FORM 2

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THE PATENTS RULES, 2003

COMPLETE SPECIFICATION

**1. TITLE OF THE INVENTION**

**SYSTEMS AND METHODS FOR DYNAMIC AND INTELLIGENT TRANSPORTATION SYSTEM (ITS) FOR SELF DRIVING CAR**

**2. APPLICANT(S)**


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**3. PREAMBLE TO DESCRIPTION**

COMPLETE SPECIFICATION -The following specification particularly describes the invention and the manner in which it is to be performed.

## SYSTEMS AND METHODS FOR DYNAMIC AND INTELLIGENT TRANSPORTATION SYSTEM (ITS) FOR SELF DRIVING CAR

### Field of the Invention

**[0001]** The present invention relates to a system and method for navigation and control of a vehicle. More specifically, the invention relates to a system and method for autonomous vehicle guidance. Moreover, the present invention provides a drone/ unmanned aerial vehicle (UAV) based autonomous navigation service system and a method of operation thereof.

### Background

**[0002]** The background description includes information that may be useful in understanding the present invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

**[0003]** Traffic safety is always one of the key questions that various governmental agencies and people are worried about. Traffic issues and street accidents are one of the most critical concerns nowadays. The rapid increase in the total number of vehicles on roads and increase in the negligence towards traffic rules, further, fuel the total number of accidents per year.

**[0004]** The technological advancements have led to the development of autonomous vehicles. Generally, autonomous vehicles are designed to perform the various driving operations to guide the vehicle to a predetermined location without any intervention from the human being/driver or optionally may require minimal input from the driver. Such autonomous vehicles comprise a control system and high-speed image sensors to monitor the surrounding environment of the vehicle. The image sensor detects various conditions such as traffic jams, traffic lights, obstacles, road turns, etc. The onboard control system utilizes the real-time data of the image sensors to manage driving (e.g. control the speed and direction) of the vehicle to move the vehicle at an appropriate speed. Further, the control system can detect various road markings (e.g. stripes or solid type lane markings) to determine the current driving lane.

**[0005]** The control system controls the deceleration and steering of the vehicle to stop the vehicle at a required location (e.g. before an intersection). Various prior art documents disclose such smart control system for autonomous vehicles.

**[0006]** The KR20170082165A relates to a vehicle autonomous traveling service system, a cloud server for the same, and a method of operating the same. The autonomous vehicle traveling service system according to an embodiment of the present invention includes an autonomous control unit which is configured to construct and manage precision map data based on raw data received from a user terminal requesting the driving map data and a plurality of collecting vehicles running at different positions. The cloud server for searching the precise map data to obtain autonomous running map data and transmitting the obtained autonomous running map data to the autonomous driving vehicle.

**[0007]** The US9880006B2 discloses an autonomous vehicle is improved with a navigational system having both cameras and echolocation sensors, each including overlapping fields of view. The cameras and echolocation sensors may be part of an optical and echolocation system, respectively, that may work in conjunction with a global positioning system to determine a course for the autonomous vehicle to reach an objective while detecting and avoid obstacles along the course.

**[0008]** The US20200012829A1 discloses a navigation aiding system comprises a self-describing fiducial includes which comprise a communication element that optically communicates navigation-aiding information. The navigation-aiding information may include a position of the self-describing fiducial with respect to one or more coordinate systems and the communication element communicates the navigation-aiding information to one or more navigating objects in the vicinity of the self-describing fiducial. In another embodiment, the communication element is further configured to communicate supplementary information describing a spatial relationship between the self-describing fiducial and the surrounding environment.

**[0009]** However, the connectional control system of autonyms vehicles have many drawbacks such as non-reliable, expensive and does not consider/determine the street region and non-street region, does not suggest path based on the current traffic condition etc. Thus, there remains a need for further contributions in this area of technology. More specifically, a need exists in the area of technology for dynamic routing of an autonomous vehicle.

**[00010]** All publications herein are incorporated by reference to the same extent as if each individual publication or patent application were specifically and individually indicated to be incorporated by reference. Where a definition or use of a term in an incorporated reference is inconsistent or contrary to the definition of that term provided herein, the definition of that term provided herein applies and the definition of that term in the reference does not apply.

**[00011]** In some embodiments, the numbers expressing quantities of ingredients, properties such as concentration, reaction conditions, and so forth, used to describe and claim certain embodiments of the invention are to be understood as being modified in some instances by the term "about." Accordingly, in some embodiments, the numerical parameters set forth in the written description and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by a particular embodiment. In some embodiments, the numerical parameters should be construed in light of the number of reported significant digits and by applying ordinary rounding techniques. Notwithstanding that the numerical ranges and parameters setting forth the broad scope of some embodiments of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as practicable. The numerical values presented in some embodiments of the invention may contain certain errors necessarily resulting from the standard deviation found in their respective testing measurements.

**[00012]** As used in the description herein and throughout the claims that follow, the meaning of "a," "an," and "the" includes plural reference unless the context clearly dictates otherwise. Also, as used in the description herein, the meaning of "in" includes "in" and "on" unless the context clearly dictates otherwise.

**[00013]** The recitation of ranges of values herein is merely intended to serve as a shorthand method of referring individually to each separate value falling within the range. Unless otherwise indicated herein, each individual value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g. "such as") provided with respect to certain embodiments herein is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention otherwise claimed. No language in the specification should be construed as indicating any non-claimed element essential to the practice of the invention.

**[00014]** Groupings of alternative elements or embodiments of the invention disclosed herein are not to be construed as limitations. Each group member can be referred to and claimed individually or in any combination with other members of the group or other elements found herein. One or more members of a group can be included in, or deleted from, a group for reasons of convenience and/or patentability. When any such inclusion or deletion occurs, the specification is herein deemed to contain the group as modified thus fulfilling the written description of all Markush groups used in the appended claims.

## Objects of the Invention

**[00015]** An object of the present disclosure is to overcome one or more drawbacks associated with conventional mechanisms.

**[00016]** An object of the present disclosure is to provide driving assistance to self-driving vehicle

**[00017]** An object of the present disclosure is to ease traffic jam related problems.

**[00018]** An object of the present disclosure is to provide information related to drowsiness lanes.

**[00019]** An object of the present disclosure is to provide a Modular Intelligent Transportation System (MITS).

## Summary

**[00020]** The present invention relates to a system and method for navigation and control of a vehicle. More specifically, the invention relates to a system and method for autonomous vehicle guidance. Moreover, the present invention provides a drone/ unmanned aerial vehicle (UAV) based autonomous navigation service system and a method of operation thereof.

**[00021]** In an aspect, the present invention relates to a system for dynamic and intelligent transportation system (ITS) for a self-driving vehicle, the system comprises: a wireless communication link; a drone which is configured to acquire information related to a vicinity of the self-driving vehicle, wherein the drone comprises: one or more image sensors arranged to capture one or more images; and data transmitter to transmit the captured one or more images; the self-driving vehicle, further, comprises: a communication unit configured to captured one or more images from the drone, through the wireless communication link; a non-transitory storage device comprising: one or more executable routines; and one or more processing means coupled to the non-transitory storage device and operable to execute the one or more routines, wherein the one or more routines include: an image data receive module, which when executed by one or more microprocessors, receives the captured one or more images from the drone, through the communication unit; a map generation module, which when executed by the one or more microprocessors, generates a three-dimensional map based on the received one or more images; and a navigation determination module, which when executed by the one or more microprocessors, determine navigation condition based on the generated three-dimensional map.

**[00022]** In an another aspect, the present invention provides a method for dynamic and intelligent transportation system (ITS) for a self-driving vehicle, the system comprises: capturing one or more images of the environment which is vicinity of the self-driving vehicle, by one or more image sensors of a drone; receiving, at the self-driving vehicle, captured one or more images from the drone, through a wireless communication link; generating, a three-dimensional map based on the received one or more images; and determining a navigation condition based on the generated three-dimensional map.

**[00023]** In an embodiment, the self-driving vehicle comprises a GPS sensor.

**[00024]** In an embodiment, the three-dimensional map comprises a location of one or more object selected from a group of traffic signs, traffic lights, roadblocks, one or more vehicles, and buildings.

**[00025]** In an embodiment, the one or more image sensors are selected from a compact camera, an infrared camera, a 3D camera, an ultraviolet camera, a closed-circuit television (CCTV) camera, digital single-lens reflex camera (DSLR) camera, a mirrorless camera and a 360 camera.

**[00026]** The system of claim 1, wherein the self-driving vehicle stores the generated three-dimensional map.

**<u>Brief Description of the Drawings</u>**

**[00027]** FIG. 1 shows an architecture for dynamic and intelligent transportation system (ITS) for a self-driving vehicle in accordance with an embodiment of the present disclosure.

**[00028]** FIG. 2 illustrates exemplary functional engines/modules for dynamic and intelligent transportation system (ITS) for a self-driving vehicle, in accordance with embodiments of the present disclosure.

**[00029]** FIG. 3 illustrates an exemplary flow diagram depicting steps for dynamic and intelligent transportation system (ITS) for a self-driving vehicle in accordance with an embodiment of the present disclosure

## Detailed Description

**[00030]** The following discussion provides many example embodiments of the inventive subject matter. Although each embodiment represents a single combination of inventive elements, the inventive subject matter is considered to include all possible combinations of the disclosed elements. Thus if one embodiment comprises elements A, B, and C, and a second embodiment comprises elements B and D, then the inventive subject matter is also considered to include other remaining combinations of A, B, C, or D, even if not explicitly disclosed.

**[00031]** The present invention relates to a system and method for navigation and control of a vehicle. More specifically, the invention relates to a system and method for autonomous vehicle guidance. Moreover, the present invention provides a drone/ unmanned aerial vehicle (UAV) based autonomous navigation service system and a method of operation thereof.

**[00032]** Referring to FIG. 1, there is shown an architecture 100 for dynamic and intelligent transportation system (ITS) for a self-driving vehicle 102 (also refer as vehicle 102), in accordance with an embodiment of the present disclosure. The system 100 can comprise one or more drone 104 and a wireless communication link 106. The drone 104 can comprise one or more image sensors 104a, one or more drive systems to provide propulsion force or manoeuvring effect to the drone 104, a battery, a charging unit to charge the battery, a data transmitter, one or more sensors (e.g. an accelerometer, a GPS sensor, a battery status monitor etc.) and other known components known in prior arts.

**[00033]** The image sensors 104a can be configured to capture one or more images of the roads, building, or any other objects which are present on the road or side of the road. The exemplary image sensors can be selected from a compact camera, an infrared camera, a night vision camera, a 3D camera, an ultraviolet camera, a closed-circuit television (CCTV) camera, digital single-lens reflex camera (DSLR) camera, a mirrorless camera and a 360 camera. The image sensor 104a can capture images and/or video at various pixel resolutions selected from 9921×14008, 7016×9921, 4961×7016, 3508×4961, 2480×3508, 1748×2480, 1240×1748, 874×1240 and 614×874.

**[00034]** The communication link 106 can be a short-range communication network (e.g. a Bluetooth® network, an infrared network, a wireless network etc.) and/or a long-range communication network (e.g. a telecommunication network, wireless metropolitan area network (WMAN), a WiFi® network, internet etc.) known in prior arts. In an embodiment, the communication link 106 can transmit data at a rate selected from maybe 50Mbps, 55Mbps, 60Mbps, 65Mbps, 70Mbps, 75Mbps, 80Mbps, 85Mbps, 90Mbps, and 95Mbps, greater or less than 100Mbps depending on the particular network environment.

**[00035]** The transmission of the captured images from drone 104 to the vehicle 102 and/or other components of the system 100 can be accomplished in various ways, for example, by pressing a physical button (not shown in the figure) of the drone 104 or can be initiated automatically (e.g. in run-time or after every 30 minutes, 60 minutes or like that).

**[00036]** In one of the embodiments, the vehicle 102 can be configured to receive the captured images from the drone 104. The vehicle 102 may comprise one or more memory units/ non-transitory storage devices and one or more processors. The non-transitory storage device may include, but is not limited to, fixed (hard) drives, magnetic tape, floppy diskettes, optical disks, compact disc read-only memories (CD-ROMs), and magneto-optical disks, semiconductor memories, such as ROMs, PROMs, random access memories (RAMs), programmable read-only memories (PROMs), erasable PROMs (EPROMs), electrically erasable PROMs (EEPROMs), flash memory, magnetic or optical cards, or another type of media/machine-readable medium suitable for storing executable instructions (e.g., computer programming code, such as software or firmware). The executable instructions executed by the processor to perform various operations.

**[00037]** Upon receiving the captured images, the vehicle 102 can analyse the received images to create a three-dimensional (3D) map of an environment in which the vehicle 102 is present. Based on the generated 3D map, the vehicle 102 can determine navigation condition which can be selected from: a position of the vehicle, vehicle 102 is following a lane-based driving, traffic condition in the lane in which the vehicle 102 is present, traffic condition of the other vehicles, which is the fastest moving lane, change in the speed of the vehicle 102, change in route of the vehicle based on the detected traffic condition, alert the driver or any other person, alert various governmental agencies etc.

**[00038]** The generated three-dimensional map may comprise road geometry (i.e. total number of lanes), the shape of the road (e.g. curvature of the road, number of intersections of the roads/lanes), elevation/slope of the road/lane, etc.

**[00039]** In an alternative embodiment, the three-dimensional map may comprise other traffic-related information such as road diversion, presence of traffic lights, one-way traffics, nearby landmarks (e.g. bank, hospital, parking lot, amusement park, police station etc.), roadblocks, one or more other automobile/vehicles, buildings etc.

**[00040]** In an embodiment, the vehicle 102 may comprise an advanced driver assistant system (ADAS) and a lane departure warning system (LDWS) to improve safety and generate an alert based on the received images of the drone 104.

**[00041]** In an exemplary embodiment, the drone 104 can analyse the captured images and generate a 3D map. The generated 3D map can be transmitted to the vehicle 102.

**[00042]** FIG. 2 illustrates exemplary functional engines/modules 200 for dynamic and intelligent transportation system (ITS) for a self-driving vehicle 102, in accordance with embodiments of the present disclosure. As illustrated, the functional engines comprise Image Data Receive Module 202, Map Generation Module 204, And Navigation Determination Module 206.

**[00043]** In an embodiment, the image data receive module 202, which when executed by one or more microprocessors, receives the captured one or more images from the drone 104, through the communication unit 106.

**[00044]** In an embodiment, the map generation module 204, which when executed by one or more microprocessors, generates a three-dimensional map based on the received one or more images. In exemplary embodiment the map generation module 204 can use various machine learning-based algorithm such as artificial neural network, Hidden Markov Model (HMM) based classifier, etc. to generate the three-dimensional map. In an embodiment, the map generation module 204 can extract one or more objects (e.g. lane marking, traffic light etc.) which are present in the received images, the relationship between the extracted objects, the depth value of the objects etc.

**[00045]** In an embodiment, the navigation determination module 206, which when executed by one or more microprocessors, determine navigation condition based on the generated three-dimensional map. The navigation condition can be selected from an optimal route, ideal lane, required speed of the vehicle 102, anti-collision measure, collision point prediction, alert for a change in the lane, or combination thereof. Based on the determined navigation condition, the control system of the vehicle 102 can adjust driving condition.

**[00046]** In an embodiment, the navigation determination module 206 can deploy known path recognition algorithm which can distinguish the street region and non-street region. This distinction technique can help to derive tailor-made driving condition. For example, reduce speed in the residential block, higher speed on the road and maximum speed on the highway.

**[00047]** In an embodiment, the navigation determination module 206 can assist the driver or vehicle control system by providing appropriate notification about lane detection in a congested area, automated parking of the vehicle 102, assistance in traffic jams (e.g. suggestion of alternative road, or change to a lane which is moving faster etc.), assistance in driving through congested/small streets or road to prevent collision/accident.

**[00048]** FIG. 3 illustrates an exemplary flow diagram 300 depicting steps for dynamic and intelligent transportation system (ITS) for a self-driving vehicle 102 in accordance with an embodiment of the present disclosure. In an implementation, the proposed method can include: at step (302), capturing one or more images of the environment which is vicinity of the self-driving vehicle 102, by one or more image sensors 104a of a drone 104; at step (304), receiving, at the self-driving vehicle 102, captured one or more images from the drone 104, through a wireless communication link 106, at step (306), generating, a three-dimensional map based on the received one or more images; and at step (308), determining a navigation condition based on the generated three-dimensional map.

**[00049]** Throughout the present disclosure, the term ‘processing means’ or ‘processor’ or ‘processors’ relates to a computational element that is operable to respond to and processes instructions that drive the system. Optionally, the processor includes, but is not limited to, a microprocessor, a microcontroller, a complex instruction set computing (CISC) microprocessor, a reduced instruction set (RISC) microprocessor, a very long instruction word (VLIW) microprocessor, or any other type of processing circuit. Furthermore, the term “processor” may refer to one or more individual processors, processing devices and various elements associated with a processing device that may be shared by other processing devices. Additionally, the one or more individual processors, processing devices and elements are arranged in various architectures for responding to and processing the instructions that drive the system.

**[00050]** The term “non-transitory storage device” or “memory,” as used herein relates to a volatile or persistent medium, such as a magnetic disk, or optical disk, in which a computer can store data or software for any duration. Optionally, the memory is non-volatile mass storage such as physical storage media. Furthermore, a single memory may encompass and in a scenario wherein computing system is distributed, the processing, memory and/or storage capability may be distributed as well.As used herein, and unless the context dictates otherwise, the term "coupled to" is intended to include both direct coupling (in which two elements that are coupled to each other contact each other) and indirect coupling (in which at least one additional element is located between the two elements).

Therefore, the terms "coupled to" and "coupled with" are used synonymously. Within the context of this document terms "coupled to" and "coupled with" are also used euphemistically to mean “communicatively coupled with” over a network, where two or more devices are able to exchange data with each other over the network, possibly via one or more intermediary device.

**[00051]** It should be apparent to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms “comprises” and “comprising” should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Where the specification claims refer to at least one of something selected from the group consisting of A, B, C …. and N, the text should be interpreted as requiring only one element from the group, not A plus N, or B plus N, etc.

**<u>Advantages of the Invention</u>**

**[0001]** An advantage of the present disclosure is overcoming one or more drawbacks associated with conventional mechanisms.

**[0002]** An advantage of the present disclosure is providing driving assistance to self-driving vehicle

**[0003]** An advantage of the present disclosure is easing traffic jam related problems.

**[0004]** An advantage of the present disclosure is providing information related to drowsiness lanes.

**[0005]** An advantage of the present disclosure is providing a modular Intelligent Transportation System (MITS).

## CLAIMS

We Claim:

1. A system for dynamic and intelligent transportation system (ITS) for a self-driving vehicle, the system comprises:

    a wireless communication link;

    a drone which is configured to acquire information related to a vicinity of the self-driving vehicle, wherein the drone comprises:

        one or more image sensors arranged to capture one or more images; and

        data transmitter to transmit the captured one or more images;

    the self-driving vehicle, further, comprises:

        a communication unit configured to captured one or more images from the drone, through the wireless communication link;

        a non-transitory storage device comprising:

            one or more executable routines; and

        one or more processing means coupled to the non-transitory storage device and operable to execute the one or more routines, wherein the one or more routines include:

an image data receive module, which when executed by one or more microprocessors, receives the captured one or more images from the drone, through the communication unit;

a map generation module, which when executed by the one or more microprocessors, generates a three-dimensional map based on the received one or more images; and

a navigation determination module, which when executed by the one or more microprocessors, determine navigation condition based on the generated three-dimensional map.

2. The system of claim 1, wherein the self-driving vehicle comprises a GPS sensor.

3. The system of claim 1, wherein the three-dimensional map comprises a location of one or more object selected from a group of traffic signs, traffic lights, roadblocks, one or more vehicles, and buildings.

4. The system of claim 1, wherein the one or more image sensors are selected from a compact camera, an infrared camera, a 3D camera, an ultraviolet camera, a closed-circuit television (CCTV) camera, digital single-lens reflex camera (DSLR) camera, a mirrorless camera and a 360 camera.

5. The system of claim 1, wherein the self-driving vehicle stores the generated three-dimensional map.

6. A method for dynamic and intelligent transportation system (ITS) for a self-driving vehicle, the system comprises:

    capturing one or more images of the environment which is vicinity of the self-driving vehicle, by one or more image sensors of a drone;

    receiving, at the self-driving vehicle, captured one or more images from the drone, through a wireless communication link,

    generating, a three-dimensional map based on the received one or more images; and

    determining a navigation condition based on the generated three-dimensional map.

7. The method of claim 6, wherein the self-driving vehicle comprises a GPS sensor.

8. The method of claim 6, wherein the three-dimensional map comprises a location of one or more object selected from a group of traffic signs, traffic lights, roadblocks, one or more vehicles, and buildings.

9. The method of claim 6, wherein the one or more image sensors are selected from a compact camera, an infrared camera, a 3D camera, an ultraviolet camera, a closed-circuit television (CCTV) camera, digital single-lens reflex camera (DSLR) camera, a mirrorless camera and a 360 camera.

10. The method of claim 6, wherein the vehicle stores the generated three-dimensional map.

Dated this **14, Dec, 2020**

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## ABSTRACT

The present invention provides A method for dynamic and intelligent transportation system (ITS) for a self-driving vehicle, the system comprises: capturing one or more images of the environment which is vicinity of the self-driving vehicle, by one or more image sensors of a drone; receiving, at the self-driving vehicle, captured one or more images from the drone, through a wireless communication link, generating, a three-dimensional map based on the received one or more images; and determining a navigation condition based on the generated three-dimensional map.

Fig. 1

Dated this **14, Dec, 2020**

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