Remotely Controllable Driverless Vehicle Equipped With Computer Vision System

PRESENTED BY

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Introduction

Objectives

➢Develop a prototype car with computer vision system

➢Integrate automatic lane detection

➢Develop automatic lane following control

➢Develop remote control of the car

Project Flow

Project Flow

Prototype Car with Vision support → Road Detection → Road Driving → Additional Remote Control
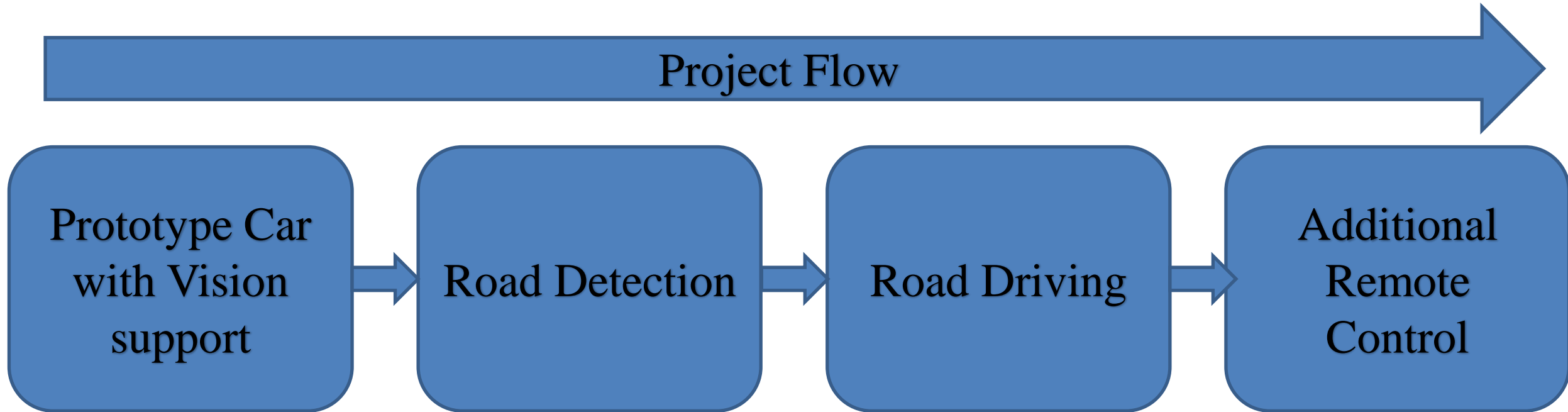
Scopes

- Automation in car includes all the components of mechatronics, like hardware, software, intelligence
- Reduce traffic accidents caused by human error
- Increase safety on the road
- Collaborate in the advancement of car technology
- The prototype can be used to test more advanced features in physical world rather than in simulation.

Literature Review

| Author	Title	Contribution
Hummel, R. [1]	Image enhancement by histogram transformation	Suggested a number techniques makes use of easily computed local context features by each point's gray level during histogram transformation.
J. P. Gonzalez and U. Ozguner [2]	Lane detection using histogram-based segmentation and decision trees	Exploits the characteristics of the gray level histogram of the road to detect lane markers.

Literature Review

Author	Title	Contribution
P. Pramkeaw and C. Thongchaisuratk rul [3]	Automated Driving System of Lane Detection Using Image Processing Techniques	A system that is mostly accurate in an environment where there is no objects or obstruction, the road is clearly seen and the light is not too bright.
Gurjashan Singh Pannu, Mohammad Dawud Ansari and Pritha Gupta[4]	Design and Implementation of Autonomous Car using Raspberry Pi	Uses Hough line transformation. They also have an extra feature of region of interest.

Literature Review

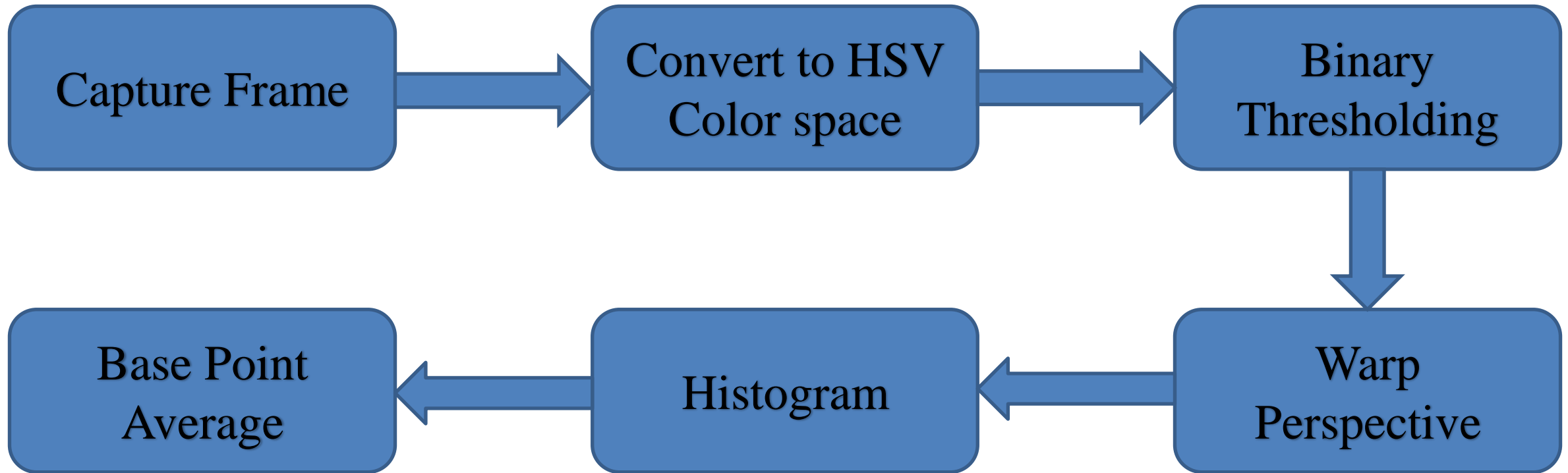| Author	Title	Contribution
N. P. Pawar and M. M. Patil [5]	Driver Assistance System based on Raspberry Pi	Used Hough line transformation for finding lane lines and gave satisfactory results. They also compressed there video before streaming. Network bandwidth made a significant impact on video transmission.
Raja Muthalagu, Anudeepsekhar Bolimera, V. Kalaichelvi[6]	Lane detection technique based on perspective transformation and histogram analysis for self-driving cars	Preprocessing of the image. Both Sobel operator and color thresholding is used. Preprocessing is computationally expensive.

Methodology

System Overview
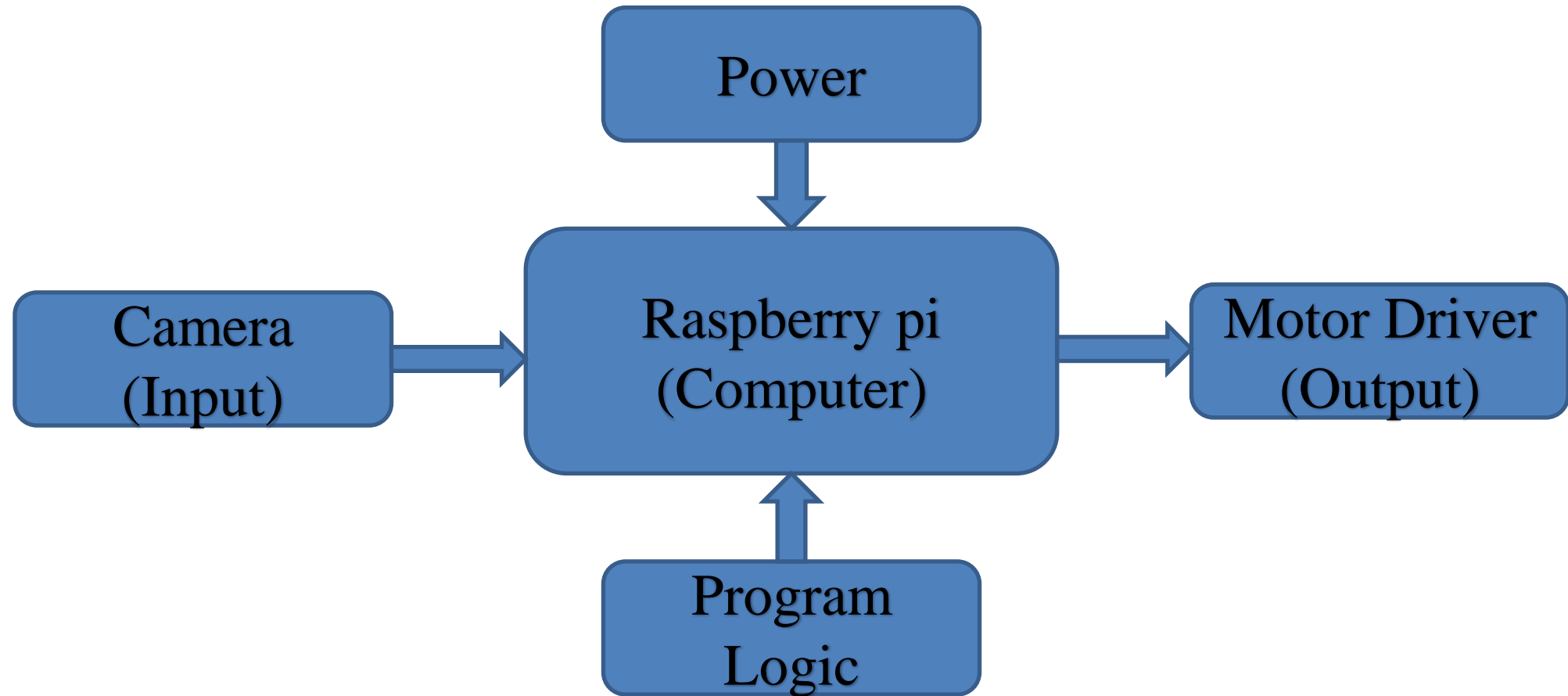
System Overview (Continued)

The system is composed of four major sections:

- Camera for real time environment image input
- Computer for central processing.
- Power management system
- Two wheel rear drive.
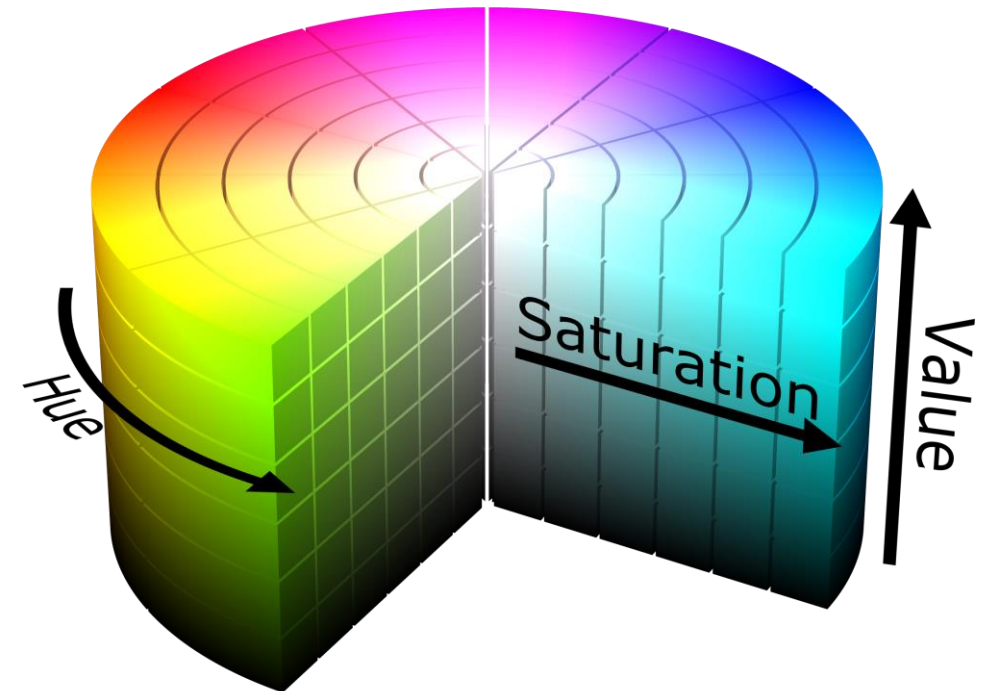
Image Processing Pipeline

```
Capture Frame  →  Convert to HSV Color space  →  Binary Thresholding
                                                         ↓
Base Point Average  ←  Histogram  ←  Warp Perspective
```

Thresholding

HSV Color Selection

HSV Color Space [7]

Thresholding and Binary Masking

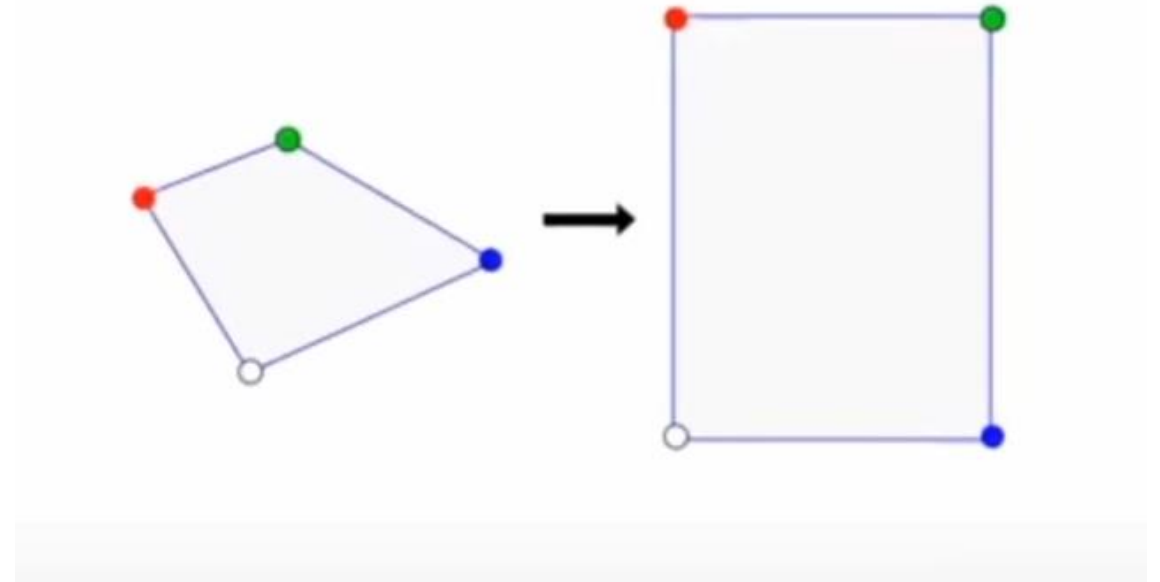**Original Image**   **HSV Thresholded**   **Binary Masked (0,1)**

Warp Perspective / Birds Eye

- OpenCV function is "Perspective Transformation"
- Corrects error caused by camera angle alignment
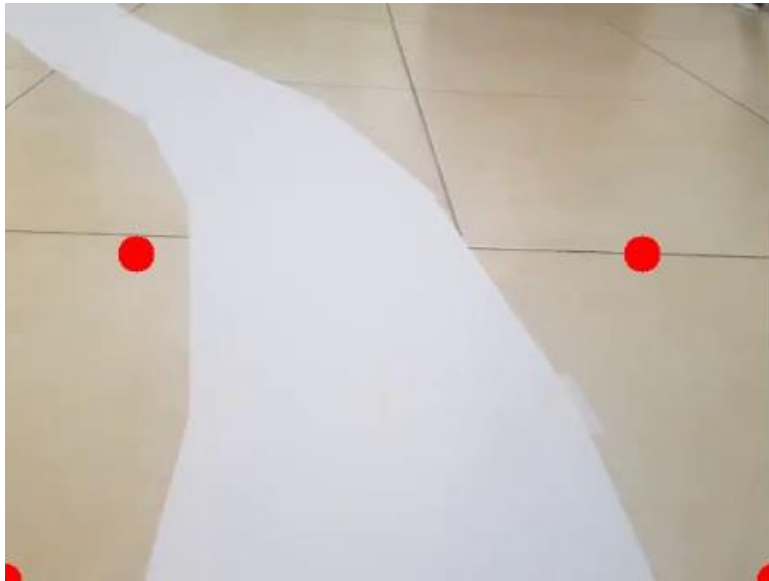- Required for Correct angle calculation.

Warp Effect

Original Image with points ➡️ Binary Image ➡️ Warp

Histogram

- Approximate representation
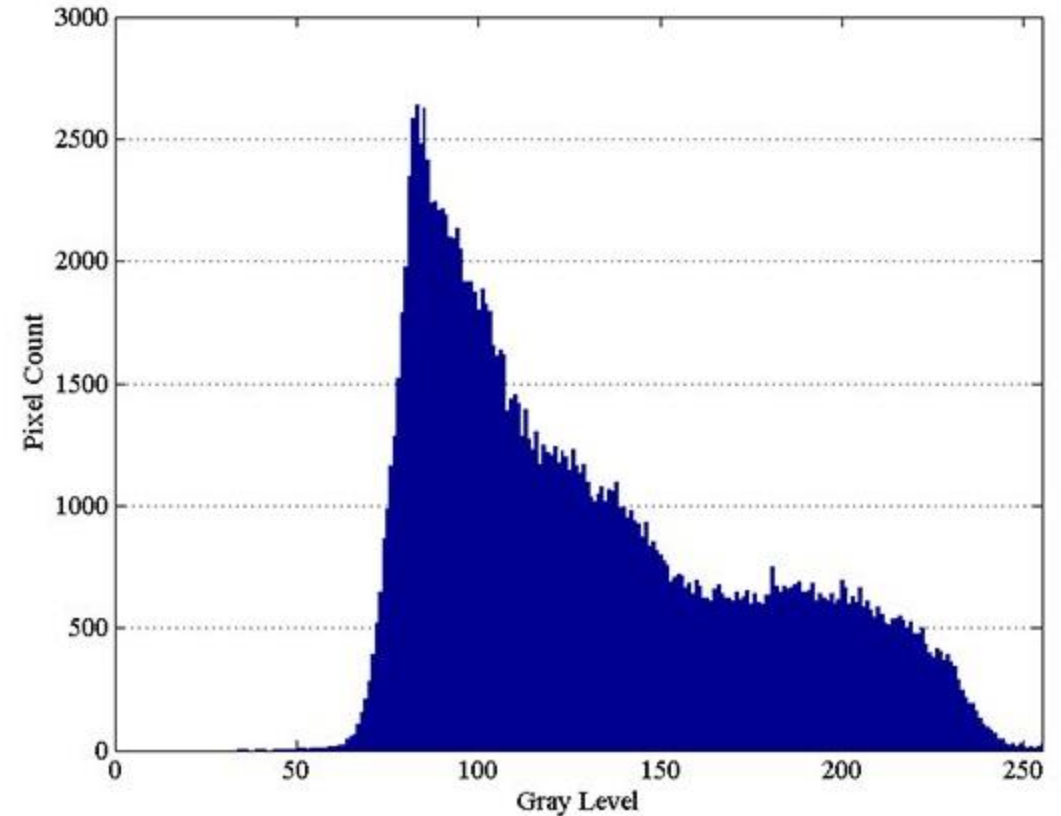- Distribution of numerical data
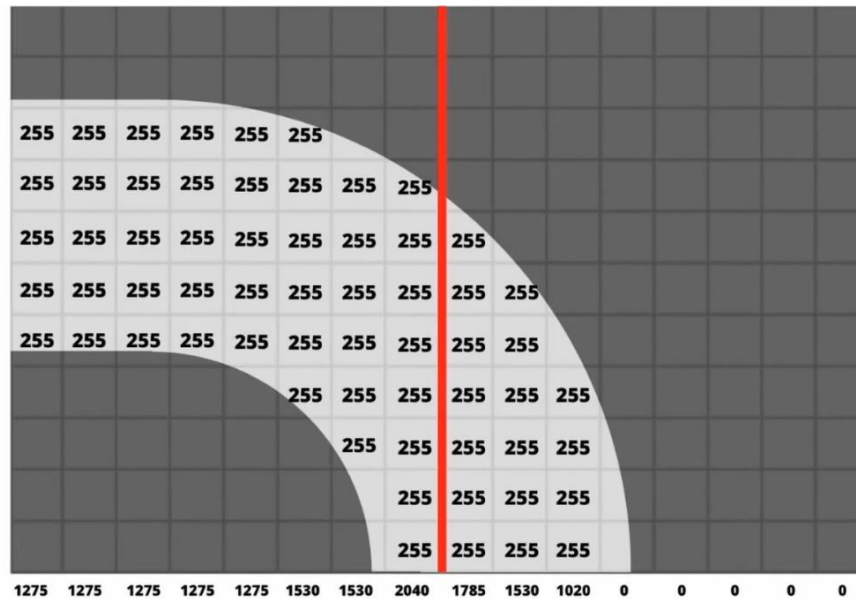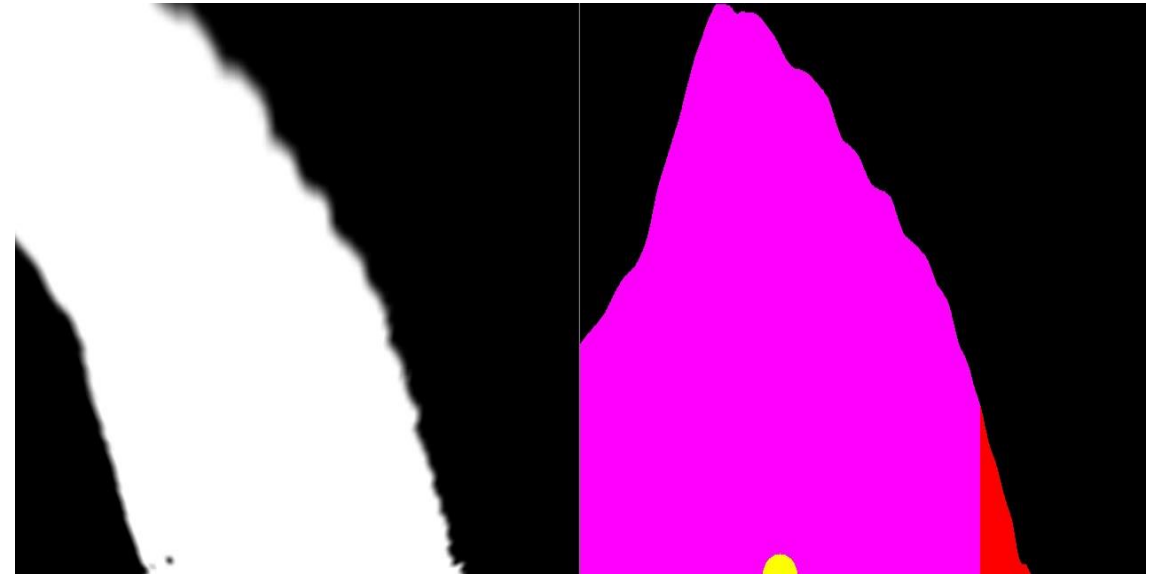- Used for continuous data

Fig: Histogram [8]

Histogram

Pixel Summation[9]

Histogram Visualization

Decision Logic

- Calculate average in the lower region.
- Determine average point location
- Locate middle line
- If more pixels is on the right side, move right and vice versa

PIXEL SUMMATION [9]

LESS PIXELS MORE PIXELS

SAME PIXELS SAME PIXELS

MORE PIXELS LESS PIXELS

RIGHT CURVE   STRAIGHT   LEFT CURVE
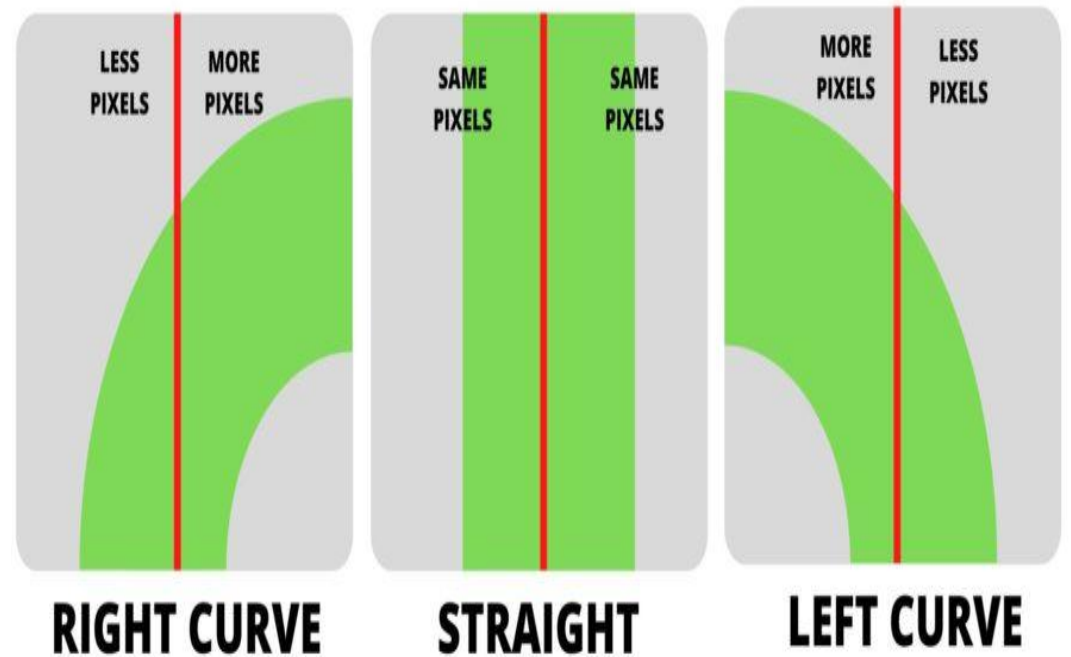
Decision / Logic Flow

Motor Driver Diagram

Left Motor

Right Motor

Logic Power

Ground

Ground

Motor Power

L293D

Power Design

```
┌─────────────────────────┐        ┌─────────────────────────┐
│      5V DC              │        │                         │
│  (Strict Regulation)    │ ─────► │     Logic System        │
└─────────────────────────┘        └─────────────────────────┘

┌─────────────────────────┐        ┌─────────────────────────┐
│      12-6V             │        │                         │
│  (Unregulated)          │ ─────► │     Drive System        │
└─────────────────────────┘        └─────────────────────────┘
```
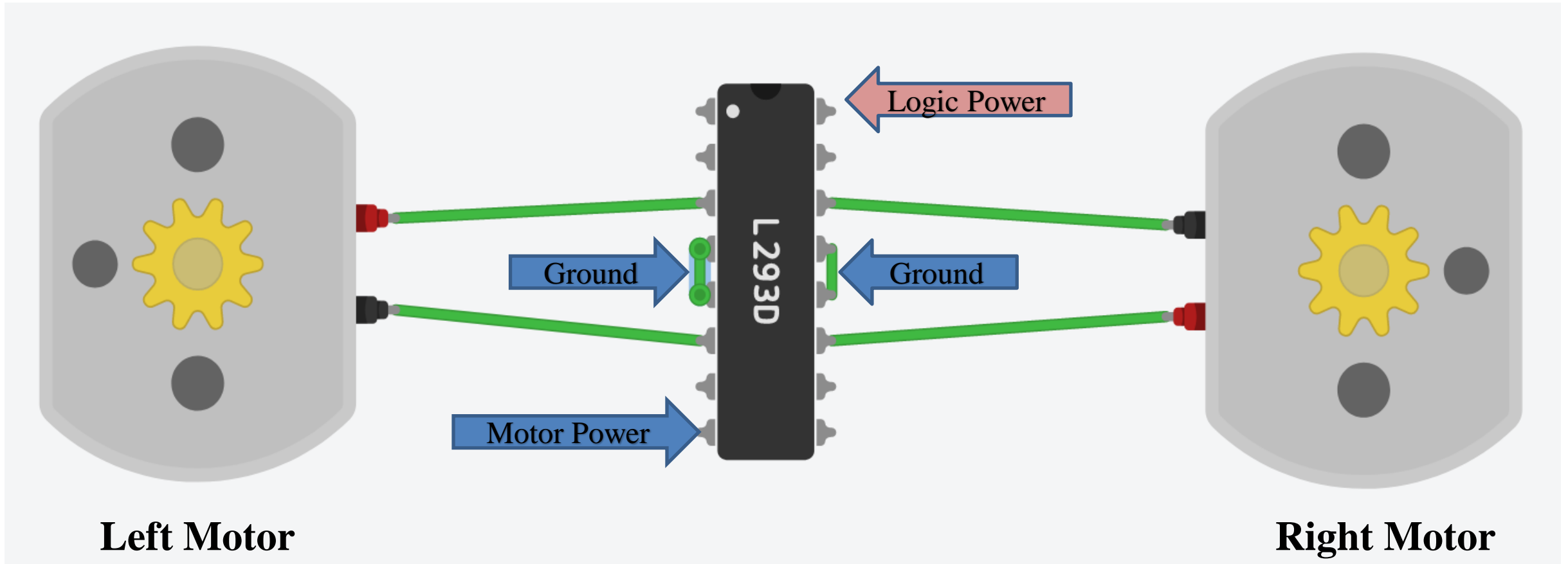
Power for Logic System

```
┌─────────────────┐      ┌─────────────────┐      ┌─────────────────┐
│ Two Li-ion       │      │                 │ ──►  │  Raspberry Pi   │
│ battery          │ ──►  │  5V Voltage     │      └─────────────────┘
│ in series        │      │  Regulator      │      ┌─────────────────┐
└─────────────────┘      └─────────────────┘ ──►  │  Motor Driver   │
                                                    │  Logic          │
                                                    └─────────────────┘
```
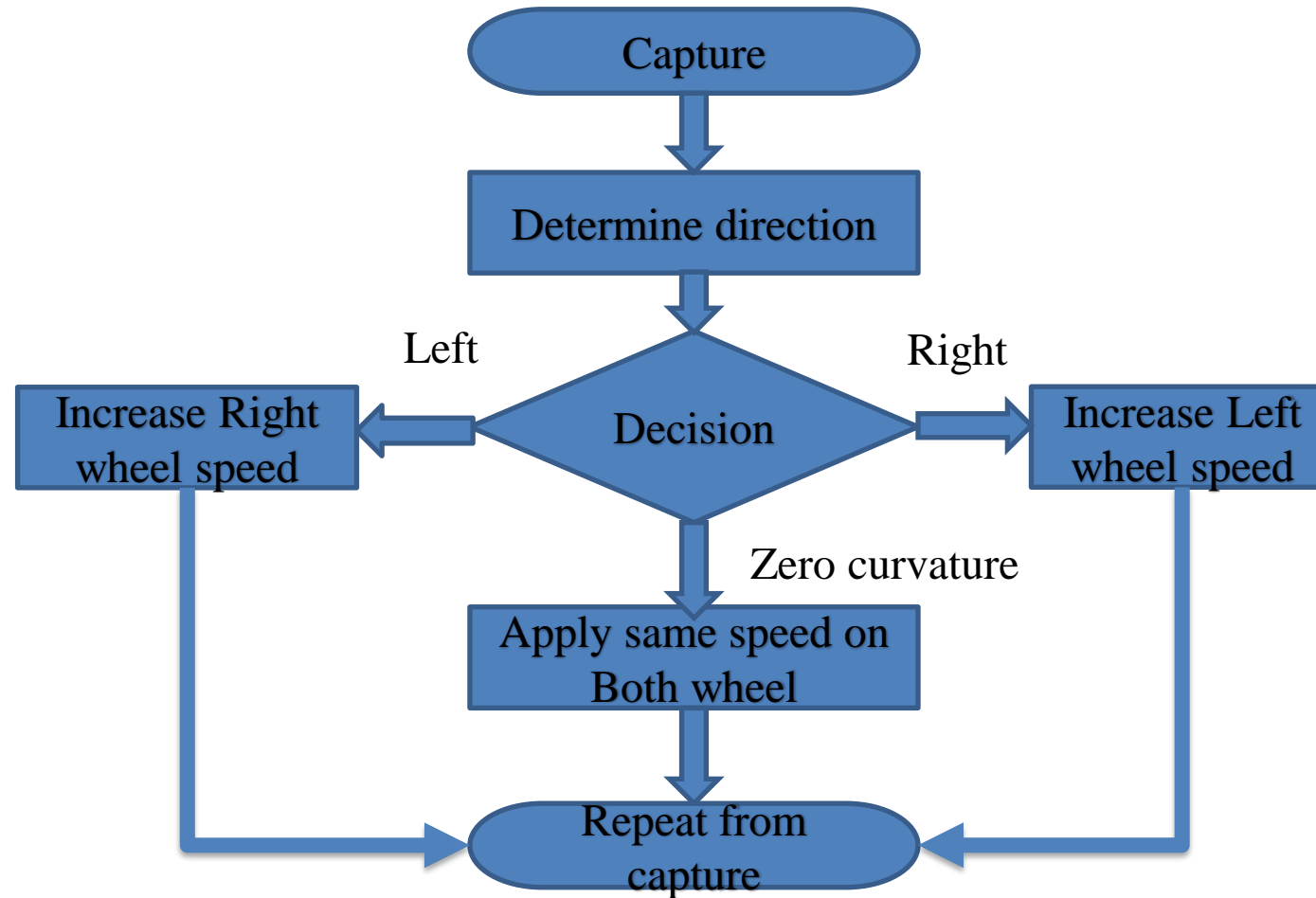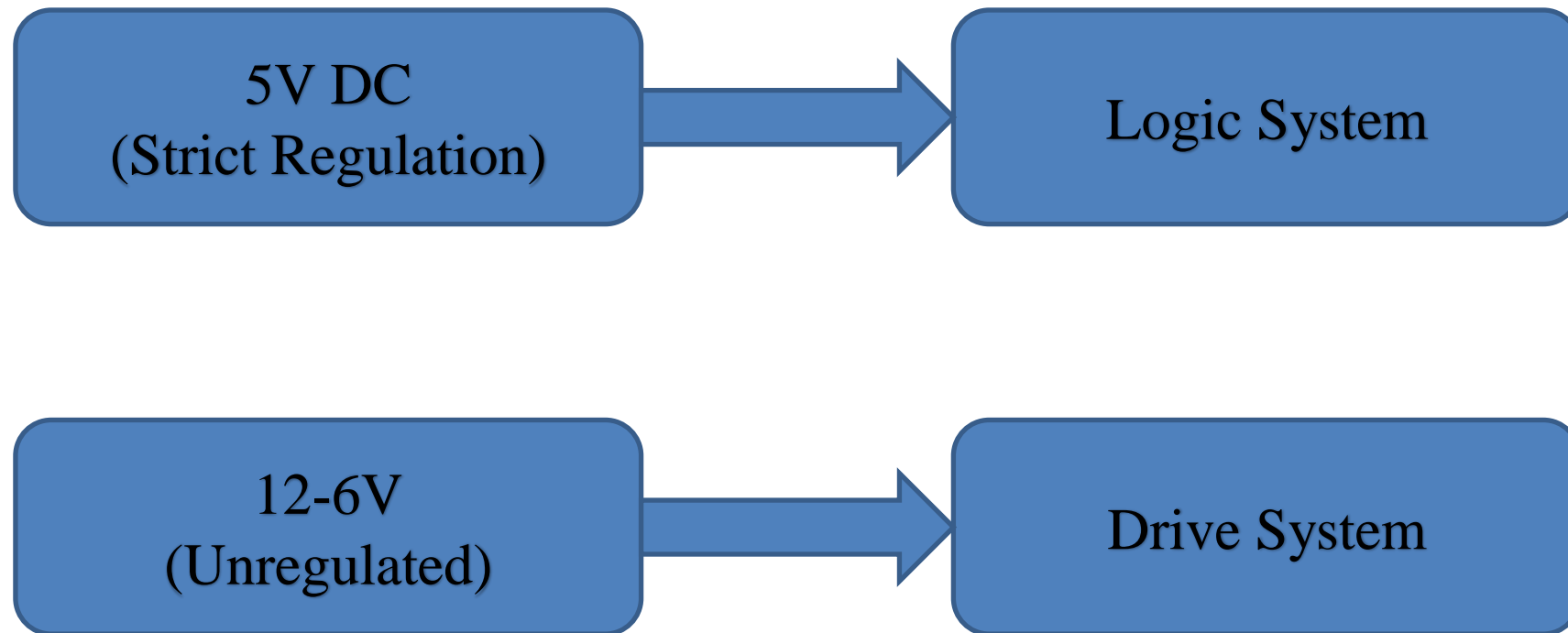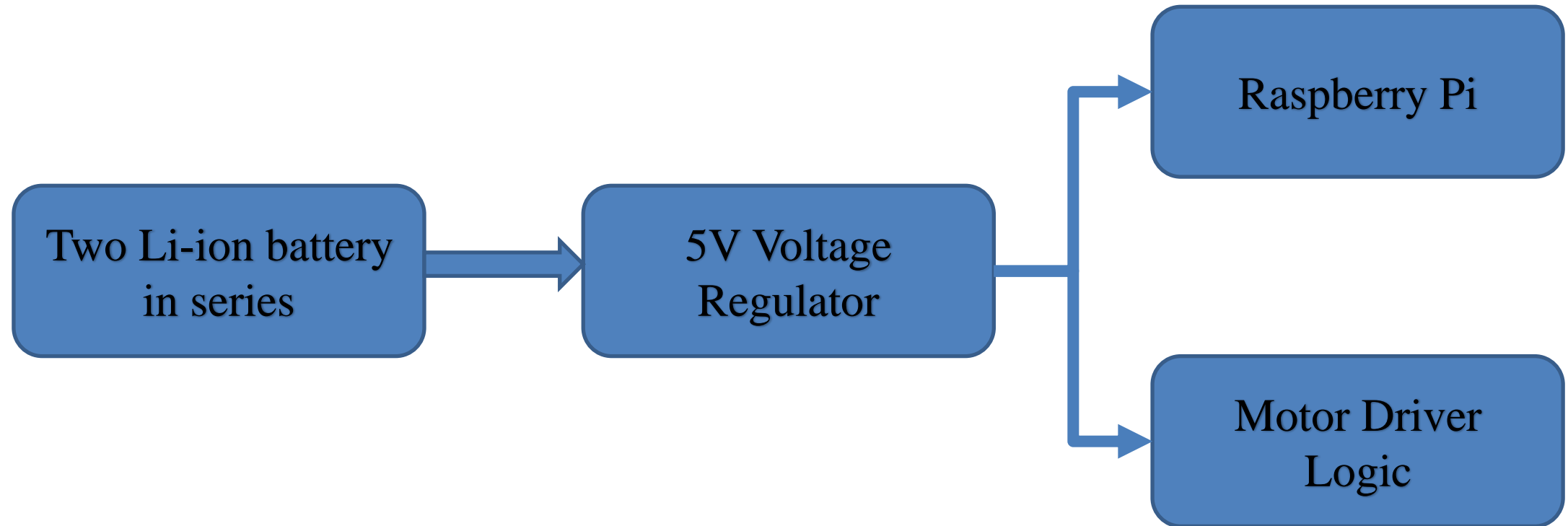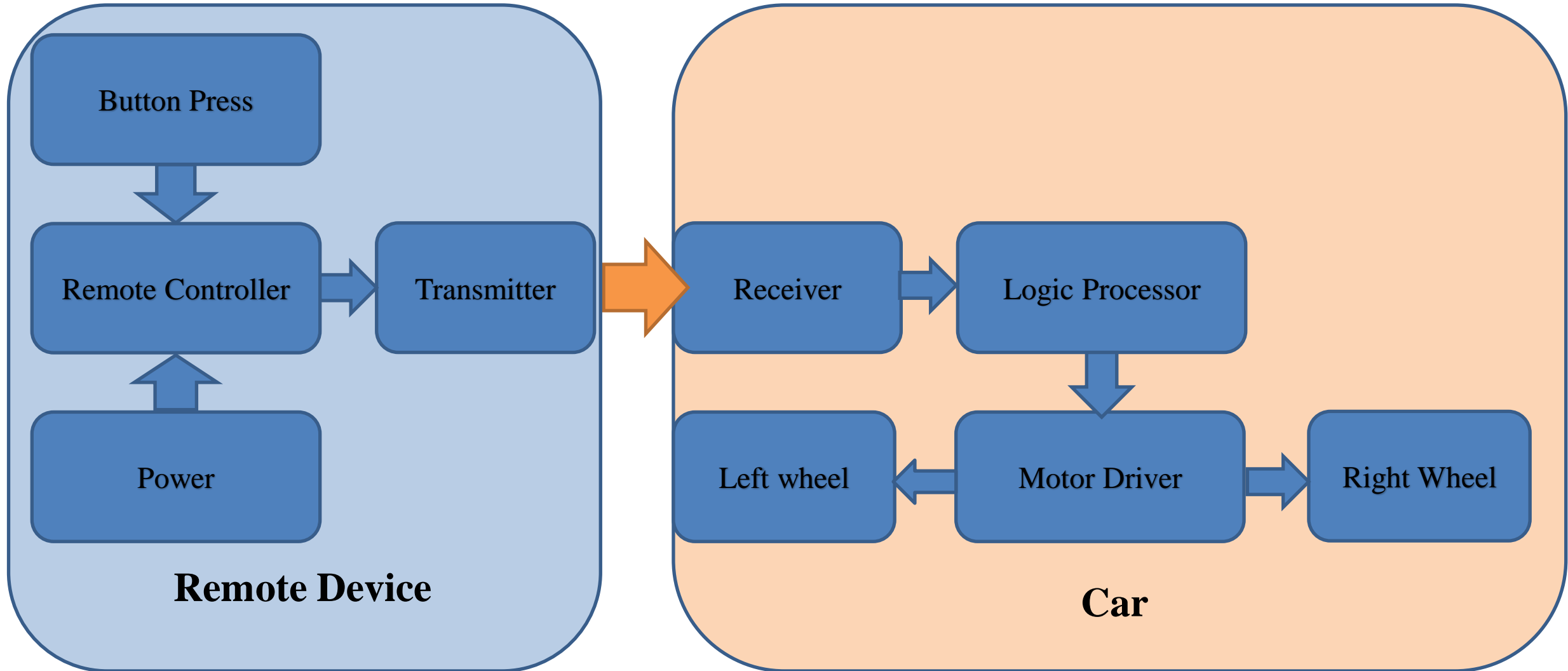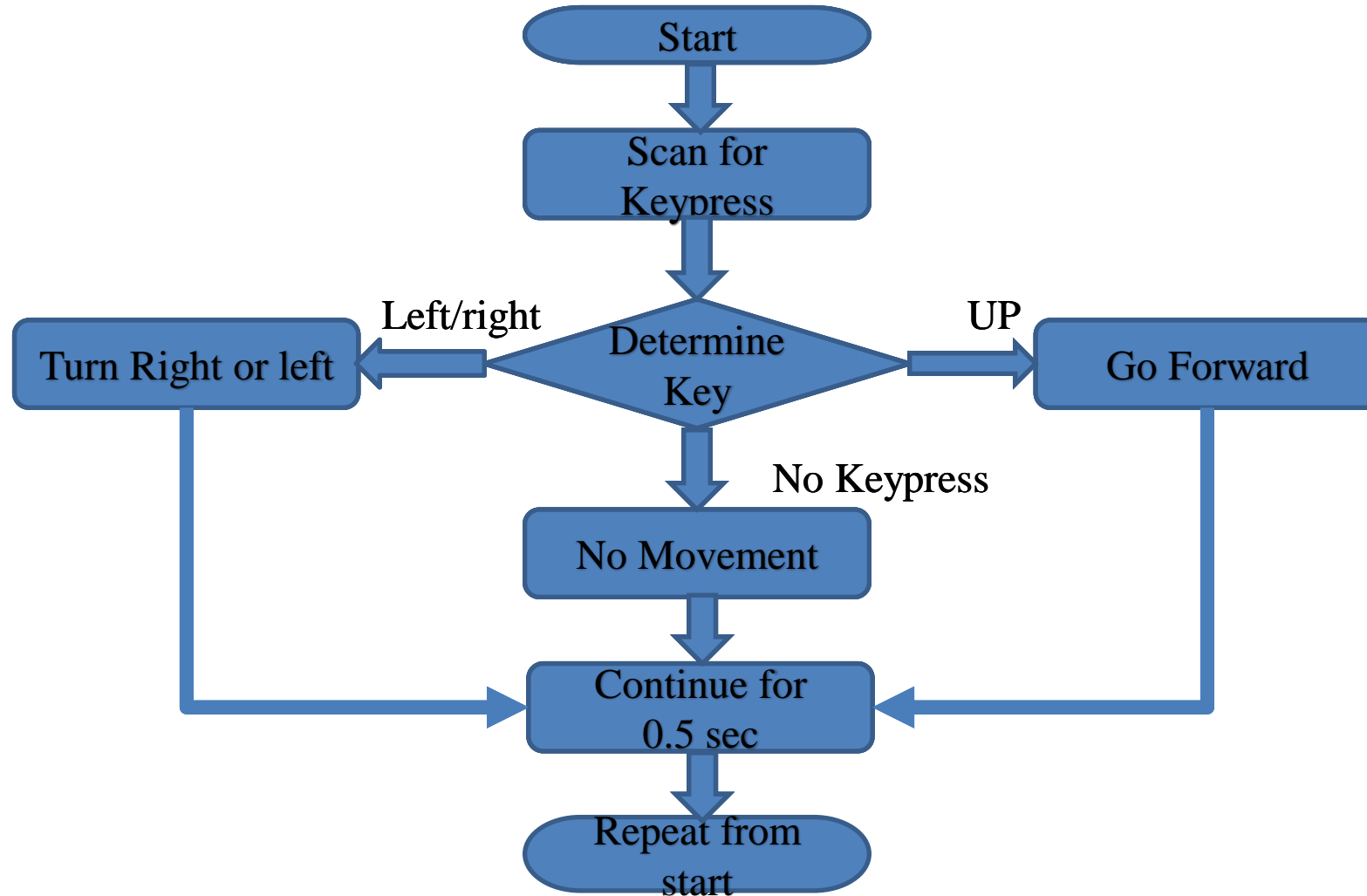
Remote Control System

Remote Control Algorithm

Result and Limitation

- The car successfully drives over straight, left and right turns
- The car is able to accommodate additional sensors
  - Though this requires multithreading programming, which is more complex. So it will be worked on future implementation.
- The car is very slow
  - Detection and processing takes long time. Need to use powerful processor.
- Remote control works. But single press is processed at any moment.

Video with Explanation

- Google Drive link: https://drive.google.com/file/d/1PJA7G-LvgrDHkBlLhBRDVgVZ1TRDPb1S/view?usp=sharing

References

- [1] Hummel, R., "Image enhancement by histogram transformation", ieht.rept, 1975.
- [2] J. P. Gonzalez and U. Ozguner, "Lane detection using histogram-based segmentation and decision trees," ITSC2000. 2000 IEEE Intelligent Transportation Systems. Proceedings (Cat. No.00TH8493), Dearborn, MI, USA, 2000, pp. 346-351, doi: 10.1109/ITSC.2000.881084.
- [3] P. Pramkeaw and C. Thongchaisuratkrul, "Automated Driving System of Lane Detection Using Image Processing Techniques", International Journal of the Computer, the Internet and Management Vol.27 No.1 (January-April, 2019) pp. 58-63
- [4] Gurjashan Singh Pannu, Mohammad Dawud Ansari and Pritha Gupta. Article: Design and Implementation of Autonomous Car using Raspberry Pi. *International Journal of Computer Applications* 113(9):22-29, March 2015

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- [5] N. P. Pawar and M. M. Patil "Driver Assistance System based on Raspberry Pi", International Journal of Computer Applications (0975 – 8887),Volume 95– No.16, June 2014

- [6] Raja Muthalagu, Anudeepsekhar Bolimera, V. Kalaichelvi, Lane detection technique based on perspective transformation and histogram analysis for self-driving cars, Computers & Electrical Engineering, Volume 85, 2020, 106653, ISSN 0045-7906, https://doi.org/10.1016/j.compeleceng.2020.106653. (https://www.sciencedirect.com/science/article/pii/S0045790620305085)

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- [7] HSV cylinder, Page url:

 https://commons.wikimedia.org/wiki/File:HSV_color_solid_cylinder.png, file URL: https://upload.wikimedia.org/wikipedia/commons/4/4e/HSV_color_solid_cylinder.png, attribution: SharkD, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons. Date taken: 14 April,2021

- [8] https://www.allaboutcircuits.com/technical-articles/introduction-to-histogram-equalization/

- [9] https://www.murtazahassan.com/courses/self-driving-car-using-raspberry-pi/lesson/finding-curve/

Thank you.

Questions and Answers