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Simple and Effective Knowledge-based Vehicle Monitoring and Driving Assistance

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Abstract

We present a simple and effective knowledge-based framework for driving assistance and vehicle monitoring, exploiting a smartphone. The approach combines basic vehicle information extracted through On Board Diagnostics (OBD-II) protocol, data acquired from micro-devices embedded in smartphones, e.g. accelerometer, and information retrieved from the Web. Data fusion and classification algorithms are exploited to identify and semantically annotate relevant contexts and events in real time, and a semantic-based matchmaking process is used to infer dysfunctional situations due to either vehicle or driver behaviour and subsequently provide suggestions to the driver or inform pre-selected contacts via email/SMS.
Consider that several Electronic Control Units (ECUs) manage and monitor internal components and subsystems in modern cars. International regulations mandate all new vehicles must support the On Board Diagnostics, version 2 (OBD-II) protocol (http://www.arb.ca.gov/msprog/obdprog/obdprog.htm) as reference standard for communication and data interface and be equipped with an OBD-compliant interface to provide direct and common access to data in the internal automotive network. Furthermore, in case of malfunctions, Diagnostic Trouble Code (DTC) values are stored in the car ECU and can be later retrieved by maintenance technicians using proper tools. Recently, access has been granted also to the general public of car enthusiasts by the development of OBD-II scan tools, cheap electronic devices that bridge the OBD-II port with standard wired (RS-232, USB) or wireless (Bluetooth, IEEE 802.11) computer communication interfaces.
We propose a system that interprets vehicle data extracted via OBD-II, integrates environmental information and detects potential risk factors. Particularly, by means of properly devised processing and fusion algorithms, the system is able to identify and classify given high-level events and conditions, based on low-level data streams. Furthermore, leveraging Semantic Web languages and technologies, events are annotated with respect to an ontology that models characteristics influencing driving safety and undergo a matchmaking process exploiting an embedded reasoner. The matchmaking outcome is used to suggest the driver (via her smartphone) actions and behaviours she should adopt to reduce a possible risk or inform pre-selected contacts via email/SMS.
Beside providing warnings when potential risk factors are detected, the proposed system evaluates car efficiency and environmental impact also alerting selected personnel via text messages when needed. The proposed framework has been implemented in a prototypical mobile software system, using the Apple iPhone smartphone as reference platform, but it has been also granted a full compliance with Android platforms. Main Machine Learning and Data Mining research results are leveraged to allow a modelling of the "car+driver+environment" complex starting from an ontology-based domain conceptualization. Raw data collected from the car ECU and available on the smartphone are pre-processed and filtered to produce a semantic-based description to be compared with best driving practice via a matchmaking process –using non-standard reasoning services.
Particularly, the experimental evaluation has been carried out in real-world drives under different conditions, and both feasibility and usefulness of the approach appeared as evident.

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