

Driver's Assessment Using Smartphones

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ARTICLE DETAILS

Article History

Published Online: 10 January 2019

Keywords

Smartphones, Accelerometer, KMP, Driving skill characterization, pattern recognition, image processing, machine learning, License generation.

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ABSTRACT

The mishaps caused by improper and rash driving on the roads is increasing day by day, thus causing a threat to many lives. A way to avoid these accidents caused by harsh driving is addressed in this paper which is, to give a driving license only to those drivers who drive in a professional manner. Assessing the driving style of a driver during their learning phase will give information about whether they are a good driver or not, and if they are reliable enough to drive in a proper manner. This method can be helpful in reducing the number of rash drivers and eliminate any false means used to gain a driving license. The RTO can use this method to assess the driving style of an individual acquiring a license to prove their eligibility. This paper gives us information about checking the authorization of user and also how the driving styles of an authorised user is compared to the standards that are set by the RTO to be eligible for a license. It concludes with a discussions of the challenges and any future works that would bring the proposed technique in practical use.

1. Introduction

The accidents caused by the unprofessional drivers are increasing day by day. Their careless and ignorant behaviour causes many accidents which risks the safety of the pedestrians. This paper attempts to provide a method to give a fair chance to each license applicant to prove their eligibility to the license department. This project aims to help eliminate frauds practiced while getting a license through agents or any other false means. To get the permanent license the authorised user should learn proper driving in his learning phase which will be assisted by the system. The information about his driving style will be captured by the sensors in the smartphones and will be stored in the database. This information will be used to categorize the user as an eligible driver on the amount of driving done and the driving style practiced. Thus reducing the harsh drivers who drive in a rash way. Focusing on the safety of the driver and the people around, a license should be permitted to only those who drive properly, thus lowering the rate of accidents caused by unprofessional drivers. This reduces the time consumed for the entire license generation process as the proposed system automates the process. The proposed system can be used by RTO department as this will automate the entire licence generation process, thus saving time and will also help them find eligible individuals who will drive in a proper manner.

1.1 Motivation

The motivation to develop a system that permits a license to deserving drivers comes from many sources, but the most important is safety of the people. The existing license generation system being a lot more time consuming and not fair in many ways can be modified with the help of proposed system. Observing that due to the current system the drivers

being at a very young age do not know how to drive in a proper and safe manner but they still get their license through false practices, increasing the rate of accidents. A license should only be given to those drivers who can drive in a safe way which would curb the risks caused by harsh drivers by their improper driving skills. Having such a system will definitely have its contribution towards safer roads.

1.2 Goals

1. Reduce the mishaps caused due to lack of driving skills, thus increasing safety of the driver and pedestrians as well.
2. Reduce the frauds that are happening at RTO.
3. Save the time consumed by the current license generating system.
4. Improvement in the driving skills of a driver with continuous assessment.

1.3 Objectives

1. Nowadays violation of traffic rules and driving in an unsafe manner is a common problem faced around the world which is leading to many accidents. Using an application like this could help lower the rate of mishaps occurring on roads.
2. The main objective of the proposed system is to avoid any chance of drivers who are not eligible to have a license which may reduce the rate of accidents. This application could be used to analyse the driver's driving skills and conclude whether they are eligible for the license or not.
3. This system can increase the efficiency and effectiveness of the RTO.

2. Literature Survey

REF NO.	PAPER TITLE	PROBLEM ADDRESSED	TECHNIQUES USED
[1]	Analysing Driver Behaviour using	A survey of various methods for analysing driver's behaviour	Dynamic Time Warping (DTW)algorithm, accelerometer,

	Smartphone Sensors: A Survey	appeared in literature survey.	gyroscope, magnetometer, GPS, machine learning
[2]	Driving Events Recognition using Smartphone Sensors	To improve road safety and reducing road accidents, we present a methodology for driving events recognition based on Smartphone sensors (accelerometer, gyroscope, and GPS) and using K-nearest neighbour and Dynamic Time Warping algorithms.	K-nearest neighbour and Dynamic Time Warping algorithms
[3]	A Pattern-Recognition Approach for Driving Skill Characterization	An approach to driving skill characterization from a pattern-recognition perspective	artificial neural networks (MLP-ANNs), decision tree, and support vector machines (SVMs), MATLAB neural network toolbox
[4]	A Novel Motion Plane-Based Approach to Vehicle Speed Estimation	To achieve monocular video-based vehicle speed estimation	Shape-from-Template (SfT) technique,
[5]	Movement Pattern Recognition through Smartphone's Accelerometer	Recognizing situations when a pedestrian stops, crosses a street ruled by a traffic light from the accelerometer of the pedestrian's smartphone	Smartphone sensors
[6]	The Combination of JAVA with MATLAB Apply to Meteorology	Analysing the characteristics of MATLAB and Java	MATLAB engine ,Java
[7]	FACIAL PARTS DETECTION USING VIOLA JONES ALGORITHM	To detect the faces in an image and locates the facial features in an image	Haar like feature, Ada boost a machine learning method , Cascade classifier
[8]	DATA CLASSIFICATION USING SUPPORT VECTOR MACHINE	A novel learning method, Support Vector Machine (SVM), is applied on different data (Diabetes data, Heart Data, Satellite Data and Shuttle data) which have two or multi class	Rule Based classifier, Rule Based classifier with Discretization, K-NN classifier and LTF (Local Transfer Function) Classifier
[9]	Student Residential Distance Calculation using Haversine Formulation and Visualization through GoogleMap for Admission Analysis	In this paper, data mining is used for such a purpose where in which it helps in increasing the marketing of a respective educational organization	Haversine's formula and the clustering algorithm k-means
[10]	Parallel Research on KMP Algorithm	Knuth and others put forward KMP algorithm in order to promote efficiency of the pattern matching	Parallel KMP algorithm based on MPI
[11]	Complementary approach of Internet of Things and Desktop Clouds	Merging to data from IOT enabled application to Desktop Cloud	Java as open source technology in VirtualBox

3. Proposed System Architecture

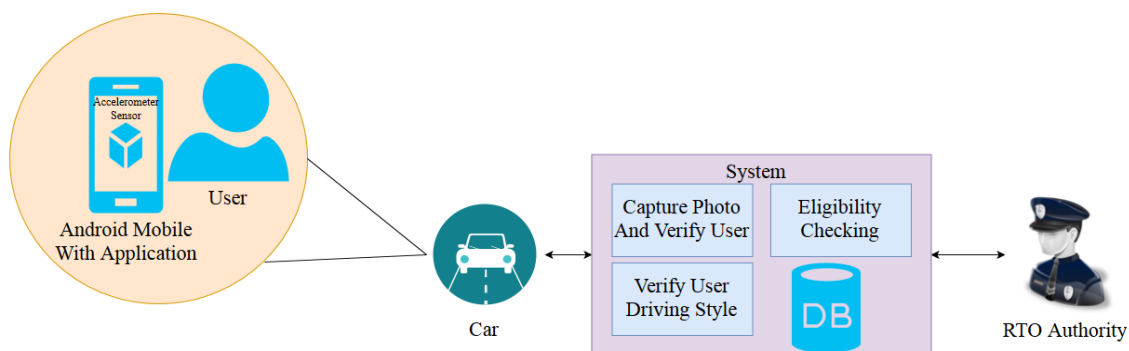


Fig 1: Proposed System Architecture

After learner's license test, the user will be given a unique login id and a password from the RTO department to login into their application to apply for a permanent license. After logging in with the given credentials the user will be verified as an authorised user with the data that is already present in the database. As soon as the user is verified to be an authorised user they can apply for the permanent license. After applying

for the permanent license the data regarding his driving behaviour will be analysed whenever he drives. In this system the driving behaviour will be analysed with the help of sensors which are present in the smartphones. The data which is captured is saved into the database for further evaluation. Whenever the driver is driving, the system will also capture user's picture after every predefined period to check whether

the data being captured is of the same authorised user or not, for this purpose image processing is done using [7] VIOLA JONES Algorithm for facial parts detection to detect the faces in an image and locates the facial features in the image and [8] SVM is used for matching the captured images with the already stored image in the database, if image of the person captured dynamically doesn't match with the stored image, an error of unauthorised user will be displayed. This is to make sure that the assessment of the driving behaviour is of the authorised person and somebody else's, thus eliminating any fraud. After the user has drove the standard distance which is required to be eligible which is set by the RTO the user's data is sent for further evaluation. The total distance travelled by the user is calculated by using the Haversine Distance formula. For the evaluation purpose the system compares the patterns of user's driving styles with the standard driving styles that are set by the RTO. This pattern matching is done by KMP (KNUTH-MORRIS-PRATT) algorithm. Using these algorithms the candidate is categorized as eligible or not. If his driving styles doesn't match with the pattern set as ideal driving pattern, then he is failed. Moreover, the RTO officer will analyse the gathered data and confirm if the permanent license should be granted or not.

4. Related Algorithms

4.1 KMP (Knuth–Morris–Pratt) ALGORITHM

Considering two strings T and P. Our task is to find all the sub-strings of P in T. Simplest way of pattern matching could be comparing characters of P with characters of T one by one, this approach is simple but efficiency is not high. [10]KMP matching algorithm is an extension to the Brute-Force (BF) algorithm. Its main purpose is: when T_i and P_j are identical, the pointer i of the main string and the pointer j of the pattern string should be incremented by 1 and then go back to the match. If the match is unsuccessful, pointer i does not move and j does not go back to the first position, but returns to its proper place. The position where j returns is the key of KMP algorithm. J cannot move to the right too much and miss the effective match, but it should make use of the successful match to shift the j to right as large as possible, so that the pattern string that was satisfied doesn't need to be compared again and again. Therefore, the aim of the KMP algorithm is to look for pattern string own regularity. An array called next is used to store the law of the pattern string. Now it should compare the k ($k < j$) characters of the mode string, and the $k-1$ characters before k of the pattern string must meet the following formula [10]

$$P_1P_2...P_{k-1} = T_{i-k+1}T_{i-k+2}...T_{i-1} \quad (1)$$

And part of the matching result obtained is:

$$P_{j-k+1}P_{j-k+2}...P_{j-1} = T_{i-k+1}T_{i-k+2}...T_{i-1} \quad (2)$$

By equation (1) and (2) we deduced the following equation:

$$P_1P_2...P_{k-1} = P_{j-k+1}P_{j-k+2}...P_{j-1} \quad (3)$$

KMP string pattern matching process is described as follows:

Algorithm 1:

1. $i \leftarrow 1$
2. $j \leftarrow 1$
3. for $i \leftarrow 1$ to $TextLength$ do
4. if $j \neq 0$ and $P[j] = T[i]$ then
5. $j \leftarrow newnext[j]$
6. if $j \leftarrow m$ then

7. $match[i(m-1)] \leftarrow 1$
8. $j \leftarrow next[m + 1]$
9. $i \leftarrow i + 1$
10. else
11. $j \leftarrow j + 1$
12. $i \leftarrow i + 1$
13. $MaxPrefixLen \leftarrow j - 1$

```
int pMatch(PseqString t, PseqString p, int *next){
    int i,j,count; i=0,j=0;
    while(j<t->n)
        if(i== -1 || p->[j]==t->c[j]) {
            i++; j++; }
        else
            i=next[i];
        if(i>=p->n){
            count++; i=0; }
        return count;
    }
```

4.2 Data Processing

4.2.1 High-pass Filter

A high-pass filter should be applied on the collected data, to obtain only higher values which are the most representative for movements. Thus, we obtain smoother acceleration values to work on, which allows better results than raw data [5].

$$rollx_j = (x_j \times k) + (rollx_{j-1} * (1.0 - k))$$

$$x_j = x_j - rollx_j$$

With k as appropriate constant, the low-pass value is subtracted from the current value to get a simplified high-pass filter.

4.2.2 Data features

The smart phone can have various positions with respect to the user's body, to avoid discrimination about the smartphone position we choose to join three axes(x, y, z), rather than working on three different vectors.

Acceleration vector magnitudes were computed through (5).

$$magnitude(v) = |v| = \sqrt{v.x^2 + v.y^2 + v.z^2} \quad (5)$$

Using (5) we can make the data independent of the smart phone's position. It works even if the user is holding the smartphone in her/his hand. Along with the magnitude of the acceleration vector, mean and standard deviation of the magnitude array will also be computed, to encode the set of magnitudes as an instance of {mean, standard deviation}.

4.3 SVM (Support Vector Machine)

SVMs are set of related supervised learning methods which can be used for regression as well as classification. A special property of SVM is that it can simultaneously maximize the geometric margin and minimize the empirical classification error. SVM constructs an input vector to a higher dimensional space where a maximal separating hyperplane is constructed. The data is separated by two parallel hyperplanes that are constructed on each side of the hyperplane. This maximize the distance between the two created parallel hyperplanes. An

assumption being made that if the margin or distance between these parallel hyperplane is larger ,the generalization error of the classifier will be better [8].

Considering data points as,
 $\{(x_1,y_1),(x_2,y_2),(x_3,y_3),(x_4,y_4),\dots\dots\dots,(x_n, y_n)\}$.

Where $y_n=1 / -1$, is a constant denoting the class to which the point x_n belongs. Where $n =$ number of samples. Each x being a p -dimensional real vector. The scaling is crucial so as to guard against the variable (attributes) that has large variance. We can view this Training data, by means of the dividing (or separating) hyperplane, which takes

$$w \cdot x + b = 0 \tag{6}$$

Where b is scalar and w is p -dimensional Vector. The separating hyperplane is perpendicularly pointed by vector w . Adding an offset in this case parameter b allows us to increase the margin. Absent of b , the hyperplane is forced to pass through the origin, restricting the solution. As we are interested in the maximum margin, thus we should know about SVM and the parallel hyperplanes [8]. Parallel hyperplanes can be given as

$$w \cdot x + b = 1 \tag{7}$$

$$w \cdot x + b = -1 \tag{8}$$

If the training data are linearly separable, we can select these hyperplanes so that there are no points between them and then try to maximize their distance. The distance between the hyperplane is found as $2 / |w|$ by geometry. So we want to minimize $|w|$. To excite the points of data, we should makes sure that for all 1 either

$$w \cdot x_i - b \geq 1 \quad \text{or} \quad w \cdot x_i - b \leq -1$$

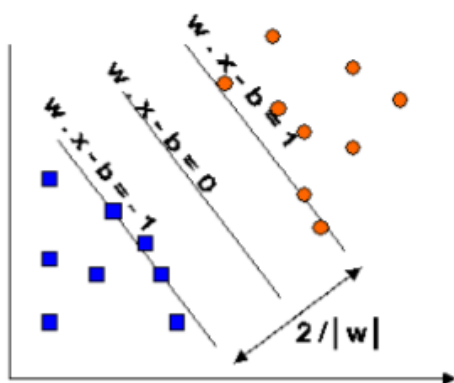


Fig: 2 Maximum margin hyperplanes for a SVM trained with samples from two classes

4.4 VIOLA-JONES FACE DETECTION

The Viola-Jones face detection method is the first framework based on object detection. It provides good detection rates in real-time and has been implemented in software ‘MATLAB’ using the method ‘visionCascadeObjectDetector()’.

The Viola-Jones contains of 3 techniques for the facial parts detection [7]:

1. The Haar like features (HLF) for the feature extraction. They are rectangular typed structures which are determined by an integral image.
2. Adaboost is a machine-learning method for detecting the face. The term ‘boosted’ determines the classifiers

that are complex at each stage, which are built on basic classifiers using boosting techniques.

3. Cascade classifier are used to combine many of the features efficiently. The term ‘cascade’ in a classifier determines the several filters on a resultant classifier.

Viola Jones Upper Body Detection

The upper body parts can be detected using this method using the still images based on the successful object detection framework on it. It also contains the model for detecting the near and frontal upper bodies [7]. The upper body detection in this model detects the upper body region, which consists of the head and the region of the shoulder combining with the face. The details of the head and the shoulder region has been encoded using the Haar features and object detection. Since the objects in the head and face use more type of features, this model is more robust against the pose or the changes in the image. Rotating the head/blinking eyes with a tilt are suitable examples. To detect The upper body using the classification model we have 3 properties:

1. Create a detector object and their properties.
2. Input image given is read and is used to detect the upper body.
3. Show the detected upper bodies in a bounding box.

4.4.1 Face Detection

Haar Features

MATLAB is used to implement the Haar cascade classifier. [7]The face detection is mainly done by the Haar Cascade classifier. The Haar features determine the presence of the features in any of the input image. By dividing the sum of black pixels by the sum of white pixels, we obtained the result of each feature. $HLF(x) = \text{Sum of black rectangle} / \text{Sum of White rectangle}$ [9]

For rapid and instant detection of a face, the rectangle features like Haar features have been used. The Haar like features is as shown in the Figure 3.



Fig 3: Haar Features

The Haar features have been allowed to convolve and scan through the images from the top left corner and it ends the detection of face processing at the right bottom corner.

4.4.2 Integral Image

The integral image concept is used to compute the rectangle like features. [7]Sum of the pixels in any rectangle is determined by using the four values present at each corner of any given rectangle. In an integral image, the value at every pixel is given by the sum of the left and to the above pixel of the image. All the pixel values have been added in rectangle ‘D’.

$$\begin{aligned} G1 &= A \\ G2 &= A + B \\ G3 &= A + C \\ G4 &= A + B + C + D \\ D &= G1 + G4 - G2 - G3 = A + A + B + C + D - A - B - A - C \end{aligned}$$

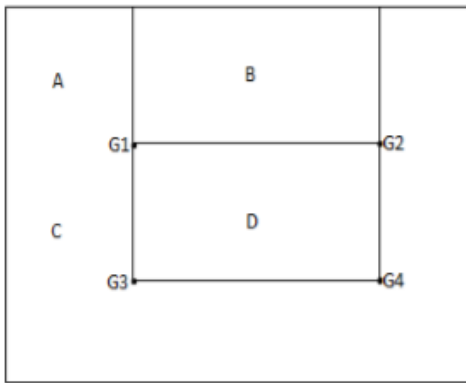


Fig: 4 Calculation of Integral Image

The various parameters like type, position and scale of the Haar features if considered, then the best features among these features have been found using Adaboost technique which is a machine learning algorithm. These may be considered as weak classifiers but Adaboost determines a strong classifier which may be the linear combination of these weak classifiers [7].

4.4.3 Cascade Classifier

If the image is of a human face in the cascade method, then it will pass the case and go on to the detection phase else it will be considered as a non-facial-region.

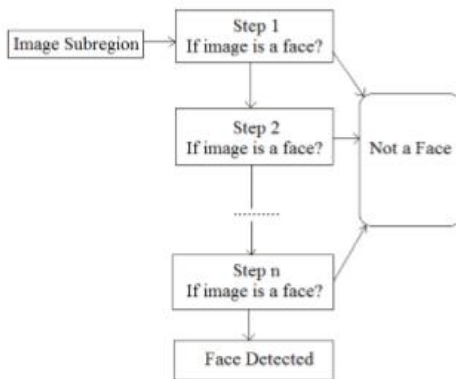


Fig 4: Cascade Classifier

4.5 Dynamic Time Warping

Dynamic time warping (DTW) is a known technique to find an optimal alignment between two given (time-dependent) sequences that have certain restrictions. The sequences are warped in a nonlinear fashion to match each other [1].

The objective being comparison between two (time-dependent) sequences.

$$X = (x_1, x_2, \dots, x_M) \text{ of length } M \in \mathbb{M} \text{ and}$$

$$Y = (y_1, y_2, \dots, y_N) \text{ of length } N \in \mathbb{N}.$$

These sequences may be discrete signals (time-series) or, featured sequences that are at equidistant points in time. Here, we have a feature space denoted by F . Where $x_n, y_m \in F$ for $n \in [1 : N]$ and $m \in [1 : M]$. To compare two different features $x, y \in F$, one needs a local cost measure, sometimes also referred to as local distance measure, which is defined to be a function

$$c : F \times F \rightarrow \mathbb{R} \geq 0$$

As observed, if x and y are similar to each other $c(x,y)$ is small (low cost), otherwise $c(x, y)$ is large (high cost).

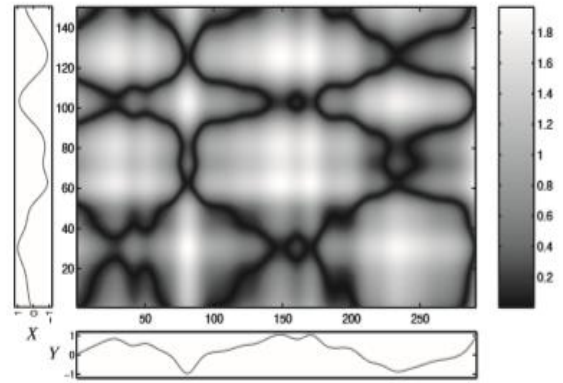


Fig: 4 Feature Space

Cost matrix of the two real-valued sequences X (vertical axis) and Y (horizontal axis) can be found using the Manhattan distance (absolute value of the difference) as local cost measure c . Regions of low cost are indicated by dark colours and regions of high cost are indicated by light colours.

The DTW distance $DTW(X, Y)$ between X and Y is then defined as the total cost of a*:

$$DTW(X, Y) = ca^*(X, Y) \quad (4.3) = \min \{c_p(X, Y) \mid p \text{ is an } (M, N)\text{-warping path}\}$$

The points to be noted about DTW are, first, note that the DTW distance is well-defined even though there may be several warping paths of minimal total cost. Second, it is easy to see that the DTW distance is symmetric in case that the local cost of c is said to be symmetric.

5. Conclusion

From the above considerations it can be concluded that the proposed system can be highly effective when it comes to the safety of people as there is an extremely high rate of accidents taking place due to unprofessional drivers driving in rash manner. Road safety problems being a major area of concern in the transport industry as the rate of people driving vehicles is increasing especially in developing countries. The proposed system makes sure that this great number of people driving vehicles know how to drive in a professional and safe manner to avoid any risk of mishaps. The existing system doesn't check the driver's ability to an extent where it can be sure about their driving skills, as it is simple enough to get a license from the existing system without completely evaluating the driver's driving behaviour. The proposed system allows the RTO authority to force people to follow all RTO rules and to drive in a proper manner for a period, which checks not only whether the driver is able to drive the car in a proper manner but also if he is able to make decisions in traffic while following rules properly. Proposed system makes sure each and every permanent license holder user is perfect in driving and is following traffic rules. This will completely eliminate the false means that people use to get a license giving each individual a fair chance to prove their eligibility to gain one. This system can also be used if a person wants to improve their driving skills to learn driving in a better manner.

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