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MOBILE SURVEILLANCE SYSTEM FOR REAL-TIME DETECTION AND PREDICTION OF TRAFFIC VIOLATIONS

Abstract

The present invention relates to a mobile surveillance system designed to enhance the detection and prediction of traffic violations using advanced imaging technology and edge computing. The system comprises an imaging device equipped with multiple cameras and license plate readers, mounted on a mobile unit. A motorized scanning mechanism may facilitate comprehensive 360-degree coverage. The captured images may be processed locally by an edge computing unit using machine learning algorithms, including convolutional neural networks (CNNs) and object detection techniques to analyze driver behavior in real-time to identify potential violations, such as distracted driving. By utilizing edge computing, the system reduces latency and conserves bandwidth, enabling efficient data processing and timely alerts. Advantageously, the system may facilitate effective traffic monitoring and support law enforcement.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. application Ser. No. 18/392,846, filed Dec. 21, 2023, which is a continuation of U.S. application Ser. No. 17/154,042, filed Jan. 21, 2021, now U.S. Pat. No. 11,900,798, issued Feb. 13, 2024, which claims benefit of U.S. Application No. 62/964,247 filed on Jan. 22, 2020, each of which is incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The invention relates generally to the field of mobile surveillance. More particularly, the invention relates to a system and methods for detecting traffic violations, such as illegal cell phone use while driving, through the analysis of data obtained by an imaging device of a mobile unit.

BACKGROUND

[0003] Traffic violations occur when drivers violate laws that regulate vehicle operation on streets and highways. One example of a traffic violation includes running a red light.

[0004] To combat red light running, recording systems have been installed at certain intersections to detect and capture such violations. These conventional systems may connect to a traffic signal controller for detecting when a vehicle has improperly entered the intersection. Traditionally, such systems develop video evidence, which can then be processed by police, government, or private contractor personnel, to produce citations which are mailed to the vehicle's owner based on the associated license plate and vehicle images.

[0005] However, the use of conventional recording systems is often limited to detecting moving violations with respect to a vehicle. This is often because such systems are static, i.e., they are at a fixed location. As a result, such systems are often unable to detect violations relating to the driver, especially those that occur outside a fixed location. Examples of violations relating to the driver may include activities that could potentially distract a driver from the primary task of operating a vehicle, such as driving while texting.

[0006] Also, many conventional systems for detecting moving violations are associated with high manufacturing and maintenance cost. This is often due to the amount of resources required, such as expensive camera equipment, sensors, and communication lines. Other factors that may increase the cost include the distance from the system to the vehicle, security concerns, and weather conditions.

[0007] Additionally, conventional systems often rely on flash illumination to capture vehicle information in dark conditions. Such illumination can distract the driver, especially at night. This may further impair the driver's focus and attentiveness.

[0008] Therefore, there is a need for a system and methods that facilitate recording, analyzing, detecting, and communicating distracted driver violations effectively and efficiently. The present invention satisfies this demand.

SUMMARY

[0009] The invention relates generally to mobile surveillance and, more particularly, to a surveillance system and methods by which an imaging device of a mobile unit is configured to

monitor and record traffic violations. Advantageously, through use of the mobile unit, the system can analyze, detect, and communicate distracted driver violations effectively and efficiently.
[0010] An aspect of the present disclosure is a surveillance system for policing traffic violations. The surveillance system may include one more imaging devices mounted on a mobile unit. The one or more imaging devices may be configured to record driver characteristics and vehicle information corresponding to another vehicle.
[0011] The one or more imaging devices may be a camera, a license plate reader or a combination of both. The imaging devices may be configured to continuously monitor surroundings and/or wake from a low power state in response to detecting the vehicle.
[0012] The surveillance system may further include data processing logic that is operatively coupled to a memory and the one or more imaging devices. In operation, the data processing logic may be operative to access the recorded driver characteristics and the vehicle information. The vehicle information may be processed to extract characteristics of the vehicle, such as license plate information.
[0013] In addition, the data processing logic may be configured to analyze the driver characteristics to detect one or more objects corresponding to an occupant of the vehicle. In response to detecting the one or more objects, the data processing logic may preserve the recorded driver characteristics and vehicle information for generating an evidentiary record, which may be utilized in policing traffic violations. Furthermore, the system may be configured to link the recorded driver characteristics, vehicle information, and traffic violation and further associate that information with at least one of a time, date, location, and combinations of each.
[0014] The system may further include a controller operatively coupled to the imaging devices, the memory, and the data processing logic. The controller may be operative to receive inputs and issue outputs. For example, the controller may be operative to activate the imaging devices in response to a user input. In another example, the controller may be operative to transmit a traffic violation over a wireless link using a transceiver.
[0015] While the invention is susceptible to various modifications and alternative forms, specific exemplary embodiments thereof have been shown by way of example in the drawings and have herein been described in detail. It should be understood, however, that there is no intent to limit the invention to the particular embodiments disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0016] Embodiments are illustrated by way of example and not limitation in the figures in the accompanying drawings, in which like references indicate similar elements and in which:
[0017] FIG. **1**A illustrates an exemplary mobile surveillance system that may aid in policing traffic violations;
[0018] FIG. **1**B illustrates the exemplary mobile surveillance system of FIG. **1**A including a mobile unit and an imaging device.
[0019] FIG. **2**A illustrates another exemplary mobile surveillance system that may aid in policing traffic violations;
[0020] FIG. **2**B illustrates the exemplary mobile surveillance system of FIG. **2**A including a license plate reader;
[0021] FIG. **3**A illustrates a dashboard of a mobile unit of an exemplary surveillance system including a computing device;
[0022] FIG. **3**B illustrates an exemplary user interface of the computing device of FIG. **3**A.

[0023] FIG. **4** is a block diagram illustrating a system that may implement one or more techniques of the invention.
[0024] FIG. **5** is a flow chart illustrating an exemplary operation for detecting and communication a traffic violation.
[0025] FIG. **6** is a flow chart illustrating another exemplary operation for detecting and communicating a traffic violation.
[0026] FIG. **7** is a flow chart illustrating yet an exemplary operation of the system for determining a traffic violation.
[0027] FIG. **8** is an exemplary computing system that may be used for implementation of all or a portion of the invention.
[0028] FIG. **9** is an exemplary cloud computing system that may be used for implementation of all or a portion of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] The invention relates generally to mobile surveillance and, more particularly, to a surveillance system and methods by which an imaging device of a mobile unit is configured to monitor, detect, and record traffic violations. Advantageously, through use of the mobile unit, the system can analyze, detect, and communicate traffic violations effectively and efficiently.
[0030] Turning now to the drawings wherein like numerals represent like components, FIGS. **1**A-**1**B illustrate an exemplary mobile surveillance system **100** that may aid in policing traffic violations, such as illegal cell phone use while driving. Private citizens and law enforcement may use system **100** for surveillance, security, traffic control applications, combinations of each, and the like.
[0031] Surveillance system **100** of FIGS. **1**A-**1**B includes a mobile unit **102** and an imaging device **104**, which may include one or more cameras and/or license plate readers (LPRs). Imaging device **104** may, automatically or in response to a user action, monitor and record information relating to a traffic violation. Imaging device **104** may be configured to continuously monitor and record information. In another example, imaging device **104** may be configured to wake from a low power state to begin capturing and recording information when detecting another vehicle **106**. In yet another example, imaging device **104** may be configured to activate in response to a user action, such as pressing a button that sends a command to the imaging device **104**.
[0032] As shown in FIG. **1**A, imaging device **104** may be configured to monitor license plate information and driver characteristics of other vehicles **106**. Other vehicle **106** may be moving in the same direction and/or in the opposite direction of mobile unit **102**. While illustrated as a car, it is contemplated that mobile unit **102** may be any suitable motor vehicle, such as a motorcycle, truck, and bus. It should be understood that the principles of the present disclosure may be applicable to a variety of vehicle assemblies and components.
[0033] Imaging device **104** may be handheld or attached to mobile unit **102** for recording and detecting traffic violations, as described in more detail below. As shown, imaging device **104** may monitor and record information in all directions (i.e., 360 degrees) around the mobile unit **102**. In addition, vertical viewing angles **108** of imaging device **104** may facilitate capturing both license plate information and drivers of other vehicles.
[0034] As illustrated in FIG. **1**A, vertical viewing angles **108** of imaging device **104** may range from about thirty degrees to about one hundred and twenty degrees, and preferably be about sixty degrees. It is further contemplated that imaging device **104** may be motorized to scan up, down, and sideways, or to point in a particular direction, and those functions can be automated and/or manual.
[0035] As shown in FIG. **1**B, a housing **110** may protect imaging device **104** from environmental conditions, such as moisture, dirt, ultra violet radiation, as well as impact conditions. Housing **110** may be dome shaped and attach to the outside or inside of the mobile unit **102** via any suitable means, such as via a bracket or railing mechanism. Also, housing **110** and/or imaging device **104**

may be mounted at a height above the roof of the mobile unit **102**. For example, the height may range from between about one inch and ten inches above the roof, and preferably between about two inches and six inches above the roof. Moreover, housing **110** and/or imaging device **104** may be at a height above the ground ranging from between about six inches and ten feet, and preferably between about twelve inches and six feet.

[0036] While illustrated as mounted on the roof of mobile unit **102**, it is contemplated that housing **110** may be mounted on the hood, bumper, doors, or any other section of mobile unit **102**. Moreover, housing **110** and/or imaging device **104** may be removably attached or permanently secured to the inside or outside of mobile unit **102**. For example, housing **110** and/or imaging device **104** may be secured to a dashboard of mobile vehicle **102**.

[0037] For power, imaging device **104** may be operatively connected to a power source of the mobile unit **102**. Alternatively, the imaging devices **104** can connect to another power source and/or be powered via reusable energy technologies, such as solar power. Examples of suitable power sources may include batteries and/or a capacitor. The batteries may be rechargeable lithium-ion batteries including, for example, thin film lithium ion batteries, a lithium ion polymer battery, a nickel-cadmium battery, a nickel metal hydride battery, a lead-acid battery, and combinations of each.

[0038] Imaging devices **104** may include one or more cameras, license plate readers, and/or other imaging equipment, such as a recording camera, a photocell, or any other device capable of capturing and producing an image and/or video. As illustrated in the exemplary surveillance system **100** of FIGS. **1**A-**1**B, imaging device **104** may include between about five and fifteen cameras, and preferably about ten cameras to facilitate capturing information all around mobile unit **102**. One or more cameras of imaging device **104** may take an image and/or recording simultaneously. For example, each camera facing the right side of mobile unit **102** may, automatically or in response to a user input, take a picture at a moment in time. The multiple images and/or records may be compiled for a complete view of the surroundings or for a side by side analysis of the information at a point in time. In addition to imaging equipment, other input devices are contemplated, such as a microphone and a signal detector.

[0039] As shown in FIG. **1**B, imaging device **104** may take images and record videos in a three hundred and sixty degree field relative to a longitudinal axis of imaging device **104**. An angle between each camera's field of view may range from about ten degrees and about twenty degrees relative to the longitudinal axis of imaging device **104**, and preferably an angle between each camera may be about fifteen degrees relative to the longitudinal axis of imaging device **104**.

[0040] FIGS. **2**A-**2**B illustrate another exemplary surveillance system **200** that may aid in policing traffic violations, such as illegal cell phone use while driving. Surveillance system **200** includes a mobile unit **202**, one or more video or still cameras **204**, and a license plate reader (LPR) system **206**.

[0041] Cameras **204** may be configured to take videos or still images of distracted drivers. Examples of cameras **204** may include video cameras, still cameras, charge-coupled device cameras, infrared cameras, and the like. As shown in FIG. **2**A, cameras **204** may be positioned on side mirrors **208** of mobile unit **202**, however, other locations are contemplated. For example, cameras **204** may be mounted on a front bumper **210** and/or a back bumper **212** of mobile unit **202**. Moreover, cameras **204** may be mounted on mobile unit in other suitable locations (e.g., front, rear, side or top of vehicle) to allow up to 360° coverage relative to mobile unit **202**.

[0042] Each camera **204** of surveillance system **200** may include a lens and various optical elements. The camera lens may provide a desired focal length and field of view. Cameras **204** may be associated with, for example, a 6 mm lens or a 12 mm lens. Also, cameras **204** may be configured to take images and/or videos in a desired field-of-view (FOV). For example, cameras **204** may be configured to have a regular FOV, such as within a range of about thirty degrees to about eighty degrees, and preferable a range of about forty degrees to about sixty degrees. In

addition, cameras **204** may be configured to have include a wide angle camera with up to a one hundred and eighty degree FOV.
[0043] As shown in FIG. **2**B, LPR system **206** may include one or more LPR cameras **214** operatively coupled to an LPR processing unit **216**. In one embodiment, LPR system **214** may be a Leonardo ELSAG Mobile Plate Hunter™ automatic license plate reader.
[0044] LPR processing unit **52** may be responsible for processing images captured by LPR cameras **214**, extracting license plate information, and/or transmitting data over a computer network. While illustrated as a separate component, LPR processing unit **216** may be physically incorporated into one or more of LPR cameras **214**, other imaging equipment of mobile unit **202** or integrated in a remote server.
[0045] Either locally or through communications with various servers-such as a DMV database server-surveillance system **200** may be configured to compare the license plate information to the various databases and identify information corresponding to the vehicle. Surveillance system **200** further may be configured to associate information and data captured by one or more components with various spatial and temporal information. For example, one or more components of surveillance system **200** may constantly monitor time and location data using, for example, GPS or other sensor data available to the system **200**.
[0046] FIG. **3**A illustrates a dashboard **302** of a mobile unit, such as mobile units **102**, **202**, of an exemplary surveillance system **300**. As shown, dashboard **302** may include a computing device **304** and an input controller **306**.
[0047] As shown, input controller **306** may include one or more physical buttons **310**. Each physical button **310** may associate with one or more operations of surveillance system **300**. While illustrated as buttons, it is contemplated input controller **310** may include dials, slider switches, joysticks, click wheels, and the like.
[0048] By engaging one or more buttons **310**, electrical signals may be sent to other input devices (e.g., imaging devices, cameras, and/or LPRs) of the surveillance system **300**. In addition to activating (or waking from a lower power state) other input devices, electronic signals may include instructions corresponding to the engaged physical button. For example, engaging one button of input controller **306** may cause one or more cameras of surveillance system **300** to begin recording for a specific duration of time. The duration of time may range between about five seconds to about sixty seconds, and preferably between about ten seconds and about forty seconds. In certain embodiments, the duration of time may range between about twenty seconds and thirty seconds.
[0049] While illustrated as separate components, it is contemplated that input controller **306** may be incorporated into computing device **304**.
[0050] Computing device **304** may be configured to request and receive information from one or more components of the surveillance system **300**. Examples of a suitable computing device may include personal computers, smartphones, tablets, and the like. Also, it is contemplated that computing device **304** may be incorporated into the mobile unit of surveillance system **300**.
[0051] As shown in FIG. **3**A, computing device **304** may include a display **308** that is configured to output various types of contents, such as images, videos, text, a graphic user interface (GUI) including various types of contents, an application execution screen, and the like. For example, the display **308** may display a user interface screen including, for example, a keypad, a touch pad, a list menu, and an input window.
[0052] Display **308** may include any suitable mechanism for outputting the various content. For example, display **308** can include a thin-film transistor liquid crystal display (LCD), an organic liquid crystal display (OLCD), a plasma display, a surface-conduction electron-emitter display (SED), organic light-emitting diode display (OLED), or any other suitable type of display. In some embodiments, display **308** can include a backlight for illuminating the display. For example, display **308** can include one or more incandescent light bulbs, light-emitting diodes (LEDs), electroluminescent panels (ELPs), cold cathode fluorescent lamps (CCFL), hot cathode fluorescent

lamps (HCFL), any other suitable light source, or any combination thereof. Display **308** can display visual content in black-and-white, color, or a combination of the two. Display **308** can display visual content at any suitable brightness level or resolution.

[0053] Computing device **304** further may include a processing component for analyzing data output from the one or more components of the surveillance system **300**, such as the imaging device of FIGS. **1**A-**1**B and/or the cameras and LPRs of FIGS. **2**A-**2**B. The data processed and produced through processing component may be stored to, for example, match with an entry from an archive accessible to the system **300** corresponding to an owner of a vehicle.

[0054] For images and video taken by the surveillance system **300**, the processing component of computing device **304** may be configured to apply an object character recognition (OCR) identification algorithm to an image or video. An exemplary OCR identification algorithm isolates one or more characters from a vehicle license plate number, segments multiple characters into a single character image, and compares the single character image against a set of standard character images to determine each character.

[0055] The processing component of computing device **304** also may facilitate object extraction and detection. Object detection is accomplished using motion, texture, and contrast in the data. Furthermore, the processing component may be configured to characterize certain objects, such as color, dimension, and shape. Using the objects and the associated characteristics thereof, rules may be applied which implement a specific surveillance function. As an example, traffic violation analysis may be performed, allowing a fast evaluation on complete lists of objects, or a simple detection of actual objects, such as phones, laptops, tablets, and seatbelts.

[0056] The computing device **304** may further include a violation detection component configured to detect and determine a traffic violation. Violation detection component may be configured to access a rules database of computing device **304** including a set of rules for applying to data output from the processing component. For purposes of this application, a set of rules may encompass protocols and procedures for detecting a violation. For example, a rule may include the detection of objects for a specific traffic violation.

[0057] Through use of computing device **304**, surveillance system **300** may determine a traffic violation. Specifically, the system may detect a traffic violation by determining that the driver is using a cell phone while operating a vehicle. The system **300** also may determine that the driver is operating the vehicle outside of proper safety regulations, such as by failing to wear a seatbelt. Other violations that the system may detect include underage driving, ingesting illegal substances while driving, noise violations, and text communications through, for example, data signal detection.

[0058] FIG. **3**B illustrates an exemplary user interface **312** corresponding to display **308** of FIG. **3**A. As shown, user interface **312** may include a number of sections and display information corresponding to one or more components of surveillance system **300**.

[0059] As shown in the exemplary user interface **312** of FIG. **3**B, a first section **314** may be configured to display an image or live feed of a vehicle operator using a cell phone monitored by a camera of the surveillance system **300**. System **300** may be configured to, automatically or in response to a user input, display information in first section **314**.

[0060] A second section **316** may be configured to zoom in on the image or recording of the first section **314**. As shown, second section **316** further may display additional information, such as location information (e.g., coordinates), a speed with which the mobile unit is moving, and a time.

[0061] A third section **318** of the exemplary user interface may be configured to display a continuously updated geographic location of surveillance system **300**. It is also contemplated that the third section **318** may display other location-related information, such as a virtual area corresponding to information that components of the system **300** may obtain.

[0062] A fourth section **320** may be configured to display an image of a license plate corresponding to the vehicle shown in first section **314** and second section **316**. As shown, fourth section **320** may

further display text corresponding to the characters extracted from the license plate by one or more components of surveillance system **300**.

[0063] Surveillance system **300** may be configured to store, either persistently or temporarily, the data generated by computing device **304**. For example, surveillance system **300** may be configured to store image and/or video data and associate that data with location/speed data. Surveillance device **300** may be configured to, automatically or in response to a user input, store the information in a local and/or remote memory or delete the information if, for example, no violation was detected. It is contemplated that the memory may be secure and/or tamperproof to, for example, facilitate use of the information for evidentiary purposes.

[0064] As shown in FIG. **3**B, user interface **312** further may include a number of view options corresponding to one or more sections of the user interface. View options may include an occupant view **322**, a rear view **324**, a plate view **326**, and map view **328**. Also, user interface **312** may include a number of control options including a save option **330**, a delete option **332**, and a settings option **334**. Setting options **334** may include, but are not limited to, configurations and rules for various components of surveillance system **300**. For example, a user, through use of setting options **334**, may define thresholds and adjust values for one or more cameras of the system **300**.

[0065] FIG. **4** illustrates an exemplary block diagram of a surveillance system **400**. As shown, surveillance system **400** may include audio equipment **402**, camera hardware **404**, and license plate readers **406**. While audio equipment **402**, camera hardware **404**, and license plate readers **406** are shown as separate interoperating components, it is contemplated that the functions of each component are subsystem components of a single integrated system.

[0066] Audio equipment **402** may be operatively coupled to a voice recognition engine **408** and data processing logic **410**. Audio equipment **402** may include, among other things, at least one microphone, at least one speaker, signal amplification, analog-to- digital conversion/digital audio sampling, echo cancellation, and/or other audio processing, which may be applied to one or more microphones and/or one or more speakers of the surveillance system **400**.

[0067] The camera hardware **404** may include at least one camera and is operatively coupled to the data processing logic **410**. Camera hardware **404** can include any suitable device for capturing images and may include multiple cameras at different locations of a mobile unit, as detailed above. Camera hardware **404** may include, among other things, at least one camera, any appropriate image sensor, such as, but not limited to, a charge-coupled device (CCD), CMOS chip, active-pixel sensor (APS), Bayer sensor, etc.

[0068] License plate readers **406** also are operatively coupled to the data processing logic **410**. It is contemplated that license plate readers **406** may be physically incorporated into one or more of cameras of camera hardware **404** or integrated in a remote system.

[0069] License plate readers **406** may be responsible for capturing and processing images and extracting license plate information. License plate readers **406** may include one or more cameras for automatically imaging a license plate and extracting a character string from the image for vehicles that come into a field of view of the camera. Also, license plate readers **406** may provide illumination, which can be in the form of a controlled light source adapted to brighten vehicle license plates during the day and/or allow camera operation during the night. Alternatively, the illumination can be an infra-red (IR) light source, i.e. invisible to the driver of the neighboring vehicles.

[0070] Additional components of surveillance system **400** may include a display **412**, antenna hardware **414**, including a transceiver **416**, other user interfaces **418**, such as, for example, a keyboard, touch sensors, mouse, buttons, and the like.

[0071] Surveillance system **400** may further include one or more sensors **420**, such as a GPS system, compass, gyroscope and accelerometer (which may be separate or integrated in a single package). Various selectable buttons and/or selectable features of display **412** may be selected in various ways, such as, but not limited to, mouse cursor point-and-click, touch screen, scrolling a

cursor to the selectable item and hitting an “enter” key, using hot keys corresponding to the selectable feature, voice commands, etc., or any other suitable way of selecting a selectable feature.
[0072] Data processing logic **410** may be configured to detect, extract, and/or process data from one or more components of the surveillance system. For example, data processing logic **410** may be configured to determine whether an audible input includes a voice command and initiate one or more processes corresponding to the voice command. In certain embodiments, data processing logic **410** may perform further language processing to understand what the voice command means and engage the necessary procedures/components required to undertake carrying out the directives of the voice command.
[0073] In another example, data processing logic **410** may be configured to extract the textual characters of a license plate into a text string. Based on the extracted characters, the surveillance system may query vehicle registries or other databases using the text string license plate and store the results of the query for further action by a user.
[0074] In yet another example, data processing logic **410** may be configured to detect an object—such as a phone, laptop, tablet, and seatbelt—captured by the surveillance system and associate that object with other data, such as a license plate. Also, data processing logic **410** may be configured to identify vehicles—such as make and model—based on, for example, pre-defined outlines or shapes of vehicles.
[0075] Controller **422** is operatively coupled to the components mentioned above and to a non-volatile, non-transitory memory **424**. The controller **422** may be configured to receive inputs and issue output signals. The output signals produced by controller **422** may be to a component of the surveillance system **400** or may be to an external system that is physically external from the surveillance system **400**.
[0076] Memory **424** may include voice recognition code **426**, LPR code **428**, object recognition code **430**, and predetermined operations **432**. The various executable codes in memory **424** correspond to the voice recognition engine **402**, the camera hardware **404**, and the license plate reader **406**. Among other things, when executed, these codes may provide instructions that cause one or more components of surveillance system **400** to record a video, capture images, process data, and store the corresponding data along with, for example, a location identifier and timestamp in memory.
[0077] Controller **422** further may be configured to match the data extracted by data processing logic **410** to a predetermined operation **432** stored in memory **424**. Based on the data, controller **422** may be configured to obtain the associated predetermined operation from memory **424** and issue an output signal **434** to the corresponding components of the surveillance system **400**. For example, if an audio recording matches an audio template stored in memory, controller may provide an output signal based on the predetermined operation associated with the audio template.
[0078] Controller **422** may also use the inputs from one or more components of the system **400** to label segments of data. Labeled segments of data may be as short as individual video frames (typically 0.033-0.040 second) or may range between five seconds and thirty seconds. Each segment may be labeled with the time and date that the segment was acquired and the exact position and orientation at the time the segment was captured. The additional data (time, date, position, orientation) may be stored along with image data, or may be stored in a separate portion of memory. If stored separately, the additional data may include a link to the location of the associated segment of camera and audio data.
[0079] Controller **422** may further use antenna hardware **414** of surveillance system **400** to output a signal **434** containing data to a second device. Antenna hardware **414** includes any known or developed structure for receiving electromagnetic energy in the radio frequency (RF) spectrum. For example, transceiver **414** may encode or decode data using amplitude modulation, frequency modulation, phase modulation or any combination thereof.
[0080] The surveillance process may be initiated using a variety of approaches. In one approach, a

user input, such as engaging a user interface (e.g., pressing a button), may initiate the process and/or wake one or more components from a powered down state (i.e. sleep mode).
[0081] In another approach, a component of surveillance system **400** may automatically send out a signal periodically to determine whether a vehicle is near, such as between about ten feet and thirty feet from mobile unit. Also, a sensor, such as a proximity sensor, may be used as a trigger one or more components of surveillance system **400** to initiate the capturing, processing, and extraction of data.
[0082] Because the components of system **400** may be powered by a local power source (e.g., a mobile unit's battery), this approach may be periodic in order to conserve battery power. Where power may be provided from a separate power source, power conservation is less of an issue and therefore the components of surveillance system **400** may be constantly scanning and processing data to, for example, detect vehicles and/or traffic violations.
[0083] Other approaches to initiate a process of system **400** are contemplated including, for example, gestures, gaze, and signals from remote devices. Such processes are further illustrated by way of example in flowcharts of the accompanying drawings and the corresponding description below.
[0084] FIG. **5** is a flowchart **500** illustrating the steps of an exemplary operation of a surveillance system for detecting and communicating a violation. The method of operation begins and, in step **502**, a mobile unit including an input device (e.g., imaging device, cameras, and/or LPRs) may monitor the surrounding environment. Mobile unit may be moving, for example, via a residential road, commercial road, highway, freeway, and expressway.
[0085] In decision step **504**, the system may detect a user input. Examples of a user input may include pushing a button or a detecting a voice command. If in decision step **504**, the system does not detect an input, the system reverts back to step **502**. If the system does detect a user input, in step **506**, the system may activate one or more imaging devices of the mobile unit. It is also contemplated that the system may automatically activate one or more imaging devices in response to a trigger event, such as detecting another vehicle traveling in the same direction or in an opposite direction.
[0086] In step **506**, the system may record vehicle information and/or driver characteristics corresponding to the operator in another vehicle. Vehicle information may refer to characteristics of a vehicle, such as make, model, color, and license plate number.
[0087] In step **508** of FIG. **5**, the system may, automatically or in response to a user input, process the driver characteristics to determine a violation. For example, the system may process the driver characteristics to determine that a cell phone is being used while operating the vehicle. It is contemplated that the that system may determine a violation use by accessing phone records. In step **510**, the system will communicate the violation and/or recommend a course of action, such as issuance of a citations for the violation.
[0088] Communication of the violation may be to a private citizen, law enforcement, third party agency, and/or the operator of the vehicle, which the system can determine by matching vehicle information to an entry of a database accessible to the system. For example, the system may physically mail or electronically communicate the citation to the operator of the vehicle. The system also may be configured to determine whether the operator of the vehicle has a warrant or other history and communicate that information to an appropriate user.
[0089] FIG. **6** is a flowchart **600** illustrating the steps of another exemplary operation of a surveillance system. The method of operation begins and, in step **602**, the system may, automatically or in response to a user input, detect a vehicle. In response to detecting a vehicle, in step **604**, the system may be configured to begin recording that vehicle via an input device, such as an imaging device, camera, or LPR. In step **606**, the system may be configured to analyze the recorded data.
[0090] In decision step **608**, the system will determine whether a violation is detected. The system

may be configured to automatically detect a violation, for example, based on a set of rules accessible to the system. Alternatively, the system may determine that a violation has occurred based on an input from a user. The system may be configured to preserve the recorded data and generate an evidentiary record for use in policing traffic violations. If in step **608** a violation is detected, in step **610**, the system will communicate the violation. If in step **307**, the system does not, automatically or in response to a user input, detect a violation, in step **311**, the system will delete the recorded data.

[0091] FIG. **7** is a flowchart **700** illustrating the steps of yet another exemplary operation of a surveillance system. The method of operation begins and, in step **702**, the system may access a memory. In step **704**, the system may retrieve data recorded by an input device, such as an imaging device, a camera, and/or an LPR. In step **706**, the system will analyze the retrieved data using operational or programming instructions stored in the memory. For example, the system may facilitate detecting and extracting objects corresponding to the driver of a vehicle. In step **708**, the system will apply a set of rules, which may be stored in the memory or accessible to the system. In step **710**, the system may be configured to determine a violation based on the analyzed data.

[0092] FIG. **8** illustrates an exemplary computer system **800** that may be used to implement the methods according to the present invention. One or more computer systems **800** may carry out the present invention according to processing instructions, or computer code.

[0093] Computer system **800** includes an input/output interface **802** connected to communication infrastructure **804**—such as a bus—which forwards data such as graphics, text, and information, from the communication infrastructure **804** to other components of the computer system **800**. The input/output interface **802** may be the imaging device of FIGS. **1**A-**1**B, the cameras and LPRs of FIGS. **2**A-**2**B or, alternatively any other peripheral device capable of capturing and/or recording a violation. Furthermore, interface **802** may be the input controller of FIG. **3**A or a keyboard, joystick, trackball, and mouse for a user to enter what he or she believes to be a violation.

[0094] One or more processors components **806** may be a special purpose or a general-purpose digital signal processor that processes certain information. Computer system **800** may also include a main memory **808**, for example random access memory ("RAM"), read-only memory ("ROM"), mass storage device, or any combination of tangible, non-transitory memory as well as a secondary memory **810** such as a hard disk unit **812**, a removable storage unit **814**, or any combination of tangible, non-transitory memory.

[0095] Computer system **800** may also include a communication interface **816**, for example, a modem, a network interface (such as an Ethernet card or Ethernet cable), a communication port, a PCMCIA slot and card, wired or wireless systems (such as Wi-Fi®, Bluetooth®, Infrared), local area networks, wide area networks, intranets, etc. Communication interface **816** allows software, instructions and data to be transferred between the computer system **800** and external devices or external networks.

[0096] Computer programs, when executed, enable the computer system **800**, particularly processor **806**, to implement the methods of the invention according to computer software instructions. The computer system **800** of FIG. **8** is provided only for purposes of illustration, such that the invention is not limited to this specific embodiment. It is appreciated that a person skilled in the relevant art knows how to program and implement the invention using any computer system.

[0097] Computer system **800** may be a handheld device and include any small-sized computer device including, for example, a personal digital assistant ("PDA"), smart hand-held computing device, cellular telephone, or a laptop or netbook computer, hand held console or MP3 player, tablet, or similar hand held computer device, such as an iPad®, iPad Touch® or iPhone®.

[0098] Separate and apart from, or in addition to, computer system **800**, the methods according to the invention may be implemented using a cloud computing system. FIG. **9** illustrates an exemplary cloud computing system **900** that may be used to implement the methods according to the invention. Cloud computing system **900** includes a plurality of interconnected computing

environments. Cloud computing system **900** utilizes the resources from various networks as a collective virtual computer, where the services and applications can run independently from a particular computer or server configuration making hardware less important.

[0099] Specifically, cloud computing system **900** includes at least one client computer **902**. Client computer **902** may be any device through the use of which a distributed computing environment may be accessed to perform the methods disclosed herein, for example, the computer described above in FIG. **8**, a portable computer, mobile phone, personal digital assistant, tablet to name a few. Signals are transferred between Client computer **902** and external devices including networks such as Internet **904** and cloud data center **906**. Communication may be implemented using wireless or wired capability such as cable, fiber optics, a phone line, a cellular phone link, radio waves or other communication channels.

[0100] Client computer **902** establishes communication with the Internet **904**—specifically to one or more servers—to, in turn, establish communication with one or more cloud data centers **906**. A cloud data center **906** includes one or more networks **910***a*, **910***b*, **910***c* managed through a cloud management system **908**. Each network **910***a*, **910***b*, **910***c* includes resource servers **912***a*, **912***b*, **912***c*, respectively. Servers **912***a*, **912***b*, **912***c* permit access to a collection of computing resources and components that can be invoked to instantiate a virtual computer, process, or other resource for a limited or defined duration. For example, one group of resource servers can host and serve an operating system or components thereof to deliver and instantiate a virtual computer. Another group of resource servers can accept requests to host computing cycles or processor time, to supply a defined level of processing power for a virtual computer. A further group of resource servers can host and serve applications to load on an instantiation of a virtual computer, such as an email client, a browser application, a messaging application, or other applications or software.

[0101] Cloud management system **908** may be configured to query and identify the computing resources and components managed by the set of resource servers **912***a*, **912***b*, **912***c* needed and available for use in the cloud data center **906**. Specifically, cloud management system **908** may be configured to identify the hardware resources and components such as type and amount of processing power, type and amount of memory, type and amount of storage, type and amount of network bandwidth and the like, of the set of resource servers **912***a*, **912***b*, **912***c* needed and available for use in cloud data center **906**. Likewise, cloud management system **908** can be configured to identify the software resources and components, such as type of Operating System ("OS"), application programs, and the like, of the set of resource servers **912***a*, **912***b*, **912***c* needed and available for use in cloud data center **906**.

[0102] Cloud computing system **900** of FIG. **9** is provided only for purposes of illustration and does not limit the invention to this specific embodiment. It is appreciated that a person skilled in the relevant art knows how to program and implement the invention using any computer system or network architecture.

[0103] In sum, the foregoing surveillance system facilitates monitoring, analyzing, detect, and recording driver characteristics and vehicle information and preserving this information in response to, for example, detecting a distracted driver. In this manner, an evidentiary record may be generated which may be utilized in the policing of traffic violations.

[0104] While the invention is susceptible to various modifications and alternative forms, specific exemplary embodiments of the invention have been shown by way of example in the drawings and have been described in detail. It should be understood, however, that there is no intent to limit the invention to the particular embodiments disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

Claims

1. A system comprising: a first mobile unit configured to transport a mobile surveillance system, said surveillance system comprising: one or more cameras mounted on the mobile unit, said cameras configured to capture images of a second mobile unit; at least one license plate reader operatively coupled to the one or more cameras; and a processing unit configured to analyze captured data for detecting traffic violations associated with the second mobile unit.

2. The system of claim 1, wherein the one or more cameras are configured to capture images in a predetermined field of view.

3. The system of claim 1, further comprising a motorized scanning mechanism configured to adjust the orientation of the one or more cameras.

4. The system of claim 3, further comprising a control unit operably connected to the motorized scanning mechanism, the control unit configured to automatically direct the scanning mechanism to capture images at various angles.

5. The system of claim 4, wherein the control unit is further configured to automate scanning based on detected motion of surrounding vehicles.

6. The system of claim 5, wherein said processing unit is configured to, in response to a user input, override the automated scanning function for targeted image capture.

7. The system of claim 1, further comprising an edge computing unit operatively connected to the one or more cameras or said processing unit, wherein the edge computing unit employs machine learning to enhance the accuracy of traffic violation detection during local processing.

8. The system of claim 7, wherein said edge computing unit utilizes convolutional neural networks (CNNs) to analyze the images for detecting and predicting traffic violations.

9. The system of claim 8, wherein the edge computing unit incorporates recurrent neural networks (RNNs) to analyze temporal sequences of images for detecting patterns indicative of traffic violations over time.

10. The system of claim 8, wherein said edge computing unit further employs object detection algorithms to identify distracted driving behaviors.

11. The system of claim 8, wherein the edge computing unit is configured to apply anomaly detection algorithms to identify unusual driver behaviors, such as usage of mobile devices while driving.