Intelligent Safety Information Gathering System Using a Smart Blackbox

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***Abstract*--This paper presents an intelligent method to collect the accident or safety information using the widespread blackbox system. Conventionally, when information is needed after an accident or crime happened, investigators seek for possible clues non-systematically by hand. We propose a systematic method of gathering that information using an intelligent blackbox system which analyzes and gathers information of neighboring vehicles while driving. For this purpose, in addition to the functionality of storing the video sequence while driving, we add a recognition engine to extract and record the license plate number and color of neighboring vehicles. We also add the IOT functionality to receive information request message from the server and upload the matched information to the server.**

I. Introduction

When an accident or a crime happens, information related with those accidents is needed to find out the cause of the accident or the culprit of the crime. Conventionally that kind of information is gathered non-systematically by the investigator by means such gathering rumors or asking for the observers who happen to pass by the place at the time of accident. Recently more and more cars are adopting the blackbox system to get evident of clarifying which part is liable for the traffic accident. The conventional blackbox system is mainly composed of the image capture and video signal compression engine. Lots of information gathered and stored in blackbox is thrown away when the accident is not directly related with the car even though that information can contain the critical information.

Recently several works were reported for the extension of the blackbox functionality such as aiding the ADAS (advanced driver assistance systems) [1-4], combining with OBD (on board diagnostic) [5] or recognizing the pedestrian/vehicles [6]. However, there is little work reported to use blackbox as an efficient information gathering system.

In this paper we propose an intelligent safety information gathering system using the widespread black box system. We add several additional functionalities to the existing ordinary blackbox system. The first functionality is analyzing and extracting the key information of the surrounding vehicles while driving. For this purpose we add the recognition engine which extracts the license plate number and color of the passing by vehicles. Secondly we add the communication engine to receive the information request from the server and upload the stored information. GPS engine is also added to record the time and driving route information, which are used to match the stored information with that requested. When the server broadcasts information of some specific time and place, our intelligent blackbox system receives that request message from the server, matches the time and place tag and then send the matching information to the server.

Our system first detects the lane of the road and neighbor vehicle. Then based on the lane and vehicle information we narrow down the license plate search region and detect the location of the plate rectangle. After that we apply license plate number recognition algorithm using adaptive thresholding, labeling and artificial neural network (ANN). To overcome the shadowing effects, unclean surface, image blurring problems we use a sophisticated labeling algorithm. Since the information gathered could contain the private data, we apply the security algorithm for the storing and transferring of the data from and to the server.

II. System Description

In Fig. 1 we showed the operation scenario and system diagram of the proposed system. When the accident or crime happens it is reported to the police server system and information request message containing the time and location of the accident is broadcasted to the smart blackbox system. The smart blackbox with the recognition and GPS/OBD module matches the request message with the data in DB system. If the system finds the matched data, then it automatically uploads that information without the user intervention by the 3G/LTE network.

The algorithm flow of the recognition module we consider is shown in Fig. 2. First the audio/video signal is captured and

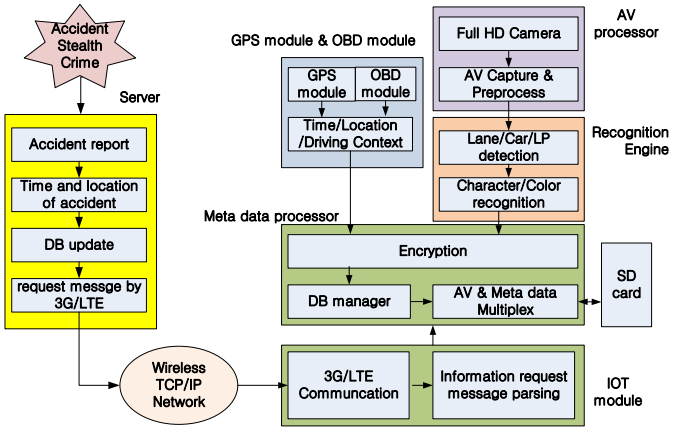

Fig. 1. Proposed system block diagram.

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compressed. In parallel, the raw image signal is transferred to the recognition module after preprocessing to adjust the brightness and remove the noise. In the recognition module, we detect the lane segment using restricted range Hough transform and line tracker algorithm. Then based on the lane information, vehicle detection algorithms are applied, which use the Harr feature based candidate region detection and the left-right edge symmetry property of the rear view vehicle image. Then we search for the license plate region inside the vehicle area using H/V edge density analysis and additional heuristics to increase confidence of the decision.

Finally we apply an adaptive binarization and connected component analysis (CCA) algorithm for character recognition. Since the light change, dark shadowing and dirt on the plate region altogether hinders the character recognition accuracy, we carefully apply an adaptive threshold decision algorithm using the local intensity variations and sophisticated shadow removal algorithm. Color information is also extracted using HSV domain histogram analysis method around the license plate region. For the character recognition we apply a dual-layer perceptron neural network with a single hidden layer. By transforming the input pixel domain to the feature domain we reduce the number of input nodes in ANN.

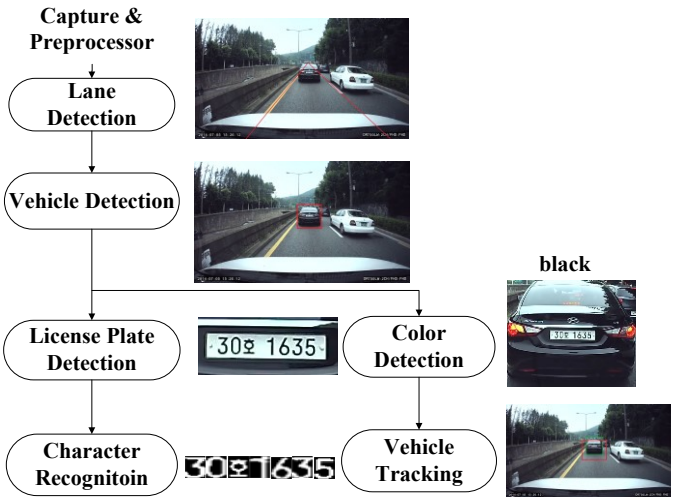

Fig. 2. Functional diagram of the recognition module.

III. Simulation Results and Implementation

In table 1 we show the performance of the proposed recognition algorithm by computer simulation. Since it is not easy to show the detection and false alarm rate accurately while driving, we recorded the still and moving picture of various rearview vehicle images taken at a suitable distance. We reduced the number of the input node of neural network to 144 by feature domain representation of the input pixels and used half the size of the input node as a hidden layer. Since it is not easy to get a sufficient number of character images (there seems to be no standard DB for a license plate number recognition whereas there exists MNIST dB for the handwritten character recognition), we made a test pattern generation algorithm to extend the training character image. As shown table 1, our system shows approximately 80~85% accuracy in vehicle license plate number and color recognition.

Table. 1. Simulation results.

Function	# of Sample	Detection rate	False alarm rate
Vehicle detection	2000	88 %	18 %
Color recognition	1000	83 %	-
License plate detection	2000	85 %	21 %
Plate number recognition	1000	81 %	-

We implemented the system using the commercial ASIC chip adopting multi-core microprocessor system. The chip contains floating point DSP in addition to three CPU cores which deal with the A/V signal capture, preprocessing and H.264 data compression. Our search engines are ported to the DSP core and communicate with other submodules for data transfer. In Fig. 3 we show the picture of the proposed prototype blackbox system.

Fig. 3. Picture of smart blackbox system.

IV. Conclusions

In this paper, we proposed an intelligent blackbox based safety information gathering system. We added additional functionalities to the ordinary car blackbox such as license plate number and color recognition of neighboring vehicles and IOT functionality to receive the information request message and upload the stored information. We also show the simulation and implementation details of the proposed system.

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