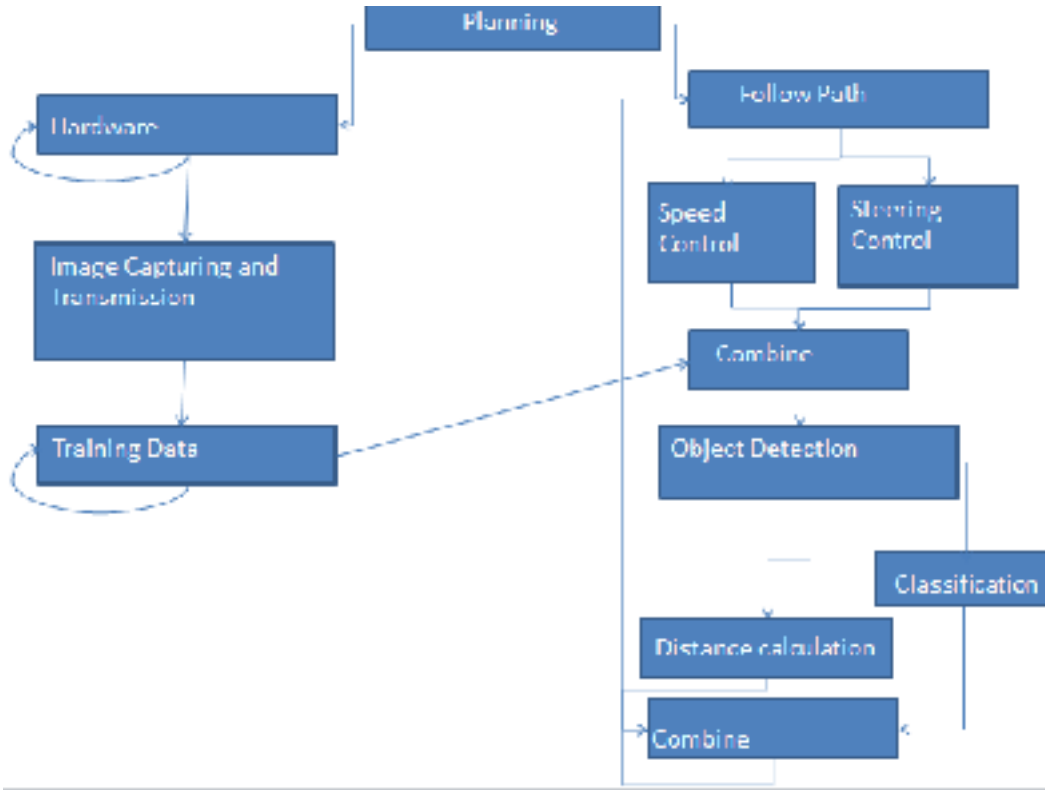

Fig 1 :Work plan

1.7 Materials/Tools required

- Raspberry Pi 3 B
- Camera
- SD card
- Male-Female Cables
- Breadboard
- Batteries
- Power Bank
- LD 293D
- Bot Car
- Router
- USB Receiver 5Mhz

Chapter 2: Analysis, Design Methodology and Implementation Strategy

2.1 Module Description:

Object Detection: It will detect the image ahead through the camera which will be mounted on the system and later transmit that image to the system for further use.

Object Classification: After getting the image through the Detection module the system will work on that image and then it will classify the image.

Distance Estimation: Main objective of this module is to estimate the distance ahead, the distance from the vehicle and the bot car is being calculated and later it is being used for object collision avoidance.

Steering Control: When the car detects and classify the object, the control of the car is forwarded to the steering. This module is a subpart of the car as a whole.

Speed Control: As the Steering Control, Speed Control is also the subpart of the car as a whole the Speed control will judge the speed the according to the object ahead.

CNN: Convolutional networks were inspired by the connectivity pattern between neurons in the animal visual cortex. Individual cortical neurons respond to stimuli only in a restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they cover the entire visual field. To give such a vision to a machine, we use CNN.

In machine learning, a convolutional neural network (CNN, or ConvNet) is a class of deep, feed-forward artificial neural network that has successfully been applied to analyzing visual imagery.

2.2 Use Case Diagram:

1) User will start and stop the system manually.
2) System will mainly include the system bot car, Raspberry Pi, Camera, and core program.

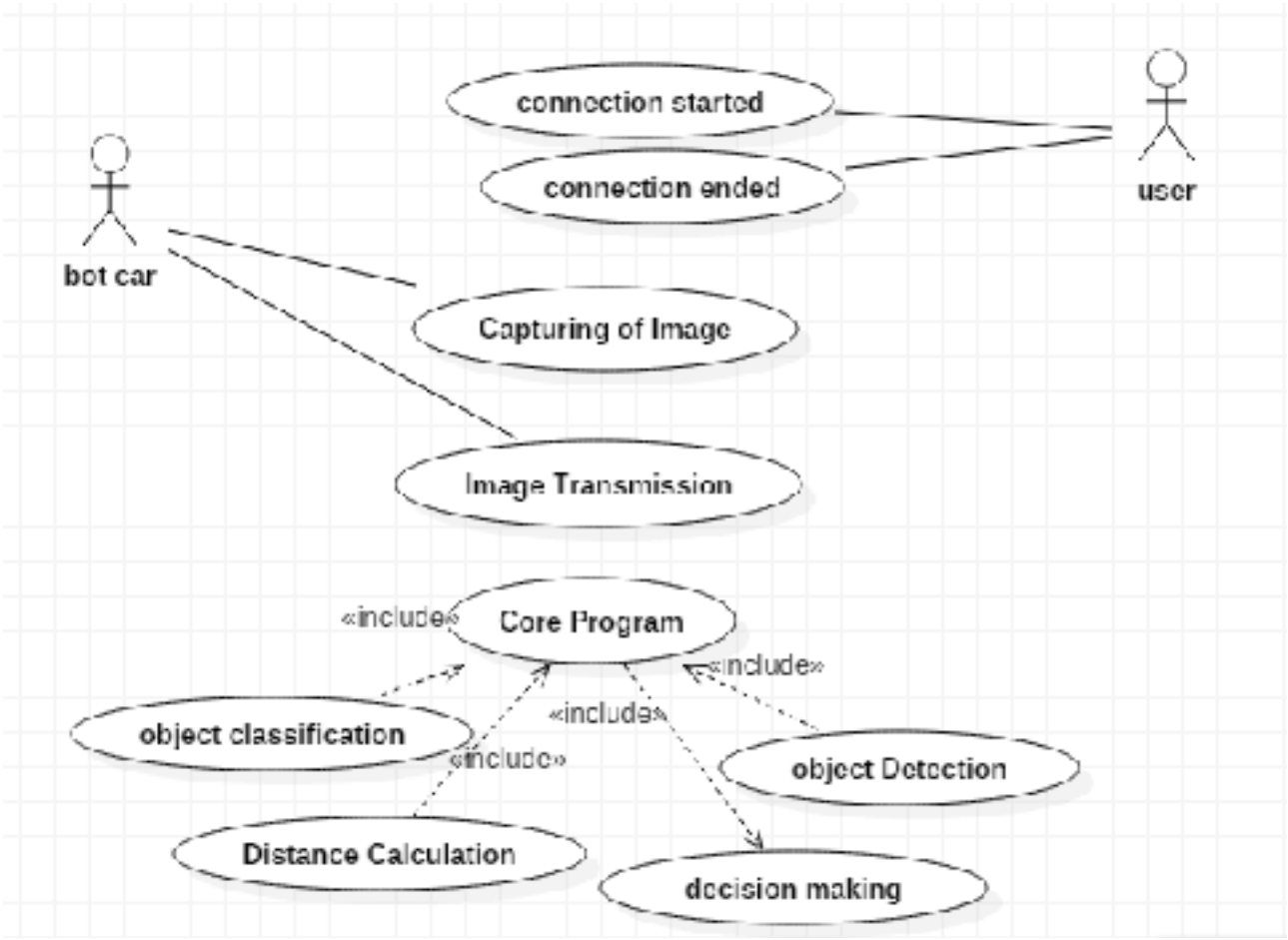

Fig 2: **Use Case Diagram**

2.3. Activity Diagram:

The activities here mentioned will trigger after the object has been scanned through the camera attached on the car.

- Object Detection.
- Object Classification.
- Calculating Distance.

After these Activities the core-program will itself generate a command for the bot-car and that will work as an output.

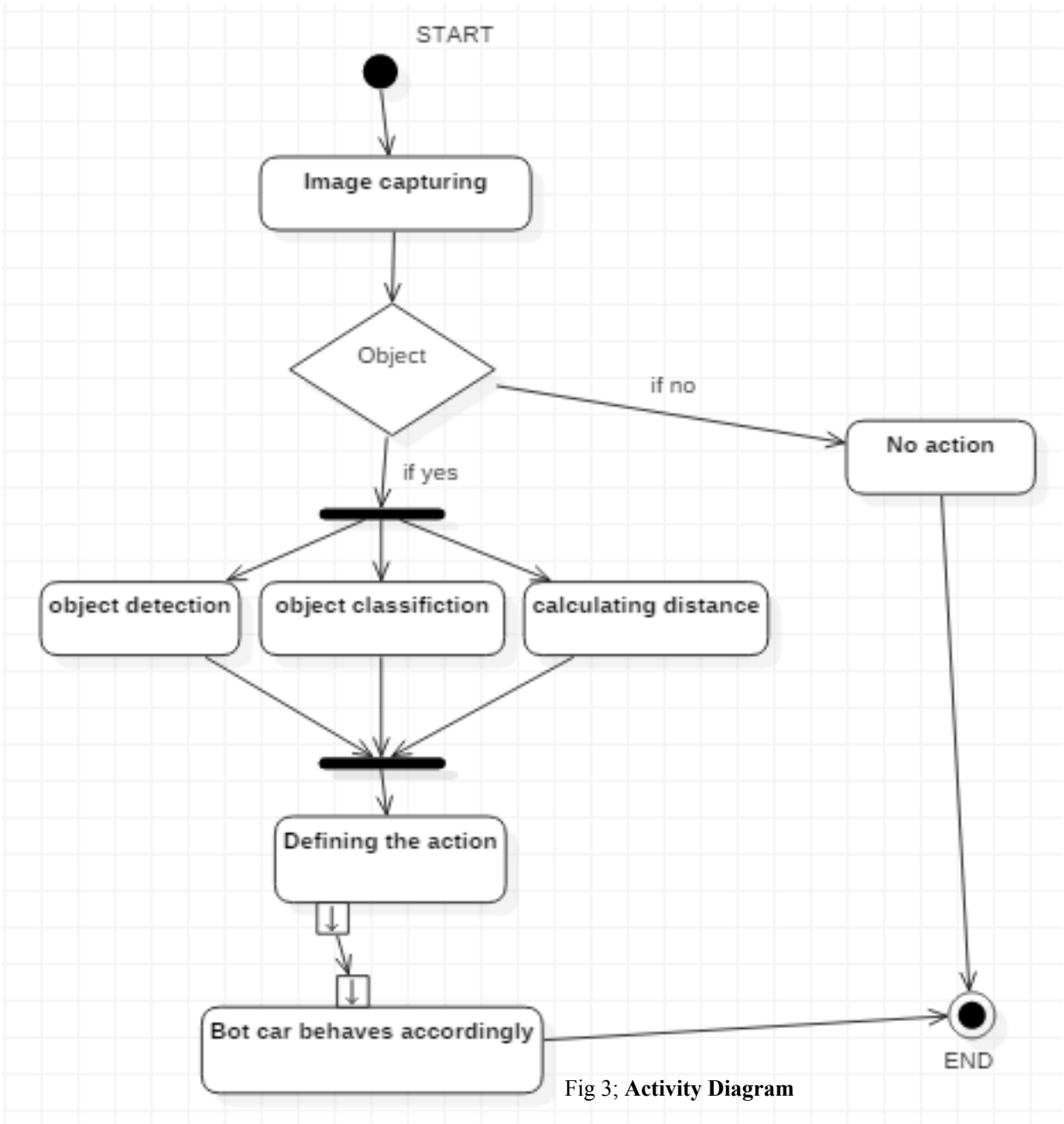

Fig 3; **Activity Diagram**

2.3. Sequence Diagram:

Here, Sequence of the system is illustrated by the use of a diagram, this diagram provides information about all the interactions between the entities of the system. How do they work together on a running state.

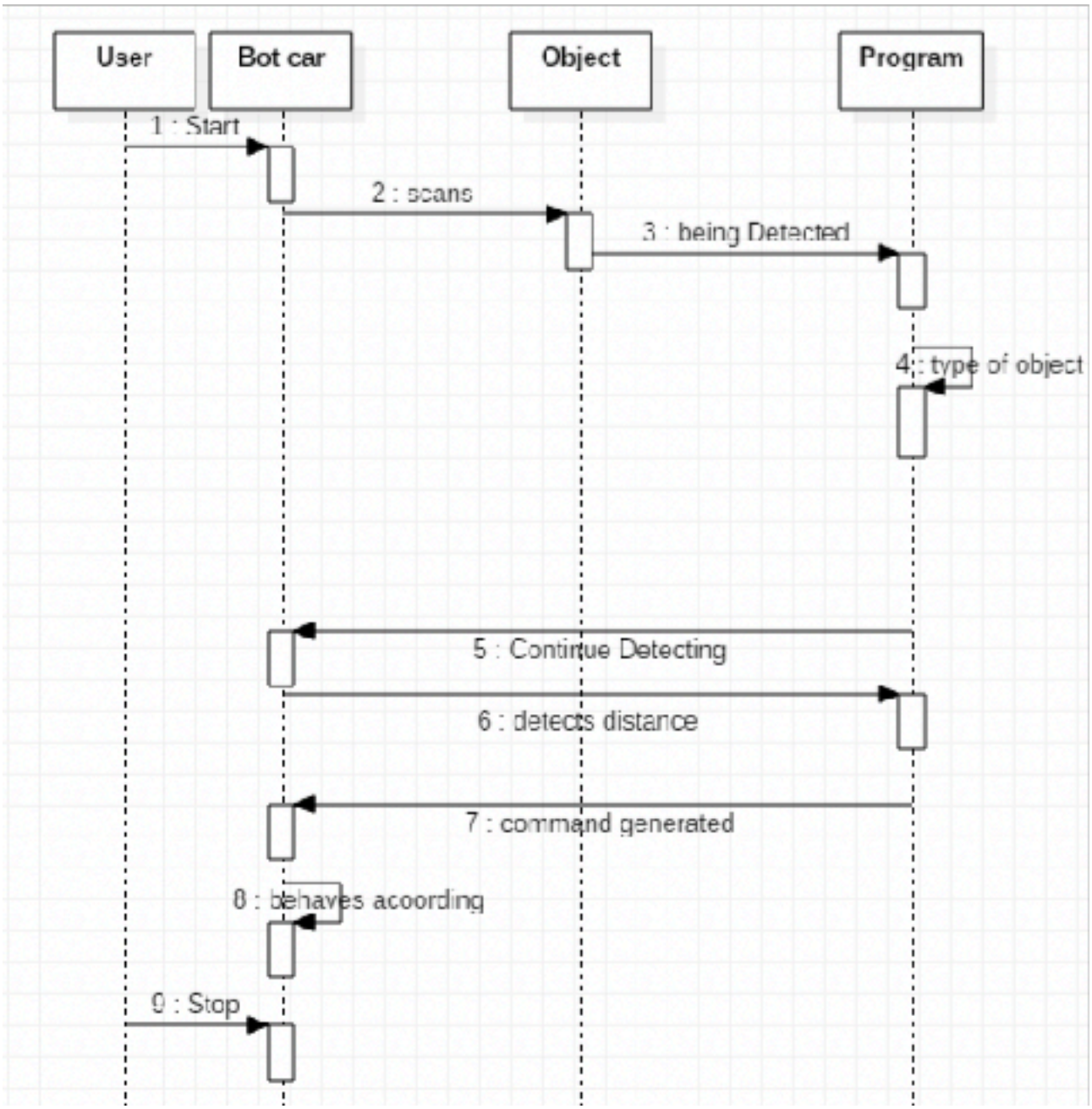

Fig 4; **Sequence Diagram**

2.4. State Diagram:

State Diagram gives overview of a state in the system.
Here, In our state diagram we are covering the state of how do the program gives the output to the bot car.
How does it gets the proper command to generate an output for the car.

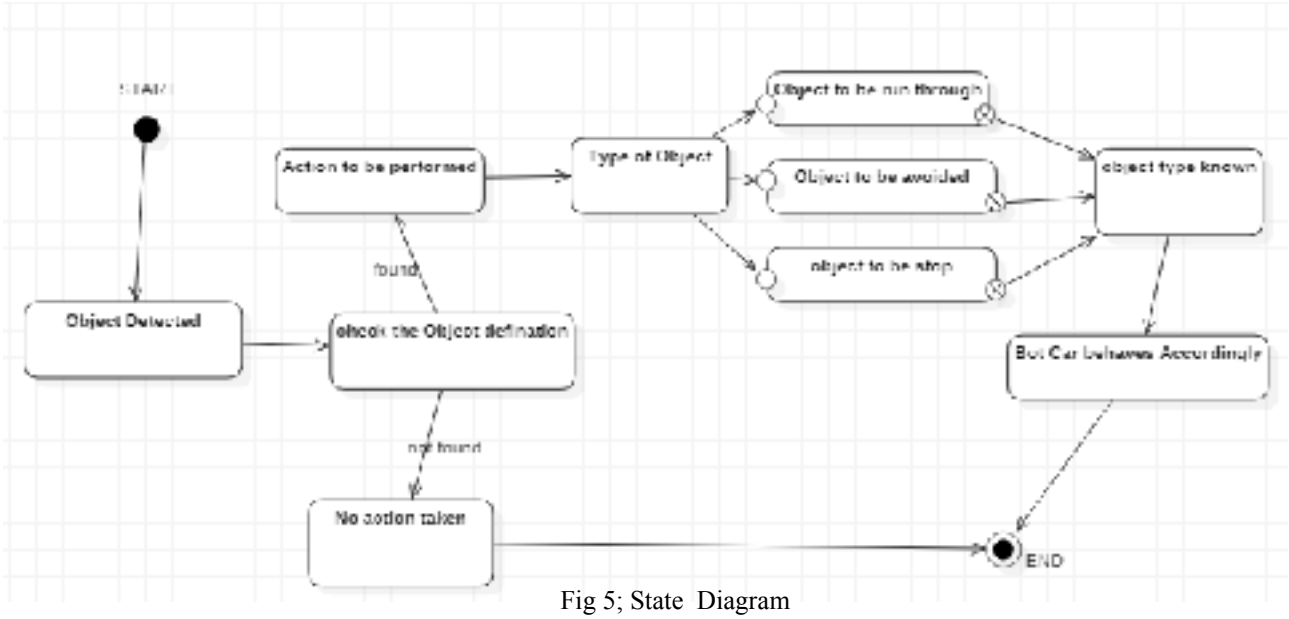

Fig 5; State Diagram

2.5 AEIOU Canvas:

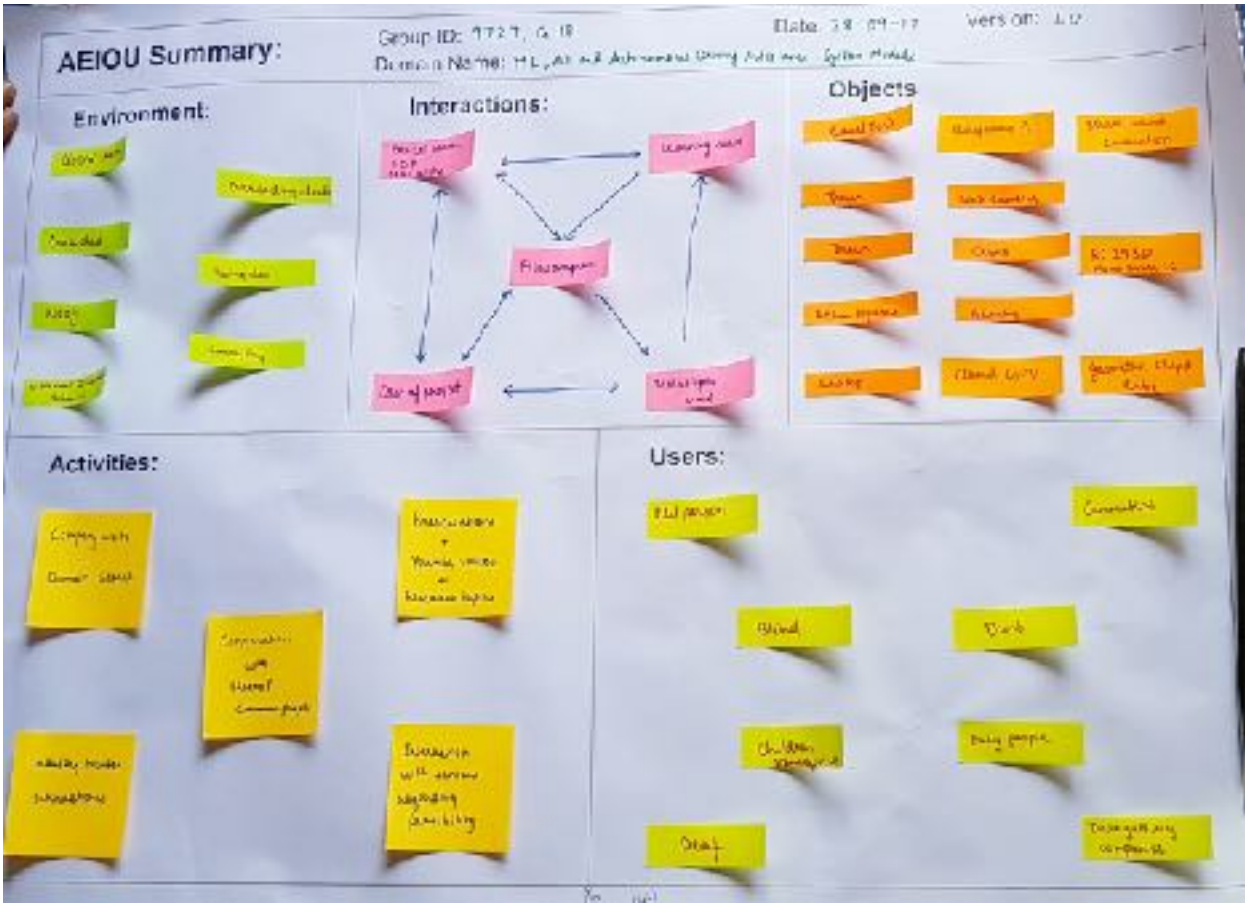

Fig 6: AEIOU Canvas

2.6 Ideation Canvas:

An ideation canvas is a rough whiteboard/sheet where ideas can be stretched into any limits or dimensions. Its aim is to define the best possible problem and stretch out its possible scope. The field is set and the overall agenda is to build the clones of the ideas and pivot them throughout the canvas so as to discover new possibilities.

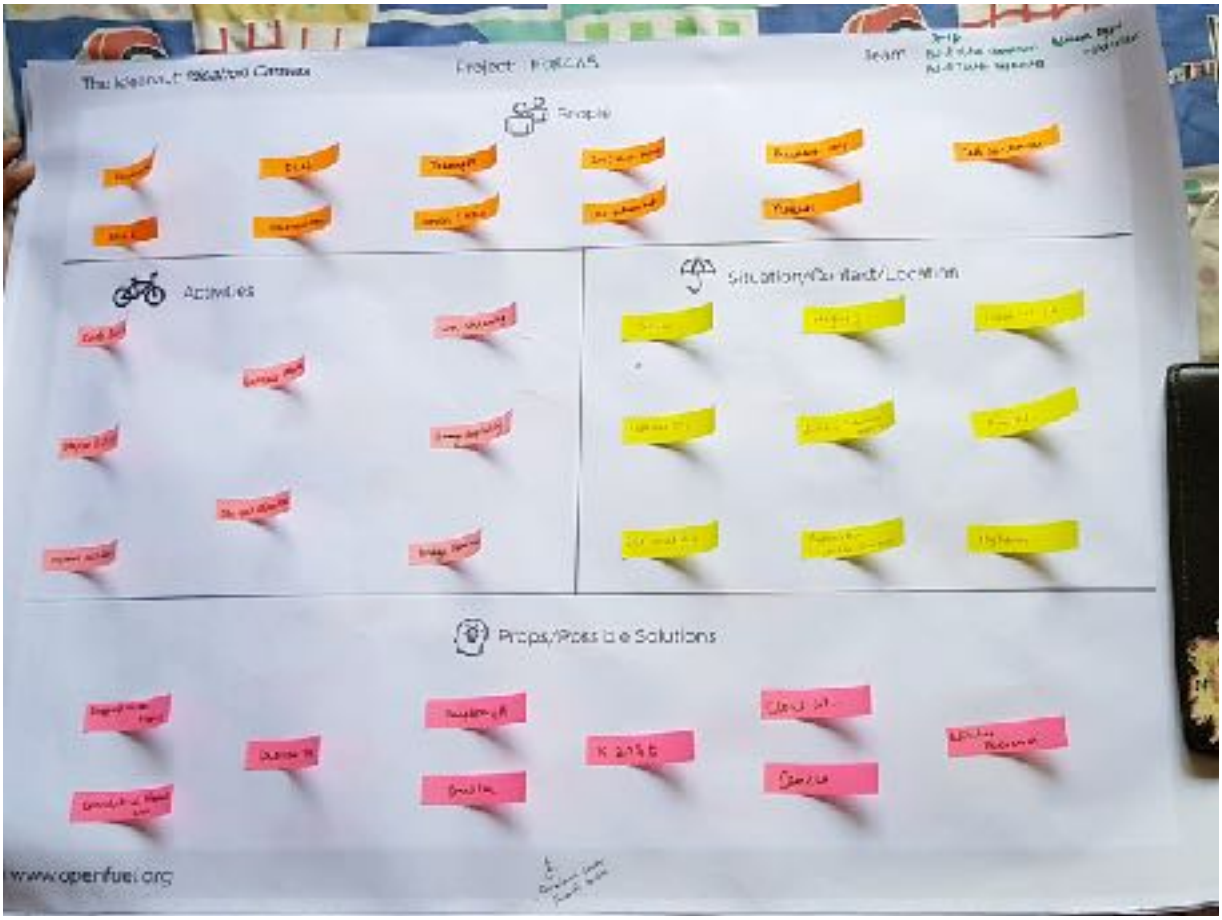

Fig 7: Ideation Canvas

2.7 Product Development Canvas:

This exercise is meant for giving strategic orientation to the project of each team so that it achieves its true goal as defined by the previous canvas exercises. This exercise is more about developing strategy for the proposed product/solution design.

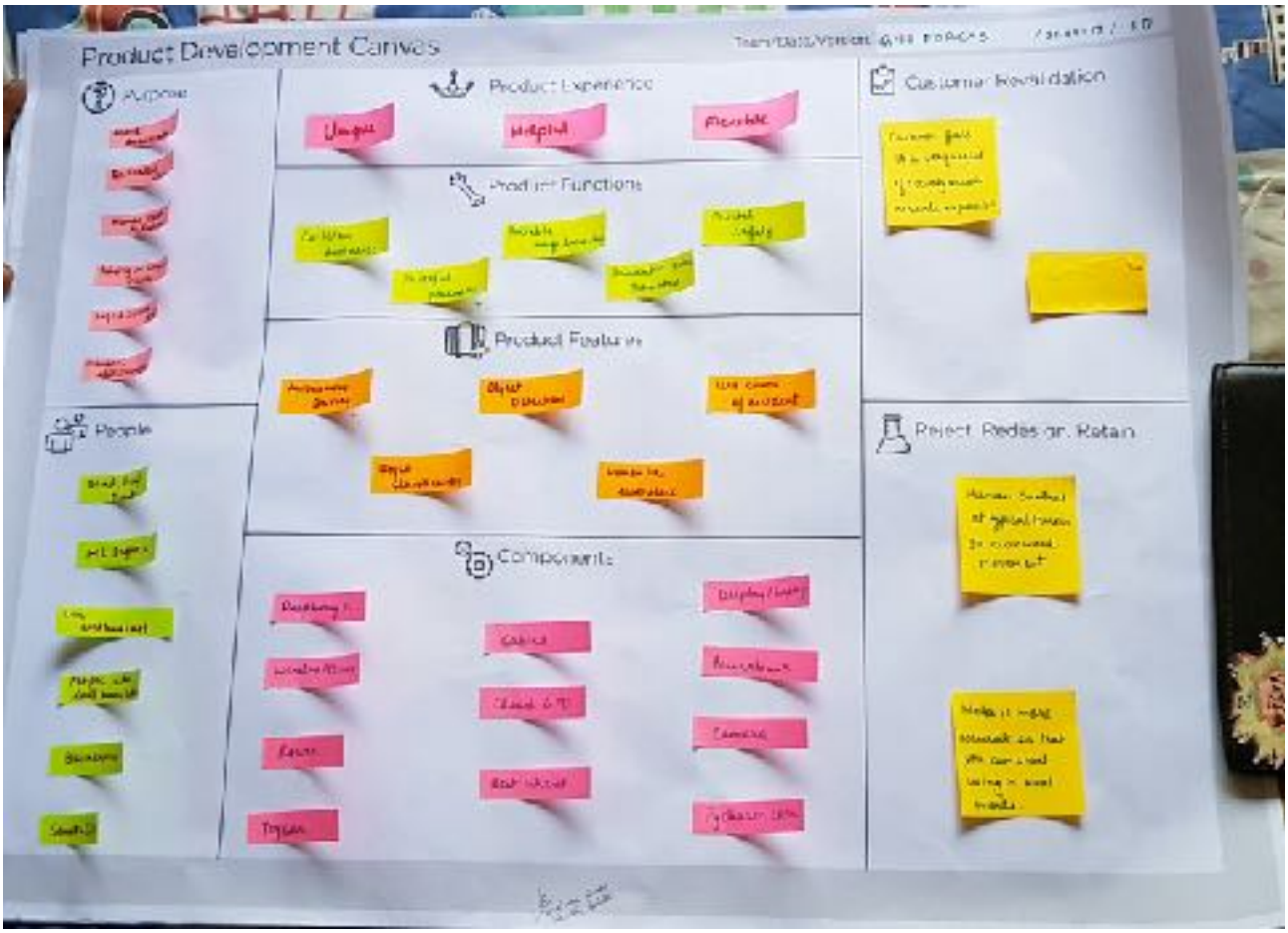

Fig 8: Product Development Canvas

2.8 Empathy Canvas:

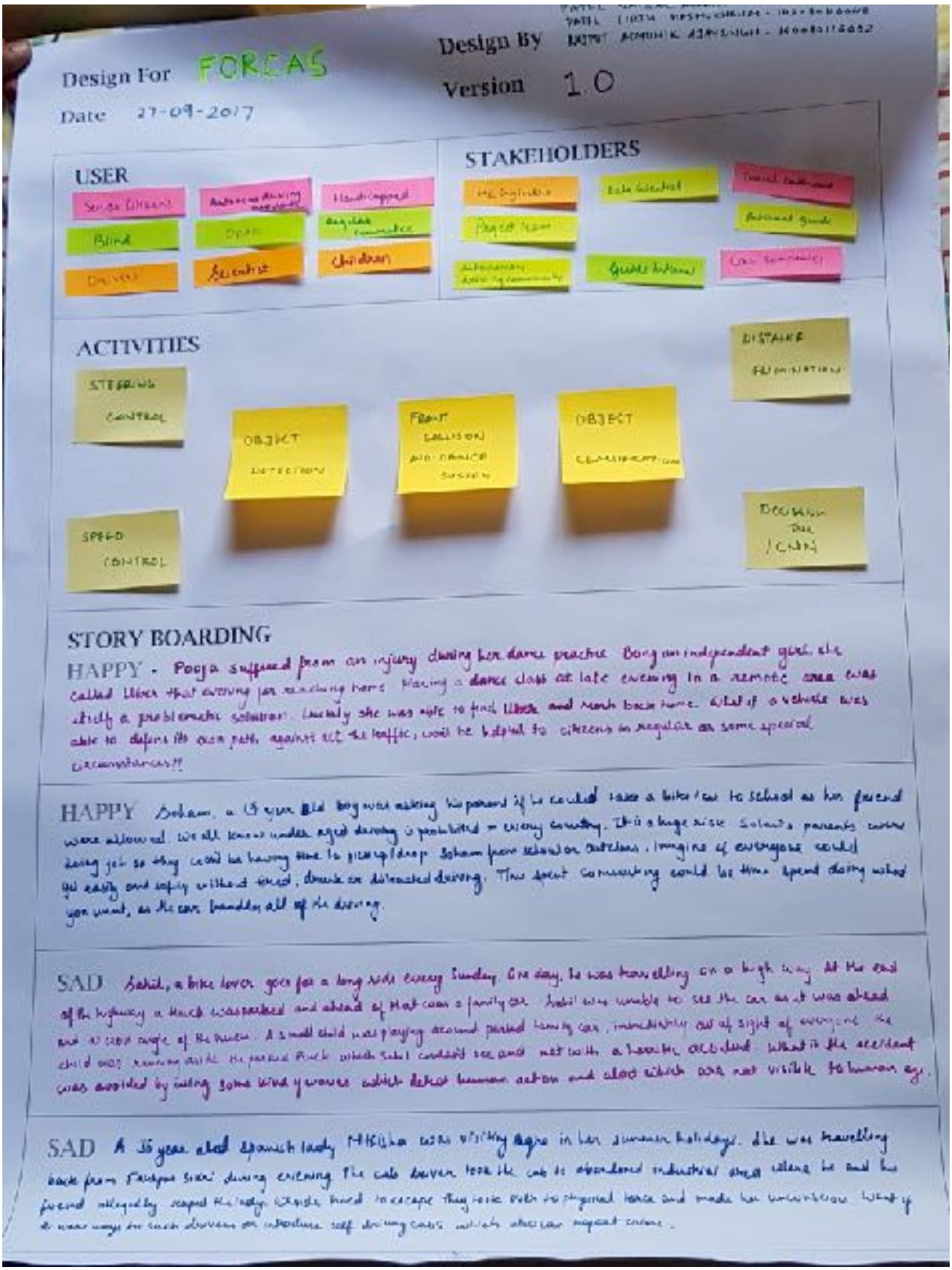

Fig 9: Empathy Canvas

Chapter 3: Implementation

3.1 FORCAS Methodology:

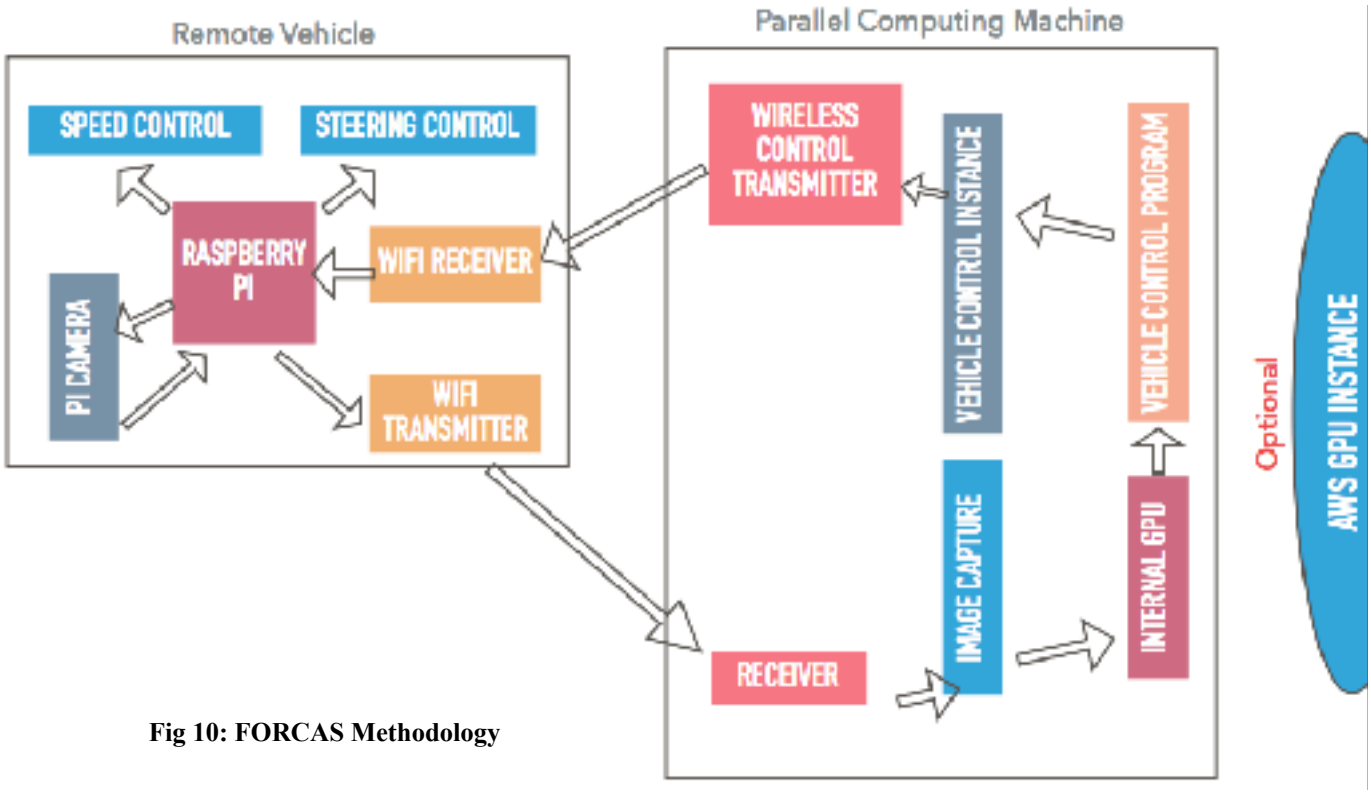

Fig 10: FORCAS Methodology

3.2 Assembled Hardware

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside of its target market for uses such as robotics. Peripherals (including keyboards, mice and cases) are not included with the Raspberry Pi.

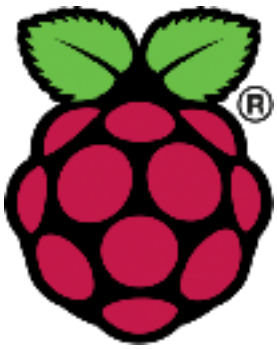

Fig 11: Raspberry PI

The general purpose input & output pins are used in the raspberry pi to associate with the other electronic boards. These pins can accept input & output commands based on programming raspberry pi. The raspberry pi affords digital GPIO pins. These pins are used to connect other electronic components. For example, you can connect it to the temperature sensor to transmit digital data.

Motor Driver IC 293D:

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

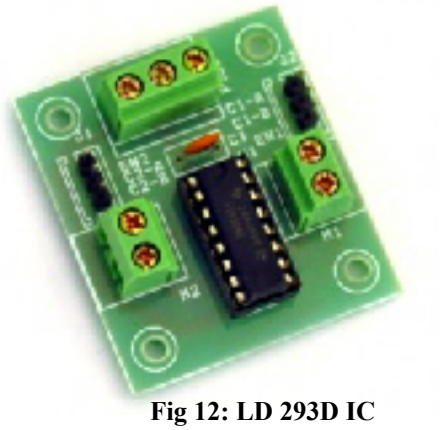

Fig 12: LD 293D IC

Fig 13: OpenCV

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products.

The library has more than 2500 optimized algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database etc. We have installed this library on Raspberry Pi for image capturing

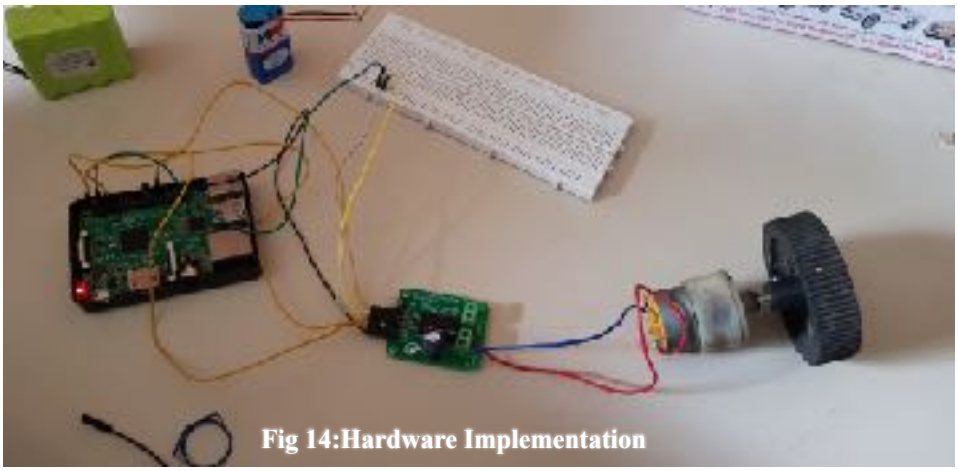

Fig 14:Hardware Implementation

- **Pin 2** = **Logic 1** and **Pin 7** = **Logic 0** | Clockwise Direction
- **Pin 2** = **Logic 0** and **Pin 7** = **Logic 1** | Anticlockwise Direction
- **Pin 2** = **Logic 0** and **Pin 7** = **Logic 0** | Idle [No rotation] [Hi-Impedance state]
- **Pin 2** = **Logic 1** and **Pin 7** = **Logic 1** | Idle [No rotation]

Bot Car on which camera gets mounted

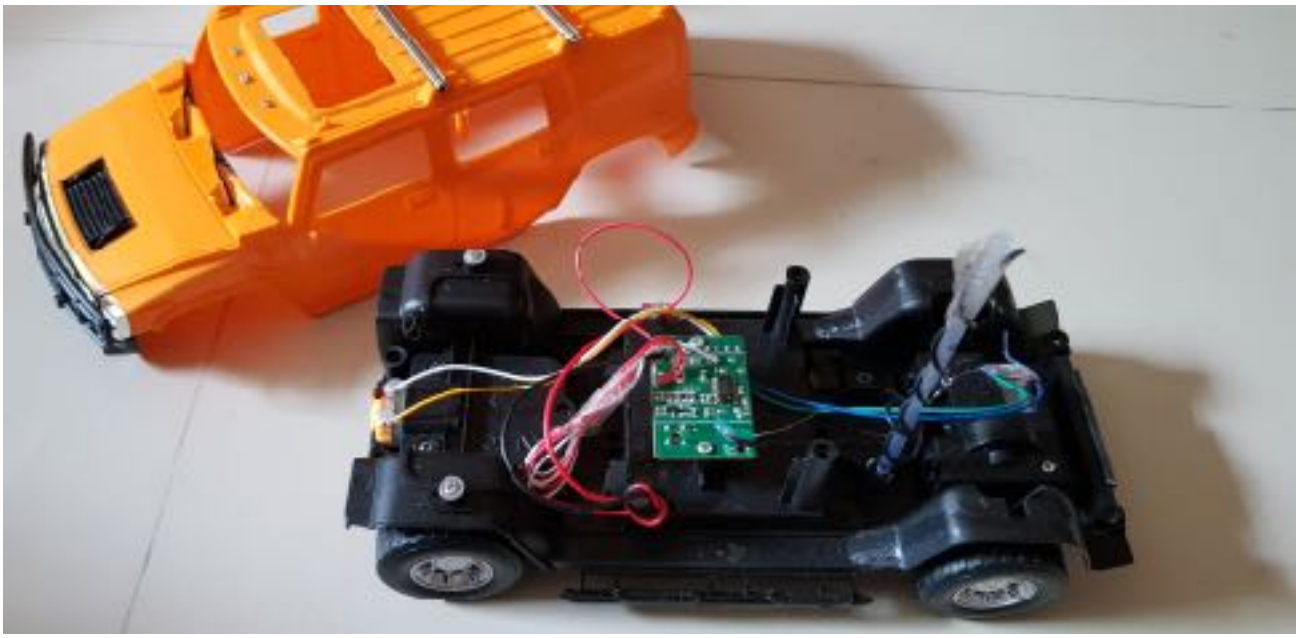

Fig 15:Bot Car

3.3 Software Interface:

Fig 16:Histogram of Oriented Gradients

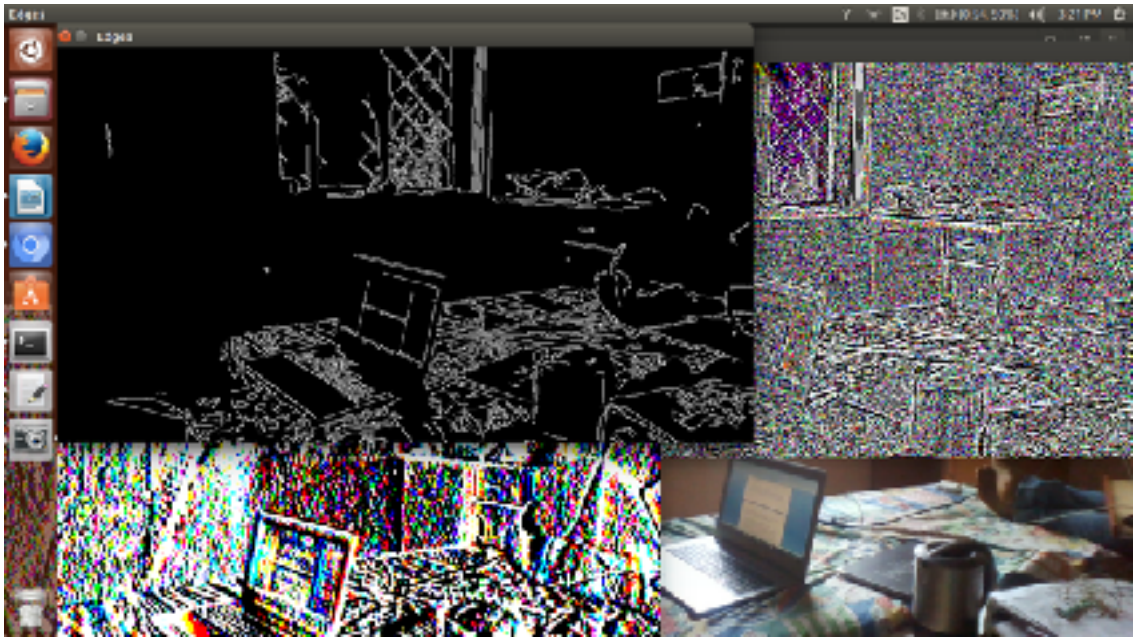

Fig 17:Canny Edge Detection, Sobelx, Solbely & Laplacian Transformation

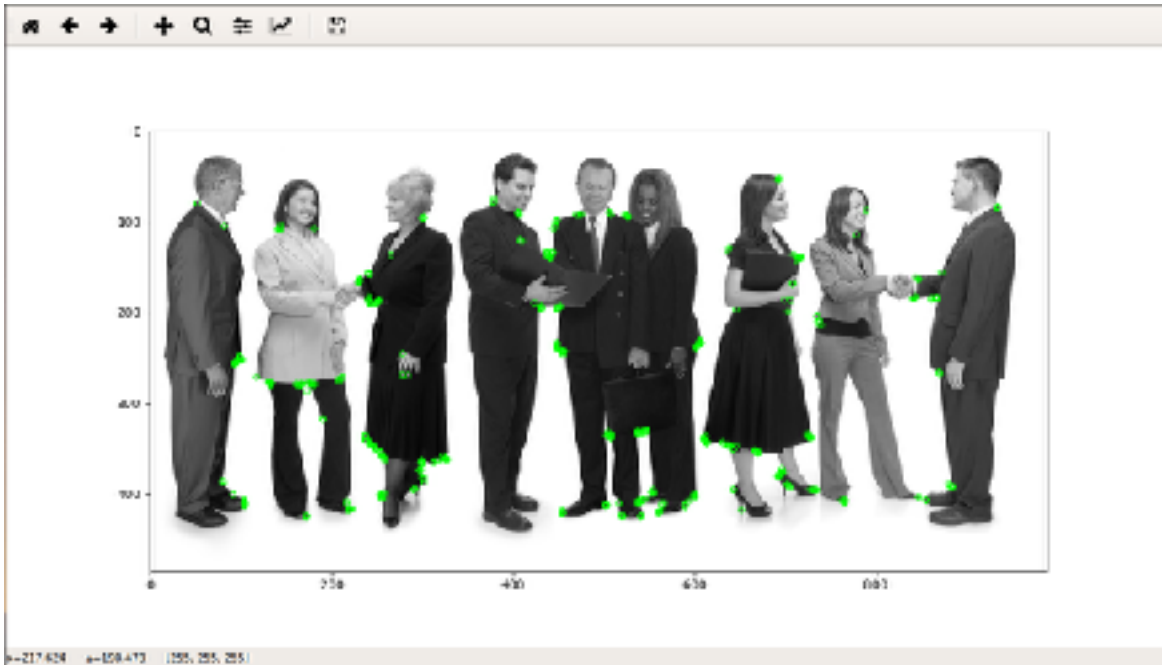

Fig18: FAST (Features from Accelerated Segment Test)

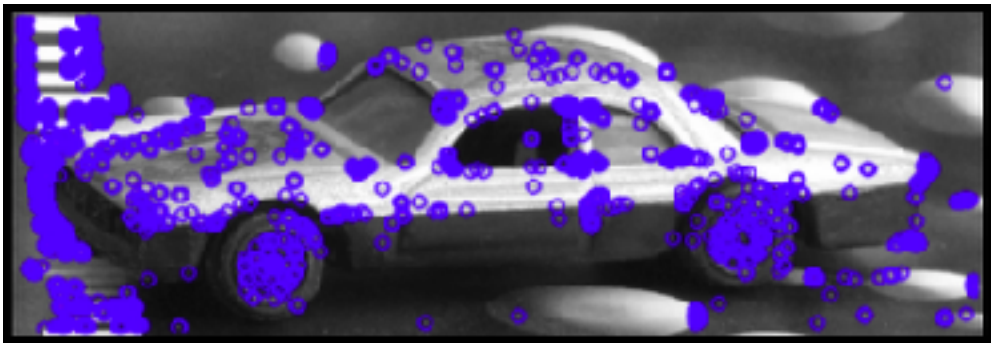

Fig19:ORB (Oriented FAST and Rotated BRIEF)

3.4 Tech Stack

Tensorflow: TensorFlow is an open source software library for numerical computation using data flow graphs. The flexible architecture allows to deploy computation to one or more CPUs or GPUs in a desktop, server, or mobile device with a single API. It is a system for building and training neural networks to detect and decipher patterns and correlations, analogous to (but not the same as) human learning and reasoning.

Fig 20: Tech Stack

Scikit-learn is a free software machine learning library for the Python programming language. It features various classification, regression and clustering algorithms including support vector machines, random forests, gradient boosting, k-means and DBSCAN, and is designed to interoperate with the Python numerical and scientific libraries NumPy and SciPy.

Chapter 4: Summary

This bot car will be having "Forward Collision Avoidance System" which in real life is an essential part of autonomous driving cars. This system will allow the car to detect, classify and avoid stationary objects. More specifically, it does this by capturing the front footages of car and take decisions through neural net designed which are trained using specific algorithms and other machine learning techniques.

4.1 Advantages:

- Fuel efficiency
- Traffic efficiency
- Mobility for disabled individuals
- Reduce in the number of road accidents.

4.2 Future Scope:

- We can add motion object detection.
- Bringing on larger scale will help society in transportation
- Can be applicable in 3-D scale i.e Drones with modifications

REFERENCES:

[1]:Capstone Experience - Visual Navigation of an RC Vehicle using Wireless Video Feedback to a PC (Steven Northrup and Christopher Paros)

[2]:Visualizing and Understanding Convolutional Networks Matthew D. Zeiler, Rob Fergus

- CS231 Standford University: Convolutional Neural Net for Visual Recognition
http://cs231n.github.io
- Daily Machine Learning - https://github.com/ buzz2vatsal/machine-learning-for-software-engineers
- OpenCV Documentation
http://docs.opencv.org
- Stack Overflow Community
www.stackoverflow.com

APPENDIX:

For System Feasibility and Research Purposes, we have done various activities, some of them are mentioned below.

Patent Search and Analysis Report (PSAR 1)

GUJARAT TECHNOLOGICAL UNIVERSITY
(GTU)
INNOVATION COUNCIL (GIC)
Patent Search & Analysis Report
(PSAR)

Date of Submission : 31/05/2017

Dear Patel Vatsal Anant,

Studied Patent Number for generation of PSAR : 12887_14080118043_1

PART 1: PATENT SEARCH DATABASE USED

1. Patent Search Database used	:	PatentScope (WIPO Patent Database)
Web link of database	:	http://patentscope.wipo.int/search/en/search.jsf
2. Keywords Used for Search	:	Machine Learning,Collision Avoidance,Car
3. Search String Used	:	Forward Collision Avoidance
4. Number of Results/Hits getting	:	20

PART 2: BASIC DATA OF PATENTED INVENTION /BIBLIOGRAPHIC DATA

5. Category/ Field of Invention	:	
6. Invention is Related to/Class of Invention	:	Computer Vision
6 (a) : IPC class of the studied patent	:	B60R 21/01 20 G08G 1/16
7. Title of Invention	:	COLLISION DETECTING DEVICE, AVOIDANCE SUPPORT DEVICE AND ALARM SYSTEM
8. Patent No.	:	JP2017126050
9. Application Number	:	2017126050
9 (a) : Web link of the studied patent	:	https://patentscope.wipo.int/
10. Date of Filing/Application (DD/MM/YYYY)	:	30/06/2017
11. Priority Date (DD/MM/YYYY)	:	03/01/2016
12. Publication/Journal Number	:	
13. Publication Date (DD/MM/YYYY)	:	19/07/2017
14. First Filled Country : Albania	:	108

15. Also Published as

Sr.No	Country Where Filed	Application No./Patent No.
1		

16. Inventor/s Details.

Sr.No	Name of Inventor	Address/City/Country of Inventor
1	YAMADA MATSUHITO	Kariya

17. Applicant/Assignee Details.

Sr.No	Name of Applicant/Assignee	Address/City/Country of Applicant
1	DENSO CORP	Kariya

18. Applicant for Patent is : Company

PART 3: TECHNICAL PART OF PATENTED INVENTION

19. Limitation of Prior Technology / Art

As the collision detection device (warning device), intended to set the alarm area according to the relative speed between the external object, performed when the external object enters the alert as there is a risk of collision with the external object in the alarm area

20. Specific Problem Solved / Objective of Invention

In the collision detection device, such as when the vehicle moves forward, it is determined whether a collision with an external object can be assumption that the vehicle is travelling in the same direction. Thus the system is designed to correlate with other external non-moving objects and consider them also as factors of risk of collision

21. Brief about Invention

In the collision detecting device of the first construction was made in order to achieve the above object, the traveling direction acquisition unit, vehicle is either trying to have or stopped down, or trying to move forward from or advancing, or acquires the traveling direction information, including whether the information trying to retreat from or retracted, the target region setting means collides with an external object when the external object is present when predicting the behavior of the host vehicle in the near future a possibility the target area is an area in which there is set according to the traveling direction information. The collision output means outputs the effect that if the presence or collision an external object vehicle there is a risk of collision with external objects in the target area.

22. Key learning Points

1. View of Camera
2. Things to keep in mind while changing state of motion of car
3. Learning various alarm areas in order to protect vehicle from collision

23. Summary of Invention

In a collision detecting device, an operation part (CPU) obtains travel direction information including information on whether an own vehicle is stopping, moving forward or moving backward, and sets an object area where there is a possibility of collision against an external object if the external object exists when predicting a behavior of the own vehicle in near future, according to the travel direction information. Therefore, the operation part outputs that the own vehicle has the possibility of collision against the external object, if the external object exists within or approaches the object area. With such an operation part, an appropriate range can be set as the object area according to a direction of travel

24. Number of Claims : 12

25. Patent Status : Published Application

26. How much this invention is related with your IDP/UDP?

< 70 %

PSAR-2

GUJARAT TECHNOLOGICAL UNIVERSITY
(GTU)
INNOVATION COUNCIL (GIC)
Patent Search & Analysis Report
(PSAR)

Date of Submission : 31/08/2017

Dear Patel Vatsal Anant,

Studied Patent Number for generation of PSAR	:	17BE7_140080116043_2

PART 1: PATENT SEARCH DATABASE USED

1. Patent Search Database used	:	Google Patents
Web link of database	:	https://patents.google.com/
2. Keywords Used for Search	:	Neural Net,Object Detection,Training
3. Search String Used	:	Google Object Detection Algorithm using Neural Netork
4. Number of Results/Hits getting	:	4

PART 2: BASIC DATA OF PATENTED INVENTION /BIBLIOGRAPHIC DATA

5. Category/ Field of Invention	:	
6. Invention is Related to/Class of Invention	:	Image Processing
6 (a) : IPC class of the studied patent	:	G06K 9/00, G06K 9/32, G06K 9/66
7. Title of Invention	:	Training a neural network to detect objects in images
8. Patent No.	:	US9373057B1
9. Application Number	:	US14/530015
9 (a) : Web link of the studied patent	:	https://patentimages.storage.googleapis.com/b5/b2/cb/a63/2e417e2a80/US9373057.pdf
10. Date of Filing/Application (DD/MM/YYYY)	:	10/03/2014
11. Priority Date (DD/MM/YYYY)	:	01/11/2013
12. Publication/Journal Number	:	USPTO Assignment, Espacenet, Global Dossier,Discuss
13. Publication Date (DD/MM/YYYY)	:	21/06/2016
14. First Filled Country : Albania	:	284

Page 1

15. Also Published as

Sr.No	Country Where filled	Application No./Patent No.
1	United States	US9111338B1

16. Inventor/s Details.

Sr.No	Name of Inventor	Address/City/Country of Inventor
1	Jasmine Urban	Venice(CA)
2	Christian Szegedy	US
3	Dragomir Anguelov	Sunnyvale(CA)

17. Applicant/Assignee Details.

Sr.No	Name of Applicant/assignee	Address/City/Country of Applicant
1	Google Inc.	Mountain View (CA)

18. Applicant for Patent is : Company

PART 3: TECHNICAL PART OF PATENTED INVENTION

19. Limitation of Prior Technology / Art

Spatial pyramid matching(SPM) based coding has been the common choice for state-of-art image classification systems. But it can't use the location information to pool foreground and background features accurately to form the image-level representation.

20. Specific Problem Solved / Objective of Invention

Update of previous parameters based on penalty and rewards which serve as accurate image recognition using this neural network. Classification can be made according to required features. Complex Network can be split and used in other networks.

21. Brief about Invention

Methods, systems, and apparatus, including computer programs encoded on computer storage media, for training a neural network to detect objects in images. One of the methods includes receiving a training image and object location data for the training image; providing the training image to a neural network and obtaining bounding box data for the training image from the neural network, wherein the bounding box data comprises data defining a plurality of candidate bounding boxes in the training image and a respective confidence score for each candidate bounding box in the training image; determining an optimal set of assignments using the object location data for the training image and the bounding box data for the training image, wherein the optimal set of assignments assigns a respective candidate bounding box to each of the object locations; and training the neural network on the training image using the optimal set of assignments.

22. Key learning Points

1.Deep neural networks are machine learning systems that employ multiple layers of models, where the outputs of lower level layers are used to construct the outputs of higher level layers.

2. Method and apparatus for neural network based image signal processor

3. How Neuro Net can be modified to locate different objects like drone instead car

23. Summary of Invention

A system for training a neural network that receives an input image and outputs a predetermined number of candidate bounding boxes that each cover a respective portion of the input image at a respective position in the input image and a respective confidence score for each candidate bounding box that represents a likelihood that the candidate bounding box contains an image of an object.

24. Number of Claims : 20

25. Patent Status : Published/Application

26. How much this invention is related with your IDP/UDP?

PSAR-3

GUJARAT TECHNOLOGICAL UNIVERSITY
(GTU)
INNOVATION COUNCIL (GIC)
Patent Search & Analysis Report
(PSAR)

Date of Submission : 15/09/2017

Dear Patel Vatsal Ahant,

Studied Patent Number for generation of PSAR : 17BE7_1409901160 43_3

PART 1: PATENT SEARCH DATABASE USED

1. Patent Search Database used	:	Espacenet (EPO Patent database)
Web link of database	:	https://worldwide.espacenet.com/advancedSearch
2. Keywords Used for Search	:	Machine Learning,Driving,Controlling
3. Search String Used	:	Machine Learning in Driving
4. Number of Results/Hits getting	:	13

PART 2: BASIC DATA OF PATENTED INVENTION /BIBLIOGRAPHIC DATA

5. Category/ Field of Invention	:	
6. Invention is Related to/Class of Invention	:	Autonomous Car Driving
6 (a) : IPC class of the studied patent	:	B60W 20/00
7. Title of Invention	:	Vehicle control through machine learning
8. Patent No.	:	EP2998178
9. Application Number	:	JP2014186066
9 (a) : Web link of the studied patent	:	https://worldwide.espacenet.com/publicationDetails/originalDocument?CC=EP&NR=2998178A1&KC=A1&ND=4
10. Date of Filing/Application (DD/MM/YYYY)	:	11/09/2014
11. Priority Date (DD/MM/YYYY)	:	
12. Publication/Journal Number	:	Bulletin 2016/12
13. Publication Date (DD/MM/YYYY)	:	03/23/2016
14. First Filled Country : Albania	:	

15. Also Published as

Sr.No	Country Where Filed	Application No./Patent No.
1	United States	US20150274161
2	China	CN105438168

16. Inventor/s Details.

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17. Applicant/Assignee Details.

Sr.No	Name of Applicant/Assignee	Address/City/Country of Applicant
1	VOLVO CAR CORP	NA

18. Applicant for Patent is : Company

PART 3: TECHNICAL PART OF PATENTED INVENTION

19. Limitation of Prior Technology / Art

Manually driving vehicles lead to accidents. Vehicle ant Object detection was initially rules an sensor which can not be deployed in real life

20. Specific Problem Solved / Objective of Invention

Driverless Car has problem of following rules but now the car learns itself like a small child and doesn't have decision based tree. It works on real life training

21. Brief about Invention

Determining an updated set of control values for the actually driven route, and storing said updated set of control values.

22. Key learning Points

Car gets to learn the real life based driving techniques without following rules

23. Summary of Invention

Method for managing rules or policies in a vehicle, the vehicle comprising at least one controllable unit. The method comprises the steps of: determining , at the start of a driving, an active route of the vehicle, selecting a set of control values from a plurality of stored sets of control values, where one control value of said set of control values corresponds to one predetermined interval of the determined active route, and controlling the at least one controllable unit based on the selected set of control values. The method further comprises recording, during the current driving of the vehicle , a set of control result values, where one control result value corresponds to a predetermined interval of the determined active route which the vehicle has driven, and the control result values are indicative of the result of the controlling during the predetermined interval. The method further comprises, at the end of the driving based on said set of control result values, determining an updated set of control values for the actually driven route, and storing said updated set of control values.

24. Number of Claims : 16

25. Patent Status : Published Application

26. How much this invention is related with your IDP/UDP?

> 91 %

27. Do you have any idea to do anything around the said invention to improve it? (Give short note in not more than 500 words)

GUJARAT TECHNOLOGICAL UNIVERSITY

(GTU)

INNOVATION COUNCIL (GIC)

Patent Search & Analysis Report

(PSAR)

Date of Submission : 14/08/2017

Dear Patel Vatsal Anant,

Studied Patent Number for generation of PSAR	:	17BET_140080116043_4

PART 1: PATENT SEARCH DATABASE USED

1. Patent Search Database used	:	Google Patents
Web link of database	:	https://patents.google.com/
2. Keywords Used for Search	:	Speeded up Robust Features
3. Search String Used	:	Multi-layer principal component analysis
4. Number of Results/Hits getting	:	48

PART 2: BASIC DATA OF PATENTED INVENTION /BIBLIOGRAPHIC DATA

5. Category/ Field of Invention	:	
6. Invention is Related to/Class of Invention	:	Image and Signal Processing
6 (a) : IPC class of the studied patent	:	G06K9/4647
7. Title of Invention	:	Noise-robust feature extraction using multi-layer principal component analysis
8. Patent No.	:	US7082394B2
9. Application Number	:	US10/183271
9 (a) : Web link of the studied patent	:	https://patentimages.storage.googleapis.com/[illegible]/US7082394.pdf
10. Date of Filing/Application (DD/MM/YYYY)	:	25/06/2002
11. Priority Date (DD/MM/YYYY)	:	25/12/2008
12. Publication/Journal Number	:	
13. Publication Date (DD/MM/YYYY)	:	25/07/2006
14. First Filled Country : Albania	:	284

Page

15. Also Published as

Sr.No	Country Where Filed	Application No./Patent No.
1		

16. Inventor's Details.

Sr.No	Name of Inventor	Address/City/Country of Inventor
1	Chris Burges	Bellevue
2	John Platt	WA

17. Applicant/Assignee Details.

Sr.No	Name of Applicant/Assignee	Address/City/Country of Applicant
1	Microsoft Corp	Redmond

18. Applicant for Patent is : Company

PART 3: TECHNICAL PART OF PATENTED INVENTION

19. Limitation of Prior Technology / Art

Conventional schemes approaches audio content analysis in the context of video structure parsing. This schema involves a two-stage audio segmentation and classification scheme that segments and classifies an audio stream into speech, music, environmental sound, and silence. These basic classes are the basic data set for video structure extraction. A two-stage algorithm is then used to identify and extract audio

20. Specific Problem Solved / Objective of Invention

The invention is related to a signal feature extractor, and in particular, to a system and method for using a "distortion discriminant analysis" of a set of training signals to define parameters of a feature extractor for extracting distortion- from signals having one or more dimensions, such as audio signals, images, or video data.

21. Brief about Invention

Extracting from signals for use in classification, retrieval, or identification of data represented by those signals uses a "Distortion Discriminant Analysis" (DDA) of a set of training signals to define parameters of a signal feature extractor. The signal feature extractor takes signals having one or more dimensions with a temporal or spatial structure, applies an oriented principal components analysis (OPCA) to limited regions of the signal, aggregates the output of multiple OPCAs that are spatially or temporally adjacent, and applies OPCA to the aggregate. The steps of aggregating adjacent OPCA outputs and applying OPCA to the aggregated values are performed one or more times for extracting low-dimensional noise- from signals, including audio signals, images, video data, or any other time or frequency domain signal. Such extracted are useful for many tasks, including automatic authentication or identification of particular signals, or particular elements within such signals.

22. Key learning Points

A system for training a feature extractor for extracting from an input signal comprising:
receiving at least one training signal, receiving at least one distorted copy of the at least one training signal, transforming each training signal and each distorted copy of the at least one training signal into a suitable representation for taking projections

23. Summary of Invention

A system and method for extracting from signals having one or more dimensions for use in classification, retrieval, or identification of the data represented by those signals uses a "Distortion Discriminant Analysis" (DDA) of a set of training signals to define parameters of a signal feature extractor.

24. Number of Claims : 42

25. Patent Status : Published Application

26. How much this invention is related with your IDP/UDP?

PSAR-5

GUJARAT TECHNOLOGICAL UNIVERSITY

(GTU)

INNOVATION COUNCIL (GIC)

Patent Search & Analysis Report

(PSAR)

Date of Submission : 14/09/2017

Dear **Patel Vatsal Anant,**

Studied Patent Number for generation of PSAR	:	**17BE7_140380116043_5**

PART 1: PATENT SEARCH DATABASE USED

1. Patent Search Database used	:	Google Patents
Web link of database	:	https://patents.google.com/
2. Keywords Used for Search	:	Pedestrian,Behaviour,Model
3. Search String Used	:	Driving Aid System for Autonomous Cars Pedestrains
4. Number of Results/Hits getting	:	45

PART 2: BASIC DATA OF PATENTED INVENTION /BIBLIOGRAPHIC DATA

5. Category/ Field of Invention	:	
6. Invention is Related to/Class of Invention	:	Machine Learning
6 (a) : IPC class of the studied patent	:	G01C21/00
7. Title of Invention	:	Driving Aid System And Method Of Creating A Model Of Surroundings Of A Vehicle
8. Patent No.	:	US20050085968A1
9. Application Number	:	US11228060
9 (a) : Web link of the studied patent	:	https://patentimages.storage.googleapis.com/4d/32/7b/e132bcda7bc974/US20050085968A1.pdf
10. Date of Filing/Application (DD/MM/YYYY)	:	09/03/2007
11. Priority Date (DD/MM/YYYY)	:	03/04/2006
12. Publication/Journal Number	:	
13. Publication Date (DD/MM/YYYY)	:	01/01/2009
14. First Filed Country : Albania	:	264

15. Also Published as

S.No	Country Where Filed	Application No./Patent No.
1		

16. Inventor/s Details.

S.No	Name of Inventor	Address/City/Country of Inventor
1	[illegible]	Goteborg
2	[illegible]	SE

17. Applicant/Assignee Details.

S.No	Name of Applicant/Assignee	Address/City/Country of Applicant
1	[illegible]	Stockholm

18. Applicant for Patent is : Company

PART 3: TECHNICAL PART OF PATENTED INVENTION

19. Limitation of Prior Technology / Art

For road vehicles such as cars, it is known to provide a navigation system (such as GPS) which, along with stored map data, may give information regarding speed limits, intersections, traffic lights and so forth, so that the driver can be warned when it is determined that the vehicle may encounter a hazardous situation. It is also known to use "dead reckoning" to determine the current position of the vehicle relative to an earlier known position, but the degree of accuracy was low.

20. Specific Problem Solved / Objective of Invention

Driving aid system for a road vehicle comprising a detection system for detecting and storing profiles of characteristics of objects around the vehicle along a road on which the vehicle is being driven
a positioning system for providing a current position of the vehicle to define a detected position of the vehicle, the profiles of characteristics of objects being stored in relation to the detected position of the vehicle

21. Brief about Invention

In at least one embodiment of the present invention a driving aid system for mounting in a road vehicle is provided. The driving aid system comprises a detection system for detecting and storing profiles of characteristics of objects around the vehicle along a road on which the vehicle is being driven. A positioning system is for providing a current position of the vehicle. Profiles of characteristics of objects are stored in relation to the detected position of the vehicle. A processing arrangement compares currently detected profiles with earlier stored profiles and, if a match between a currently detected profile and an earlier stored profile is found, then the current position of the vehicle is determined relative to an object corresponding to the earlier stored profile, and the same or other earlier stored profiles is used to predict the future surroundings of the vehicle.

22. Key learning Points

A driving aid system for a road vehicle comprising a processing arrangement for comparing the profiles of characteristics of objects including currently detected profiles with earlier stored profiles and, if a match between one of the currently detected profiles and one of the earlier stored profiles is found, determining the current position of the vehicle relative to an object corresponding to the earlier stored profile, and using the one or another of the earlier stored profiles to predict future surroundings of the vehicle, wherein when a match between the currently detected profile and the earlier stored profile is found, the earlier stored profile of the object is at least one of enhanced and updated using the currently detected profile.

23. Summary of Invention

This invention relates to a driving aid system and in particular, to a driving aid system to be mounted in a road vehicle for increased vehicle safety and accuracy in determining the position of the vehicle wherein the processing arrangement analyzes speed and direction of movement of moving objects detected by the detection system.

24. Number of Claims : 40

Certificate of Appreciation

It gives us pleasure to write this letter of appreciation for

"**FORCAS (FORWARD COLLISION AVOIDANCE SYSTEM)"**

the project developed by ADHUNIK RAJPUT (140080116002), TIRTH PATEL (140080116042)& VATSAL PATEL (140080116043); students of Information Technology Department, BVM Engineering College, Vallabh Vidyanagar, 2017-2018 batch, guided by the faculty of Information Technology at BVM.

I, as their guide, convey this with pleasure that the project is working truly to our satisfaction. I highly appreciate and acknowledge the effects of the students in the making of this successful project.

I am quite hopeful that these students will continue to demonstrate a similar spirit of excellence, in all their future endeavours' too. I wish them a highly satisfying and rewarding career ahead.

Prof. ZANKHANA SHAH
Project Guide

FORCAS (Forward Collision Avoidance System)

A Project Report

Submitted By:

Rajput Adhunik	140080116002
Tirth Patel	140080116042
Vatsal Patel	140080116043

For Project-I of

BACHELOR OF ENGINEERING

In

INFORMATION TECHNOLOGY

VALLABH VIDYANAGAR

Gujarat Technology University, Ahmedabad
Academic Year : 2017-2018

ACKNOWLEDGEMENT

Before we get into thick of things. We would like to add a few words of appreciation for the people who have been a part of this project right from its inception. The writing of this project has been one of the significant academic challenges we have faced and without the support, patience, and guidance of the people involved, this task would not have been completed. It is to them we owe our deepest gratitude.

We heartily express our thanks to **Dr. Indrajit N. Patel,** Principal of Birla Vishwakarma Mahavidyalaya, and **Dr. Keyur Brahmbhatt**, Head of Department of I.T. Branch for giving us such an opportunity to do our project work. We extend our gratitude to **Automation Anywhere, Vadodara** for providing us a mentor and helped us in every step to make the project a success

It gives us immense pleasure in presenting this project report on **"Forward Collision Avoidance System (FORCAS)"**. It has been our privilege to have a team of project guide who have assisted us from the commencement of this project. The success of this project is a result of sheer hard work, and determination put in by us.

We hereby take this opportunity to thank **Mr. Nakuldev Patel, Tech Lead at Automation Anywhere, Vadodara** who undertook to act as our mentor despite his many professional commitments. We also would like to extend our special gratitude to **Prof. Zankhana Shah** who undertook to act as our faculty guide. Their guidance, wisdom, knowledge, and commitment to the highest standards inspired and motivated us throughout the project.

Without their insight, support, and energy, this project wouldn't have kick-started and neither would have reached fruitfulness. We also feel heartiest sense of obligation to other staff members, class friends and seniors, who helped us in collection of resource material & also in its processing as well as in drafting manuscript. The project is dedicated to all those people, who helped us while doing this project.

BIRLA VISHVAKARMA MAHAVIDYALAYA
ENGINEERING COLLEGE
INFORMATION TECHNOLOGY DEPARTMENT

CERTIFICATE

This is to certify that project entitled with **"Forward Collision Avoidance System (FORCAS)"** has been carried out by V**atsal Patel (140080116043), Tirth Patel (140080116042) and Adhunik Rajput (140080116002)** under my guidance in fulfilment of 7th semester Project-I of Bachelor of Engineering in Information Technology Department during the academic year 2017-18.

Date:
Place:

Internal Project Guide
Prof. Zankhana Shah

Head of the Department
Dr. Keyur Brambhatt

PLAGARISM CHECK REPORT

PLAGIARISMA

92% Unique

Total 8547 chars (2000 limit exceeded) , 324 words, 14 unique sentence(s).

Results	Query	Domains (original links)
138,000,000 results	Chapter	thefreedictionary.com dictionary.com merriam-webster.com joinchapter.com chapter.org accuris.gov en.wikipedia.org chapter-living.com nursingsociety.org accuris.gov
211,000,000 results	Introduction	Get Free Access
Unique	his system will allow the car to detect, classify and avoid stationary objects	-
Unique	Many tech giants and Google has already started a project called Waymo	-
Unique	They are training the data since 2009 and getting better and better	-
Unique	Students have tried many other techniques to improve autonomous driving by using sensors	-
Unique	In reality it's really difficult to achieve 100% perfect	-
Unique	via Raspberry PI and Wireless Transmitter to a machine which combines and processes data using	-
Unique	It will distinguish the stationary objects on drivable road surface and estimate their distances	-
Unique	Classification Algorithms run on real time images and send it back to raspberry pi	-
Unique	on the basis of detected object it decides to avoid, stop or run over	
Unique	the module of Autonomous Car Driving which motivates the people in locality to pursue more	
Unique	When this achievable system is scaled up and implemented in a car or	-
Unique	1 Problem Specification This bot car will be having "Forward Collision Avoidance System" which in	-
5 results	As a real life entity, the autonomous car has numerous other functionality of recognition,	Get Free Access
Unique	decisions through neural net designed which are trained using specific algorithms and other machine learning	-
Unique	4 Prior Art search Autonomous car driving is in trend from last 2-3 years due	-

Top plagiarizing domains: accuris.gov (2 matches); en.wikipedia.org (1 matches); nursingsociety.org (1 matches); chapter-living.com (1 matches); chapter.org (1 matches); dictionary.com (1 matches); merriam-webster.com (1 matches); joinchapter.com (1 matches); thefreedictionary.com (1 matches);

Chapter 1: Introduction 1.1 Problem Summary Using camera images as a primary input, we will send this images via Raspberry PI and Wireless Transmitter to a machine which combines and processes data using convolutional neural network (CNN) based decision and distance estimation models. It will distinguish the stationary objects on drivable road surface and estimate their distances from a single camera's view. Classification Algorithms run on real time images and send it back to Raspberry PI to control the speed and steering of car. On the basis of detected object, it decides to avoid, stop or run over it. 1.2 Aim and Objective The main purpose of this system is to implement one of the module of Autonomous Car Driving which motivates the people in locality to pursue more research in the same field. When this achievable system is scaled up and implemented in a car or a drone (with some changes) it will help detect and avoid obstacles. 1.3 Problem Specifications This bot car will be having "Forward Collision Avoidance System" which in real life is an essential part of autonomous driving cars. As a real life entity, the autonomous car has numerous other functionality of recognition, location, motion, control and many real world test cases. This system will allow the car to detect, classify and avoid stationary objects. More specifically, I uses this by capturing the front footages of car and take decisions through neural net designed which are trained using specific algorithms and other machine learning techniques. 1.4 Prior Art search Autonomous car driving is in trend from last 2-3 years due to recent development of Machine Learning algorithms and computer vision techniques. Many tech giants and Google has already started a project called Waymo. They are training the data since 2009 and getting better and better. Students have tried many other techniques to improve autonomous driving by using sensors. In reality it's really difficult to achieve 100% perfect

BVM Engineering College
IT Department (7th Semester, IDP)
Academic Year 2017-18

Title of the Project:	"Forward Collision Avoidance System" (FORCAS)
Name of the industry(IF IDP) City:	Automation Anywhere Pvt. Ltd, Vadodara
Group No.:	**Enrollment Numbers and Names:** 1) 140080116043 - Patel Vatsal Anant 2)1400801160 - Patel Tirth Hasmukhbhai 3)140080116002 - Rajput Adhunik
Progress with respect to last meeting: **(To be filled by students)**	Hardware programming almost completed, solving issues with controlling Pi with laptop. Working on feature extraction and corner detection program
Remarks and Suggestions by Industry guide (IF IDP) **Sign of Industry Guide**	
Remarks and Suggestions by College guide **Sign of College Guide**	Training data for different objects need to be decided and feed into the system. Allowed for mid sem presentation 13/9/17

Progress Report No : 03 **Date:** 13-09-17

BVM Engineering College
IT Department (7th Semester, IDP)
Academic Year 2017-18

Title of the Project:	"Forward Collision Avoidance System" (FORCAS)
Name of the industry(IF IDP) City:	Automation Anywhere Pvt. Ltd, Vadodara
Group No.:	**Enrollment Numbers and Names:** 1) 140080116043 - Patel Vatsal Anant 2)140080116042 - Patel Tirth Hasmukhbhai 3)140080116002 - Rajput Adhunik
Progress with respect to last meeting: **(To be filled by students)**	Hardware implementation started. learned basic Raspberry Pi, Camera module details. Designing circuits and soldering motors. Pi
Remarks and Suggestions by Industry guide (IF IDP) **Sign of Industry Guide**	N.D. Patel 27/8/17
Remarks and Suggestions by College guide **Sign of College Guide**	- Need to learn methodology for decide the system. 26/8/17

Progress Report No : 02 **Date:** 26-08-17

BVM Engineering College
IT Department (7th Semester, IDP/UDP)
Academic Year 2017-18

Progress Report No : 01 Date: 29-07-17

Title of the Project:	Forward Collision Avoidance System (FORCAS)
Name of the industry(IF IDP) City:	Automation Anywhere Vadodara
Group No.:	Enrollment Numbers and Names: 1) 140080116043 - Patel Vatsal Anant 2) 140080116042 - Patel Tirth Hasmukhbhai 3) 140080116002 - Rajput Adhunik
Progress with respect to last meeting: (To be filled by students)	After deciding project definition, and presentation, we have defined scope and purpose. We are working on various libraries and learning python. Simple python programs and references about hardware are being read.
Remarks and Suggestions by Industry guide (IF IDP) V.P. Patel 29/7/17 Sign of Industry Guide	- STOP WATERFLOW, START AGILE - LESS DOCUMENTATION, MORE CODE - LET CODE DO THE TALK
Remarks and Suggestions by College guide Sign of College Guide	-Need to prepare SRS in systemic way 29/7/17