Gesture Control – High Level Design

*Submitted to*

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**Revision History**

**Change Record**

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| **Date** | **Author** | **Version** | **Change reference** |
| 3/20/2020 | Prithvi T B | 0.1 | Initial Version |
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**Reviewers**

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| Veena |  | 0.1 3/20/2020 | |
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|  |  |  | |

**DESIGN**

**Block Diagram**

Gesture Control System

Embedded System

Peripheral

Software

Speaker

P

Pi Camera

Twilio

Alert

DC Motor

Machine Learning Application

Fig: Block Diagram

**3.1 System Architecture Design**

Pi Camera

Twilio

Alert

Raspberry Pi 3 B+

Speaker

L293D

Alarm

DC Motor

Fig: System Architecture

The system main components are described below:

* Pi Camera
* Raspberry Pi 3 B+
* Twilio
* Speaker
* L293D
* DC Motor

**Pi Camera**

Raspberry Pi Camera V2 has a 8 mega pixel high quality Sony IMX219 image sensor. Pi camera is used to read the real time behavior of the driver which are placed in the vehicle. The Video is converted to frames and each frame is stored. The Camera is connected to Raspberry Pi Board.

**Raspberry Pi 3 B+**

. Ultimately for several reason Raspberry Pi 3 B+ was selected. Firstly, it has significantly Huge Processing Power in a compact board(Portable). Secondly it has many interfaces like HDMI, multiple USB, Ethernet, onboard Wi-Fi, Bluetooth, USB powered and many GPIOs which is very important interface to complete the required task. The **Raspberry Pi** is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse.

**Twilio**

Twilio is a developer software platform for communications. The Twilio is used to send the text alert with Latitude, Longitude coordinates and call alert with pre-recorded voice message for the subscribers when the driver has Health emergency like Heart attack or any other serious issues.

**Speaker**

Speaker is used to make an alarm to alert the driver when the driver is sleepy. It is connected to the Raspberry Pi Board

**L293D**

A L293D motor driver works as an amplifier by converting the low current control signal to high current control signal that makes DC motor run.

**DC Motor**

DC Motor is used to show application like AC control or any other in the vehicle when driver show some gestures.

**Detail System Architecture**

Raspberry Pi 3 B+ Board

Raspbian, NOOBS Operating System

MiniConda Platform

Libraries Keras Tensorflow OpenCV Twilio etc.

Classification Model

Training Model

Model.h5

Pi Camera

DC Motor

Twilio Cloud Interface

DC Motor Control

L293D

Alarm

Speaker

**3.1.1 Entity Relationship Diagram**

Embedded System

Twilio

Pi Camera

Monitor

Image

Communicates

Alerts

Speaker

DC Motor

Communicates

Communicates

Alarm

Motor Control

**3.1.2 Data flow diagram**

**3.1.2.1 Level 0 Data Flow Diagram**

System

Pi Camera

Alert

Input data

Text or Call

Control Panel

User Commands and Data

Alarm

Application Control(DC Motor)

Application Type

Alarm Type

**3.1.2.2 Level 1 Data Flow Diagram**

Twilio Cloud Interface

Send an Alert

Alert

Call or Text Alert

Alarm

Alarm

ALSA

Alarm Alert

Embedded System

Pi Camera

Camera Input

GPIOs control Supply

L293D

Control

DC Motor Control

3.3 Detailed Design

**Pi Camera**

Extract Frame per second

Continuous Video Capture

Pi Camera

Image from video

Save each frame

Embedded System

Input to

Store the Image

Continuous loop

Read Real Time Data

**Embedded System**

Raspberry Pi Board

MiniConda Software

Trained Final CNN Classifier Model

Classification

Model

**Raspberry Pi Board**

Raspberry Pi Board with SD Card

NOOBS

Raspbian

Monitor, Power Supply, Mouse & Keyboard

Raspberry Pi Installed with OS

Download & Install

Download & Install

Pi With OS

Connect to

Steps:

1. Insert the SD card into SD card reader, connect to computer and format the card.
2. Download Raspbian and NOOBS and carefully extract them to SD card.
3. Insert the SD card to Raspberry Pi board and connect the board to TV or Computer Monitor.
4. Connect Power Supply, Mouse and Keyboard to Pi Board.
5. Set the Language and Choose the OS to install.
6. Once the Installation is done, click ok and the system will reboot.
7. Select the options to reboot directly on the system desktop.

**Miniconda Software**

Miniconda is a free minimal installer for conda. It is a small, bootstrap version of Anaconda that includes only conda, Python, the packages they depend on, and a small number of other useful packages, including pip, zlib and a few others. Use the conda install command to install 720+ additional conda packages from the Anaconda repository.

Pi Board

Pi with Conda Platform

Install Required Packages

Create Virtual Environment in Conda

Download Miniconda Files

Download

Gives permission to Install

Conda Platform to run App

**Steps:**

1. Download the Miniconda files and run to start installation process.
2. After Installation, check conda installation and python version.
3. Install Anaconda Client and create Virtual Environment.
4. Install required packages in the created environment.

**Trained Final CNN Classifier Model**

We use already finalized and trained classifier model for classifying the real time image captured from pi camera. To finalize and train the CNN classifier there are several steps included which are done in the computer installing all the software and packages. Because the dataset may have several gigabytes of data which cannot be stored in Raspberry pi(it has maximum 64 GB data) to train the classifier. Training is done in computer, finalized and trained model is stored and saved as weights in a file which may have kilobytes of data. For further classification the saved trained model is used.

Dataset

Build CNN Classifier

Train CNN Final Model

Prediction Model

**Dataset**

Dataset is a collection of related sets of information that is composed of separate elements but can be manipulated as a unit by a computer. The photos will be reshaped into standard size(200\*200) before modeling so that all the images have same size. Five Category of data are collected for classification. Around 1000 images are captured and collected for each category, saved in their respective folders with the class name. Save all the Folders inside a folder named Dataset

The Categories are

1. Heart attack
2. Drowsiness
3. Gesture1
4. Gesture2
5. No Gesture

Camera

Dataset

Image

Respective Folder

Capture

Form a folder with all five sets

Send Data

Store in

**Build CNN Classifier**

Training Dataset

Training CNN Classifier

Testing CNN Classifier

Accuracy of the Classifier

Testing Dataset

**Training and Testing Data**

25% of the data is taken for testing and 75% of the data is taken for training the CNN Classifier. Each image is named with its respective class for training dataset but not for testing dataset.

**Training CNN Classifier**

Six Different CNN classifier Models are trained with same dataset. The CNN Classifier is built by arranging the convolutional layers with 3\*3 filters along with max pooling. Combined, these two layers form a block, now blocks can be repeated by increasing the depth of filters in each block like 32, 64 , 128 and 256. To ensure that Height and Width shapes of the output match he input, Padding is used on the convolutional layers. The Model with high accuracy is selected and made improvements by applying Dropout Regularization and Image Data Augmentation.

**Testing CNN Classifier**

Each Classifier Model is tested with same Unknow Test Dataset and accuracy of each classifier Model is noted. The Model with High Accuracy is selected as final model and used for prediction.

Dataset

Different Classifiers

Training Dataset

Testing Dataset

Load

Final CNN Model

Divide into

Accuracy based on

Accuracy

Divide into

Load

Calculate

Finalize

**Train CNN Final Model & Prediction Model**

After finalizing the model, to predict the real time data or image we train the final model with all the data we have without dividing into training and testing dataset. We cannot train every time to test single sample image. So, while training the final model we will store the data weights into .h5 file and save it. We will use this file for prediction.

Dataset

Sample Image

Final CNN Classifier

Load

Final\_Model.h5

Load

Predict

Display

Save

Image with predicted class

**Classification Model**

Classification model is used to check whether the saved Model is able to predict the extracted image from real time video capturing.

Web camera

Extract frame and save as image

Trained Final CNN Classifier Model(.h5 file

Load

Capture Video

Predict

Display

Image with predicted class

**Twilio Cloud Interface**

Classified Image is Heart attack

Twilio Library

Twilio Cloud Interface

Text Alert with GPS Location

Google API to Get GPS latitude and Longitude

Call Alert

Text or call Alert

Twilio Library

SMS Module

Call

Send Alert

Prerecorded call to Registered Number

Call Module

If classified image is Heart attack

Call if alert is from text module

Call if Alert is from call module

Text Message to Registered Number

Call

Google API to get Latitude and Longitude

Append the Lat & Lon Value to

Twilio Cloud Interface

send

Send

Call

Call Module

SMS Module

send

send

Steps:

1. Create a Free Account and Login into Twilio Cloud.
2. Twilio Account Create an Account Sid and Authentication Token. Save them.
3. Register the Number to which call, and text need to be sent.
4. Get the Twilio Number from which the alert should be sent.
5. Write a Python code to send the alert with given Account Sid and Authentication token by giving the registered and Twilio Number.

**ALSA**

Using Advanced Linux Sound Architecture module of Raspberry Pi, the sample audio file will be routed to external Speaker output.

ALSA

If classified image is Drowsiness

External Speaker

Call

Send Alert

Send

Alarm

Alarrm.wav file

Call

**L293D Motor Driver Chip**

A motor driver chip is an integrated circuit which is used to control DC motors. Motor driver act as an interface between Raspberry Pi and the DC motors. DC motor is used to show that, we can control some applications in vehicle like increasing and decreasing AC etc. with some simple gestures without much distraction from driving.

L299D

If classified image is Gesture 1

DC Motor

Call

Send Alert

Send

Increase the Fan

GPIOs from Raspberry pi

Call

L293D

If classified image is Gesture 2

DC Motor

Call

Send Alert

Send

Stop or Decrease the Fan

GPIOs from Raspberry Pi

Call

Steps:

1. Place the IC on breadboard, Connect Pin 1 to +5 VCC of Raspberry Pi using Connectors
2. Connect Pin 2 and 7 to GPIOs 13 & 15 of Raspberry Pi
3. Connect Pin 4,5 to Ground of Raspberry Pi
4. Connect Pin 3 to one terminal of DC Motor and Pin 6 to another terminal of DC Motor
5. Connect Pin 8 to another +5 VCC of Raspberry Pi for output power supply.