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Automotive User Profiling Using Vehicle Data Considering Different Driving Scenarios

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***Abstract*— The central idea of the paper is to find the various attributes of driver and their importance while driving so that these attributes can be used to create user profile of the drivers driving the vehicle. In this paper first we describe the architecture responsible for the generation of this attribute data and then we describe how this data can be collected and from where. Then we assigned preference to the attributes based on the seriousness of attribute, its number of occurrence and their dependencies on one another. After assigning preference we classify attributes into Primary, Secondary and Tertiary for user profile creation. Then we have described how these attributes can again be divided into Static and Dynamic for runtime comparison of driver attributes with the profiles already created. After that we consider various driving scenarios which also play crucial role in drivers driving activity.**

***Keywords*—User Profiling, Driver Parameters, Vehicle Data, Driving Scenarios**

I. INTRODUCTION

Driving is a complex information-processing task and is one of the most challenging activities people engage in on a daily basis. Driving is a dynamic task because the roadway information a driver must process (such as signs, signals, pavement markings, road curvature, position, and distance of other vehicles) changes constantly as a driver proceeds along his or her path. Along with this information processing driver has to perform various activities while driving. For driving driver use certain controls like change in gear, handling steering wheel, releasing and depressing accelerator, clutch, brake, various button events like turning on/off A.C, adjusting mirror position and many more parameters. These controls can be divided into two like major control and minor control. Major controls are those which actually control the vehicle and are regarded as being the most important. These are accelerator, brake, clutch, gear stick, handbrake, and steering wheel. Minor controls are those which are used in conjunction with major controls to help driver to state their intention to others as well as to see and be seen. These are blinkers, mirrors and light of the cars. While driver use these controls, driver activity can be recorded in vehicle itself so that using this data we can profile the automobile driver which has got various application as explained in [1][4]. Execution of these controls will generate signals and there are certain diagnostic port made available by auto manufactures at various ports like On Board Diagnostic-II (OBD-II) port, Controller Area Network (CAN) port from where these signals can be traced and they can be recorded using In Vehicle Data Recorder (IVDR) explained in [2] So that after recording these we can generate profiles out of it by assigning weights to the signals as stated in paper [1].

II. SYSTEM ARCHITECTURE

Our system comprised of Driver, Driver parameters, and Vehicle. Driver parameters comprise of Gear, Brake, Steering Wheel, Mirror Adjustment, Blinkers, Accelerator, Clutch, Seat Adjustment, Button events. While driving driver will use these parameters and will act on vehicle and thereby will generate vehicle data like Vehicle Speed, Wheel Speed, Mass air flow rate, Brake pressure, Accelerator pressure and many more. Vehicle data is the product of the interaction of these modules and this is what we require and from this data we will profile the driver by gathering the state of driver and vehicle as stated in paper [1]. This whole interaction of driver, driver parameters and vehicle is explained through Fig 1.

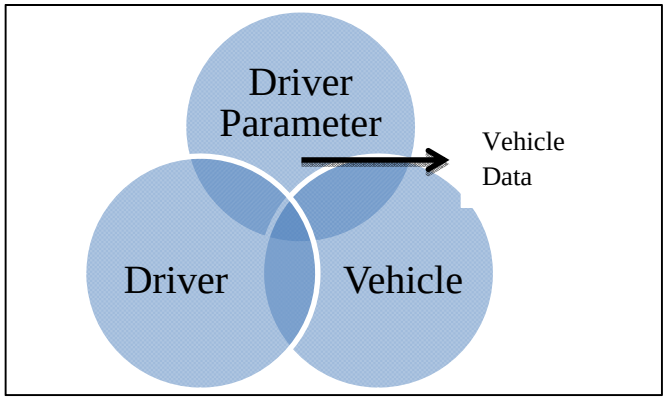

Fig. 1 System Architecture

III. VEHICLE DATA

In this scenario the interested information is various characteristics exhibited by automobile driver while driving and that can be derived from vehicle data. Ultimate aim for collection of vehicle data is to generate driver profile out of it and learning is required for deriving pattern out of this data. Learning will be carried out implicitly. No extra input is demanded from the driver. The only required input is that the driver has to drive the vehicle the way (s)he drives. Learning will take time. Driver profile cannot be generated overnight. Learning will be carried from the parameters executed by the driver and its effect on vehicle state. There will be a blind profiling stage in which no feedback will be provided to driver. Driver profile will be generated from the data collected in blind profiling stage over the period of time. These profiles generated in blind profiling stage will be used for comparison of driver behavior in current session and which has got various application stated in paper [1].

A. Vehicle data while learning phase

In the name of vehicle data [3] large number of attributes can be obtained as shown in Table. 1 through which profiling of driver can be done. During the process of vehicle data generation some attributes are generated more frequently compared with another and all this depends on the usage, requirement and execution of driver parameters from driver. For example when driver shifts gear sudden variation is observed in vehicle speed, engine speed within short span of time as compared to coolant temperature which maintains a range and takes time to vary. So our main focus is to divide those attributes taking into consideration their preference. Preference will be assigned in terms of seriousness of attribute, number of occurrence and their dependencies on one another. The signals which are affected directly by the controls performed by the driver will term as primary signals. Say when driver takes turn, he exhibits controls like steering wheel, acceleration, braking, and change in gears which in turn affects signals like steering wheel angle and its velocity, wheel speed, vehicle speed, brake, accelerator pressure and many more. Another example when driver applies brake signals like brake pressure, accelerator pressure, vehicle speed, wheel speed varies the most. So the signals like steering wheel angle and its velocity, wheel speed, vehicle speed, brake, accelerator pressure and many more as shown in Fig 2 are termed as Primary signals. There are certain signals which are affected indirectly i.e. they are changed or manipulated because of the change in primary signals. These signals will be termed as secondary signals. Signals like engine coolant, trip, fuel use are affected because of the change in signals like wheel speed, vehicle speed, acceleration and many more. But there are other signals which are affected once in a while like button events, mirror setting, seat adjustment, climate parameters and personalization parameters. These signals will be termed as Tertiary signals. Signals grouped in primary category are more significant than the rest two categories. Likewise signals from secondary category are more significant than tertiary category.

B. Vehicle data and current session

So in every new driving session there will be comparison between characteristics of new session with the characteristics of profiles we have. For comparison purpose the signals obtained can be divided into two types one is static characteristics and another is dynamic characteristics. There are various signals like steering wheel angle and its velocity, wheel speed, vehicle speed, brake, accelerator pressure and many more and if they are taken into consideration individually then it is termed as static characteristics whereas if more than one characteristic is taken into consideration simultaneously then it is termed as dynamic characteristics like when driver takes turn we have to consider how driver accelerates, how driver applies brake, how driver change gears, steering wheel angle and its velocity, whether driver gives indicator or not and likewise and that too simultaneously. Another example can be like sudden braking and for this simultaneous consideration of signals like brake pressure, accelerator pressure, vehicle speed, wheel speed, engine speed. So now we have signals like Static primary, Static Secondary, Static Tertiary in Fig 2. and Dynamic signals shown in Fig 3. This static and dynamic division of signals will also be taken into consideration while creating user profiles.

IV. DIFFERENT DRIVING SCENARIOS

While driving driver comes across various different driving scenarios like

1. Emergency
2. Weekend
3. Weekdays
4. Traffic
5. Free road
6. Day time
7. Night time
8. Outlier
9. Friend is driving

In emergency situation driver tends to drive faster than normal driving speed and might take sharp turns. Another scenario like in weekend's driver might cover larger distance than the average distance driver covers during weekdays. In Traffic condition driver behavior might be different than what is observed on free roads. So while profiling and comparison purpose of the driver these different scenarios should also be considered. Another

consideration could be like in day time driver tends to used less blinker as compared to the use of blinker during night time. From all the above consideration we can see that these different driving scenarios also governed driver's driving activity. Same goes with in case of outlier or when a friend of driver is driving as because in these scenarios the behavior which will be observed will be different than that of the regular behavior of driver.

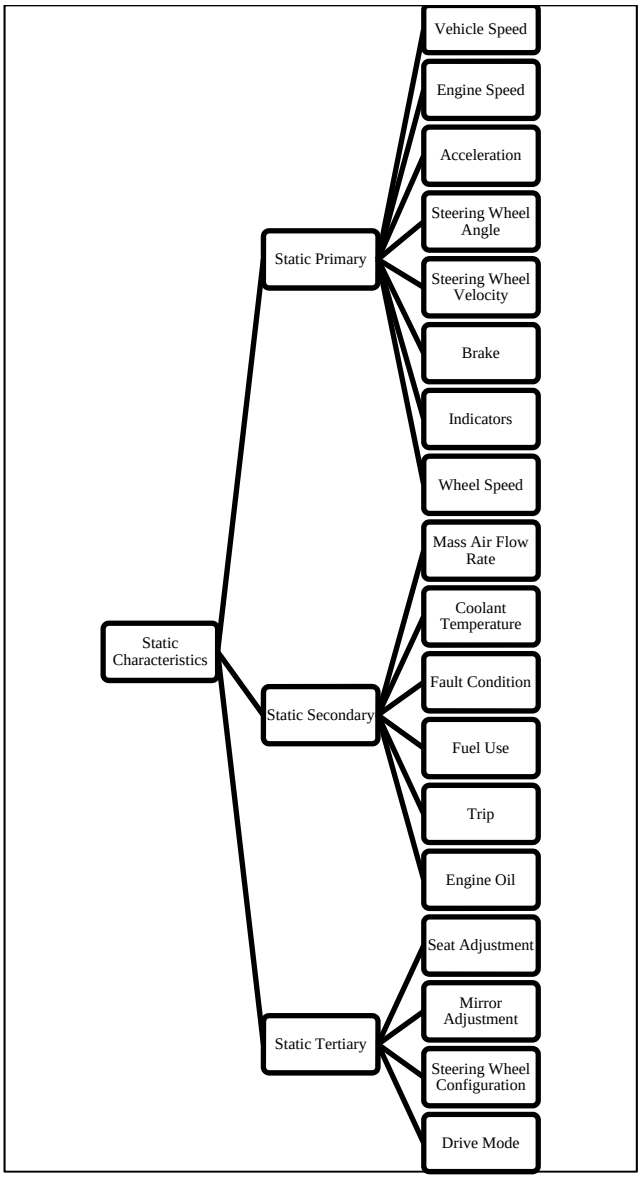

Fig. 2 Static Characteristics

These scenarios can be divided into

1. Direct Scenarios
2. Indirect Scenarios

Direct Scenarios are those which can be derived from the system itself like whether it is weekend or weekday, whether it is day time or night time all this can be derived directly from the system itself and thereby falls in Direct Scenario category whereas indirect scenarios will have to be inferred from the behavior of the driver.

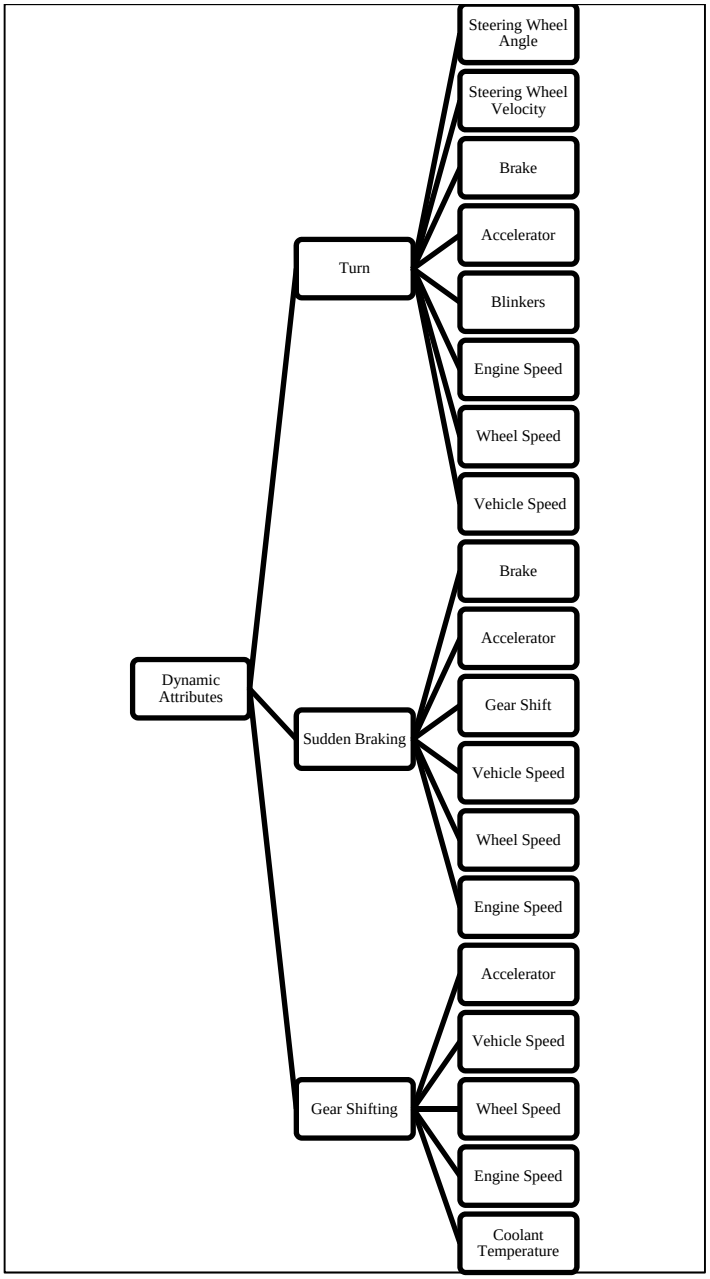

Fig. 3 Dynamic Attributes

Direct Scenarios

1. Weekends
2. Weekdays
3. Day time
4. Night time

Indirect Scenarios

1. Free road
2. Traffic
3. Outlier
4. Friend is driving
5. Emergency

They can again be divided on the basis of generality and is explained through the Fig. 4. The flow of Fig. 4 as can be seen goes from general to more specific.

Table I VARIOUS ATTRIBUTES

General Attributes	Specific Attributes
1. Running Status	Wheel Speed, Vehicle Speed, Engine Speed, Acceleration, Engine Coolant, Steering Wheel, Brake Operation, Button Event, Night Mode, Engine Oil, Throttle Position, Trip Meters, Light Status, Interior Light Status, Ignition Time and many more
2. Maintenance Parameters	Odometer, Transmission Oil, Transmission Clutch, Brake Maintenance, Malfunction Indicator, Battery Status, Tyre
3. Personalization Parameters	Mirror, Seat Adjustment, Steering Wheel Configuration, Drive Mode
4. Safety Parameters	Air Bag Status, Seat, Door, Child Safety Lock, Top Speed Limit
5. Climate Parameters	Temperature, Rain Sensor, Wiper Status, Wiper Setting, Defrost, Sun Roof, Convertible Roof, Side Window, Climate Control
6. Vision and Parking Parameters	Lane Departure Detection, Alarm, Parking Brake, Parking Light
7. Identification	Mini Car, Light Car, Compact Car, Medium Car, Heavy Car, Sport Utility Vehicle, Pick Up Truck, Van
8. Size	Total Doors, Height, Length, Width
9. Gear Type	Auto, Manual
10. Steering Wheel Configuration	To Left Side, To Right Side
11. Fuel Type	Gasoline, Methanol, Ethanol, Diesel, Electric

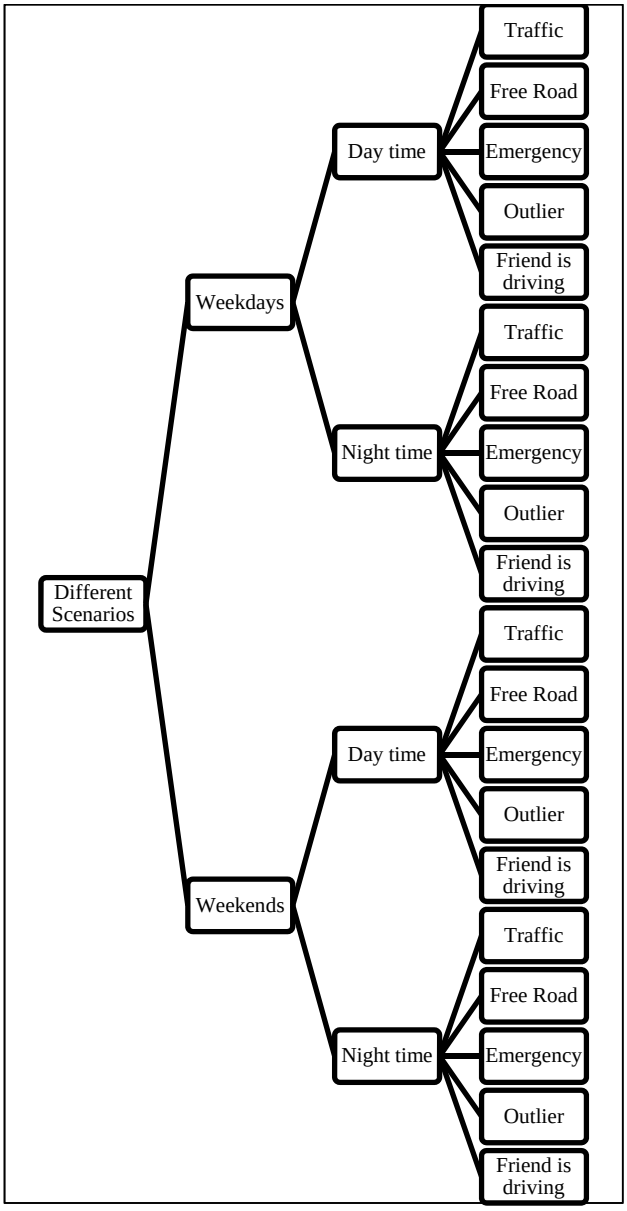

Fig. 4 Different Scenarios

V. CONCLUSION AND FUTURE WORK

Various different driving attributes are considered and preference is assigned to them. On the basis of these preferences they are further classified as primary, secondary and tertiary. Various different driving scenarios are also considered which also affects driver behavior.

Our future scope includes consideration of various other factors that can be responsible for change in driver's driving activity like fatigue, workload culture, psychological aspect and many more. Another consideration will be assigning weights to these attributes discussed for creation of driver's profile. We will also observed driving behavior and attributes in one driving session by dividing that session in terms of transaction going from one state to another such that part profiles explained in **[1]** can be created out of it.

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