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Self-Driving Car with Cloud Computing

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ABSTRACT

The research goal to build a monocular vision self-driving car with cloud computing prototype using Raspberry Pi as a processing chip. An HD camera along with an ultrasonic sensor is used to provide necessary data from the real world to the car. The car is capable of reaching the given destination safely and intelligently thus avoiding the risk of human errors. Many algorithms like object detection, action/correction detection are combined together to provide the necessary control to the car. Technological advances are pacing in an unmanageable manner. The more a nation invests in upcoming technologies, the more incentives it enjoys in the long run. These incentives branch from finer infrastructure to augmentation of the jobs sector. The prime focus of technology nowadays is to moderate the human intervention in day-to-day tasks. Machine Learning, Artificial Intelligence, and Computer Vision being the big players in doing so. We have reached a time wherein we can automate our menial tasks like driving. Insane, right? This segment of Computer Vision is popularly known as Autonomous Cars. These are vehicles that perceive their environment and move without human navigation. Self-driving cars to become more reliant on indestructible inbuilt road sensors that are embedded in the road and 'turned on' during preventive road construction maintenance or in emergencies alerting each vehicle to reduce speed or halt. Ultimately, we can expect the road beneath us to become more communicative with self-driving cars. It will not be long until self-driving cars by default will likely keep an activity log for service and debugging. Privacy, of course, will be an issue, whether it is the insurance company, the car maker, a local dealer, or even police authorities all seeking another means to track our every coming and going. Crucial components of the future will be the mobile networks, ad hoc (car to car) networks, vehicles to and from road sensors, and satellite communications.

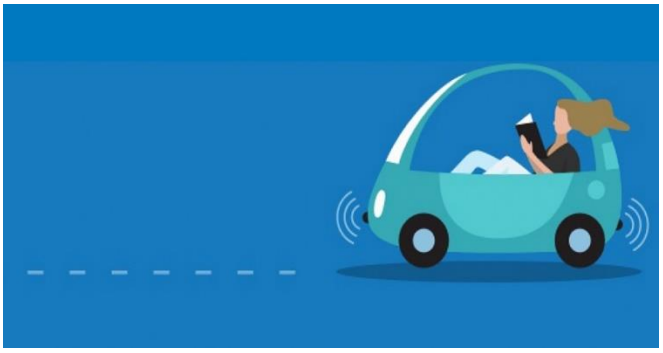
Keywords : Self-Driving Car, Machine Learning, Artificial Intelligence, Computer Vision, Satellite Communication, Road Sensor

I. INTRODUCTION

In this research I am working on the self-driving with cloud computing. Experiments have been conducted on automated driving systems (ADS) since at least the 1920s. There is some inconsistency in terminology used in the self-driving car industry. Various organizations have proposed to define an accurate and consistent vocabulary. Automated vehicle research in the U.S. was primarily funded by DARPA, the US Army, and the U.S. Navy, yielding incremental advances in speeds, driving competence in more complex conditions, controls, and sensor systems.

1.1 What is Self-Driving car?

A self-driving car is a vehicle that uses a combination of sensors, cameras, and artificial intelligence (AI) to travel between destinations without a human operator.



1.2 What is Cloud Computing?

Cloud computing is the on-demand delivery of compute power, database storage, applications, and other IT resources through a cloud services platform via the internet with pay-as-you-go pricing.

II. METHODS AND MATERIAL

Hardware Design

2.1 List of Hardware

A pre-built four wheel drive (4WD) chassis is used as a base on which following hardware components are fit [9]:

- ✓ Raspberry Pi (rev B) for GPU and CPU computations
- ✓ Wi-Fi 802.11n dongle to connect to Pi remotely
- ✓ PWM for motor Modulation
- ✓ 8 AAA batteries to provide power
- ✓ Jumper wires to connect individual components
- ✓ Pi camera
- ✓ Ultrasonic sensor to detect obstacles

2.2.1 Raspberry Pi

The Raspberry Pi is a credit card-sized single-board computer. There are currently five Raspberry Pi models in market. Model B+, the Model A+, the Model B, the Model A, and the Compute Module (currently only available as part of the Compute Module development kit).

In this research work, I have use the model B Rev 2. It comprises of a 512 MB RAM model with two USB ports and a 10/100 Ethernet controller.

2.2.1 Pi Camera

It is the camera shipped along with Raspberry Pi. Pi camera module is also available to which can be used to take high-definition videos as well as still photographs.

2.2.3 Ultrasonic Sensors

Ultrasonic sensors (also known as transceivers when they both send and receive, but more generally called transducers) evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. In this project, they are used to detect the distance of obstacles from the car.

2.2.4 Car Chassis

A chassis is the internal framework of an artificial object, which supports the object in its construction and use. An example of a chassis is a vehicle frame, the underpart of a motor vehicle, on which the body is mounted.

2.2.5 Raspbian OS

All the operating systems Arch, Risk OS, Plan 9 or Raspbian available for Raspberry Pi, Raspbian comes out on top as being the most user-friendly, best-looking, has the best range of default software's and optimized for the Raspberry Pi hardware. Raspbian is a free operating system based on Debian (LINUX), which is available for free from the Raspberry Pi website.

2.2.6 Signals

Signal are used to start and stop the car through signal lights. This signal lights are detect by the use of Harr classifiers and ultrasonic sensors. Also in this research work detect below signals also and human signs.

2.2.7 Jumper Wires

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a

circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires.

2.2.8 Batteries

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smartphones, and electric cars.

III. RESULTS AND DISCUSSION

Software Design

3.1 Open CV Python

Open CV-Python is the Python API of Open CV. It combines the best qualities of Open CV C++ API and Python language. Compared to other languages like C/C++, Python is slower. But another important feature of Python is that it can be easily extended with C/C++. Open CV Python is also provide the Harr Cascade Classifier algorithm so it's Main Benefit to use it in this project.

Cloud Services

1) Amazon S3
2) Amazon Dynamo DB
3) AWS IOT Platform
4) AWS Green Grass

1) Amazon S3

Amazon Simple Storage Service (Amazon S3). An object storage service that offers industry-leading scalability, data availability, security, and performance. This means customers of all sizes and industries can use it to store and protect any amount of data for a range of use cases, such as websites, mobile applications, backup and restore, archive, enterprise applications, IoT devices, and big data analytics.

2) Amazon Dynamo DB

Amazon Dynamo DB is a key-value and document database that delivers single-digit millisecond performance at any scale. It's a fully managed, multiregional, multimaster database with built-in security, backup and restore, and in-memory caching for internet-scale applications.

3) Amazon IOT Platform

AWS IoT Core is a managed cloud service that lets connected devices easily and securely interact with cloud applications and other devices. In this Research work we are using IOT platform's protocol. In this I am using MQTT protocol to data transfer between cloud and car. MQTT Protocol is a mediator for application to process.

4) Amazon Green Grass

AWS IoT Green grass makes it easy to perform machine learning inference locally on devices, using models that are created, trained, and optimized in the cloud. IoT Green grass gives you the flexibility to use machine learning models in Amazon Sage Maker or to bring your own pre-trained model stored in Amazon S3. Machine learning uses statistical algorithms that learn from existing data, a process called training, in order to make decisions about new data, a process called inference.

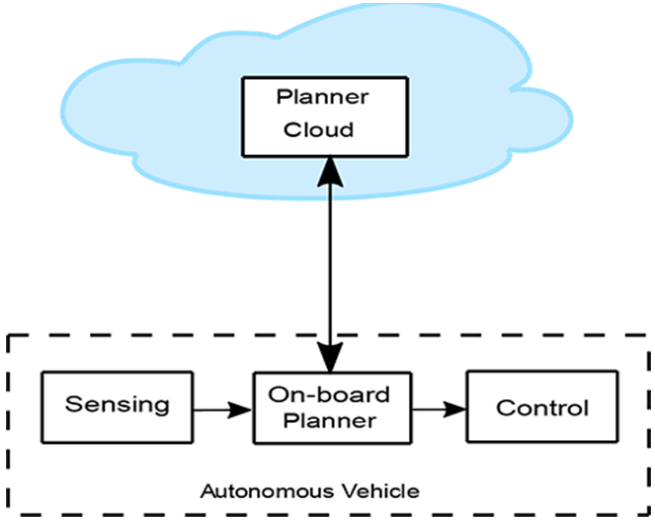
IV. Cloud Data Transfer

4.1 Cloud to Vehicle

Vehicle Cloud Computing is a technology is the combination of different networks such as mobile ad hoc networks, wireless sensor networks, vehicular ad hoc networks, and cloud computing to provide better services for automatic cars. VCC is a technologically feasible and economically viable technological shifting paradigm for converging intelligent vehicular networks towards autonomous traffic, vehicle control and perception systems.

For example sharing planned destinations for collaborative route planning requires sharing information with hundreds of vehicle using c2v communication.

4.2 How Cloud Works with Vehicle



Step – 1

Camera will sensing the image of traffic signs and human signs forward it to on-board planner.

Step – 2

On-board planner accept request from sensing and forward it to cloud. In cloud a small front application is available for making decisions so in application algorithm will run and response to on-board planer.

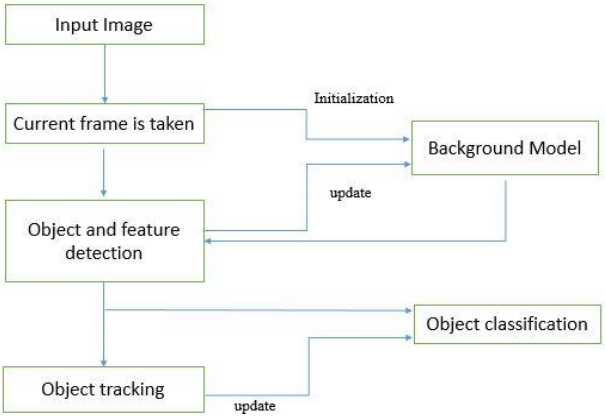
Step – 3

On-board planer request to controller for taking turns and follow the signs.

V. Object Detection

Object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class (such as humans, buildings, or cars) in digital images and videos.

5.1 Object Detection Flow Chart



Step – 1

Image detect by the camera. Image will be converted into the frame. Taken frame is divided into small pixels. And initialize by the background model. Background model is perform the image scanning and identification operation for example background model identify the image like stop sign, parking sign, and etc.

Step – 2

In the next step the algorithm is preform object feature detection operations like object shape, for example some objects are square, rectangle, etc. also here the algorithm calculate the weight of image.

Step – 3

Object tracking step is track the all updates of images and forward it to the object classifier.

Step – 4

Object classifier classify the image. The algorithm will give command to car for start and stop.

5.2 Object Detection Algorithm

- Object detection algorithms typically use extracted features and learning algorithms to recognize instances of an object category.
- In this research work I use object detection algorithm to detect objects like signals and on road like zebra crossing and left, right, turns.
- In this research work I use Open CV platform to test, detection algorithm for better results.
- For example on road ahead a stop sign so, car will detect the sign and take decision.

5.3 Action/Correction Algorithm

- Action/correction algorithm is for decision making.
- In this research work action/correction algorithm use to stop, start the car.
- Here, action/correction algorithm is take decision with the help of object detection algorithm.
- For example object detection algorithm is detect the sign and send the command to action/correction algorithm for stop and start.
- Also when something wrong happen in cloud or application the car is take default stop decision. Car will not move from current place in this condition this decision in making by action/correction algorithm.

VI.CONCLUSION AND FUTURE WORK

Conclusion

In this paper, a method to make a self-driving robot car is presented. The different hardware components and their assembly are clearly described. A novel method to determine the uneven, marked or unmarked road edges is explained in details relying upon OpenCV. Using ultrasonic sensors, the collisions with obstacles is avoided. The algorithm mentioned in the paper has been successfully implemented on a small autonomous car.

Future Work

The work could be enhanced by improving the algorithm by adding machine learning to it. The present algorithm performs the operations on all the frames. It is accurate but its efficiency could be further enhanced if it starts learning by itself and avoid unnecessary calculations of the regions which are already known or familiar. Once the car starts travelling on the roads, it determines the obstacles (mainly static) on the way and note their characteristic features. An XML file is generated every time the car travels. It stores the following information.

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