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(54) **METHOD AND APPARATUS FOR TRAFFIC CONDITION DIAGRAM GENERATION**

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G06K 9/00	(2006.01)
G06K 9/46	(2006.01)

(52) **U.S. Cl.**
CPC ***G06T 11/60*** (2013.01); ***G06K 9/00651*** (2013.01); ***G06K 9/46*** (2013.01)

(58) **Field of Classification Search**
CPC G06T 11/60; G06K 9/46; G06K 9/00651
See application file for complete search history.

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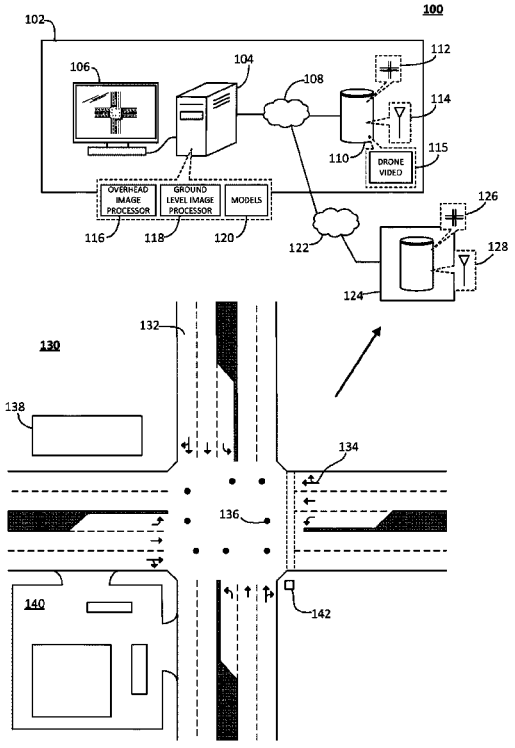
(57) **ABSTRACT**

A method and apparatus for generating traffic condition diagrams includes a computing system configured to receive an input that indicates a roadway location. The system uses overhead images, ground level images, or both, that are available in publicly accessible databases to identify roadway and related features for depiction in the traffic condition diagram. Features and their locations are identified and corresponding graphical artifacts are selected for inclusion in the traffic condition diagram. Independently sourced images such as that acquired by a drone dispatched to the roadway location can be used to validate or verify the results of processing the overhead and/or ground level images.

20 Claims, 4 Drawing Sheets



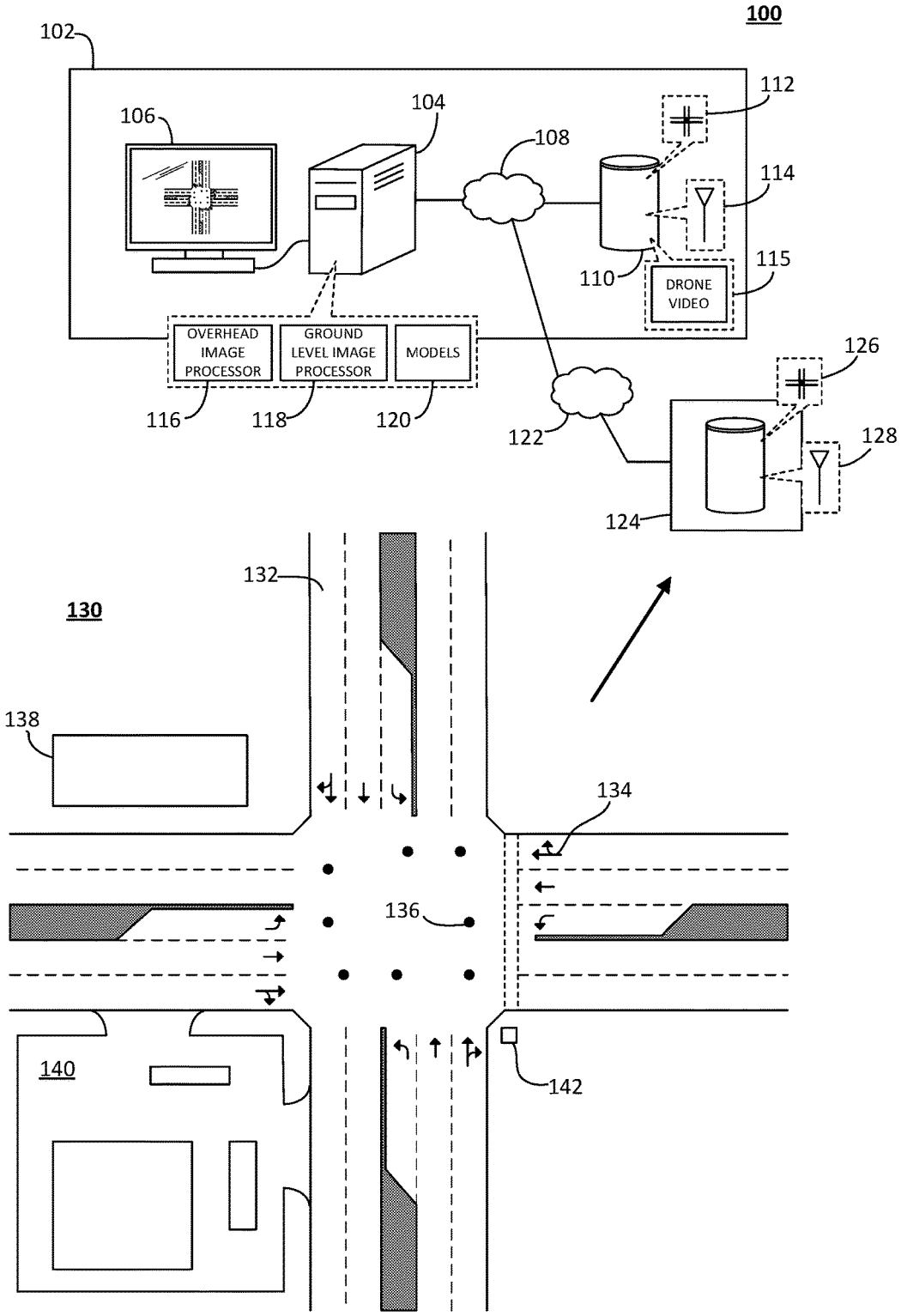

100
102
104
106
108
110
112
114
115
DRONE VIDEO
OVERHEAD IMAGE PROCESSOR
GROUND LEVEL IMAGE PROCESSOR
MODELS
116
118
120
122
124
126
128
130
132
134
136
138
140
142

FIG. 1

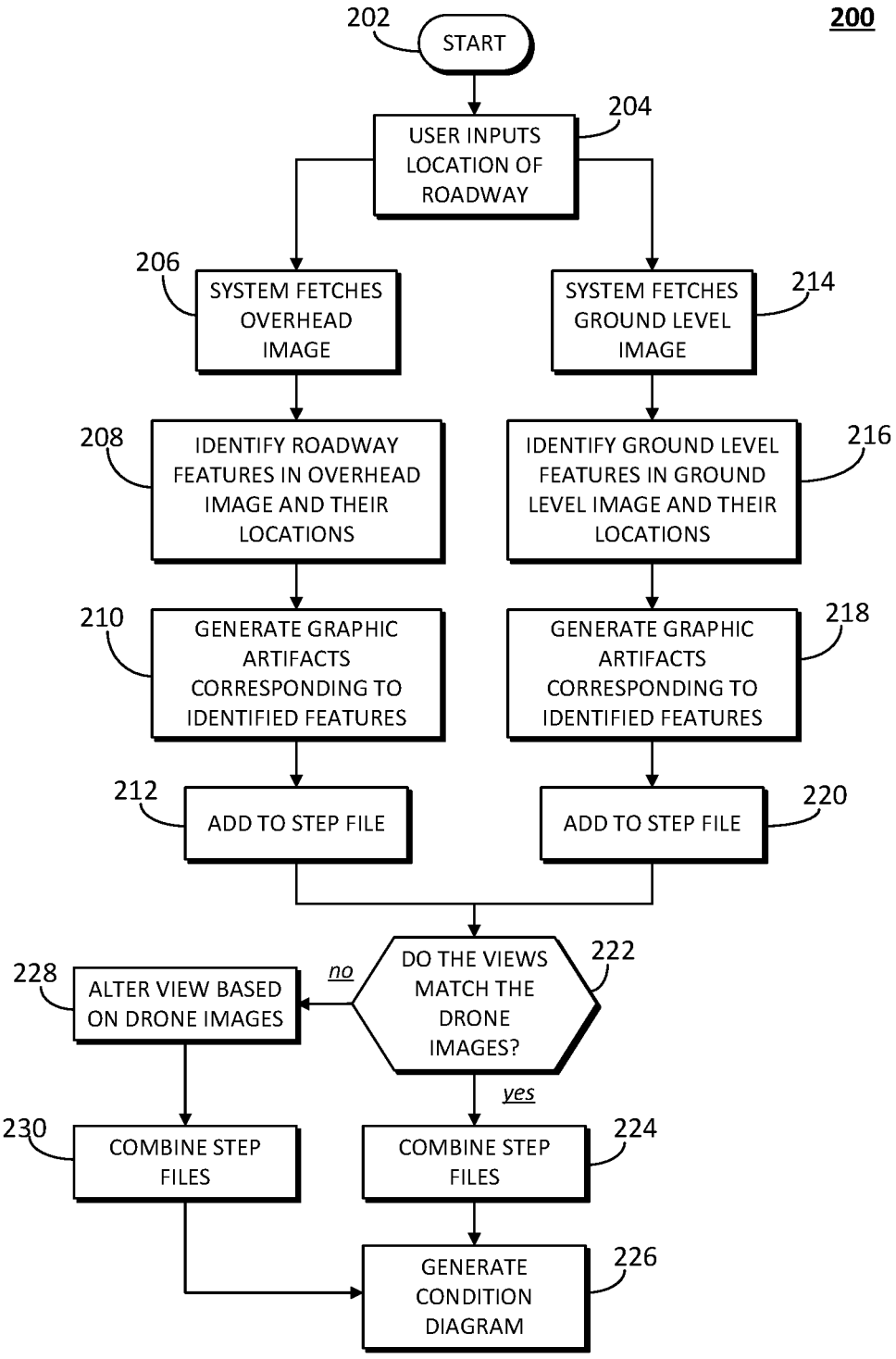

200
202
START
204
USER INPUTS LOCATION OF ROADWAY
206
SYSTEM FETCHES OVERHEAD IMAGE
214
SYSTEM FETCHES GROUND LEVEL IMAGE
208
IDENTIFY ROADWAY FEATURES IN OVERHEAD IMAGE AND THEIR LOCATIONS
216
IDENTIFY GROUND LEVEL FEATURES IN GROUND LEVEL IMAGE AND THEIR LOCATIONS
210
GENERATE GRAPHIC ARTIFACTS CORRESPONDING TO IDENTIFIED FEATURES
218
GENERATE GRAPHIC ARTIFACTS CORRESPONDING TO IDENTIFIED FEATURES
212
ADD TO STEP FILE
220
ADD TO STEP FILE
222
DO THE VIEWS MATCH THE DRONE IMAGES?
no
228
ALTER VIEW BASED ON DRONE IMAGES
yes
230
COMBINE STEP FILES
224
COMBINE STEP FILES
226
GENERATE CONDITION DIAGRAM

FIG. 2

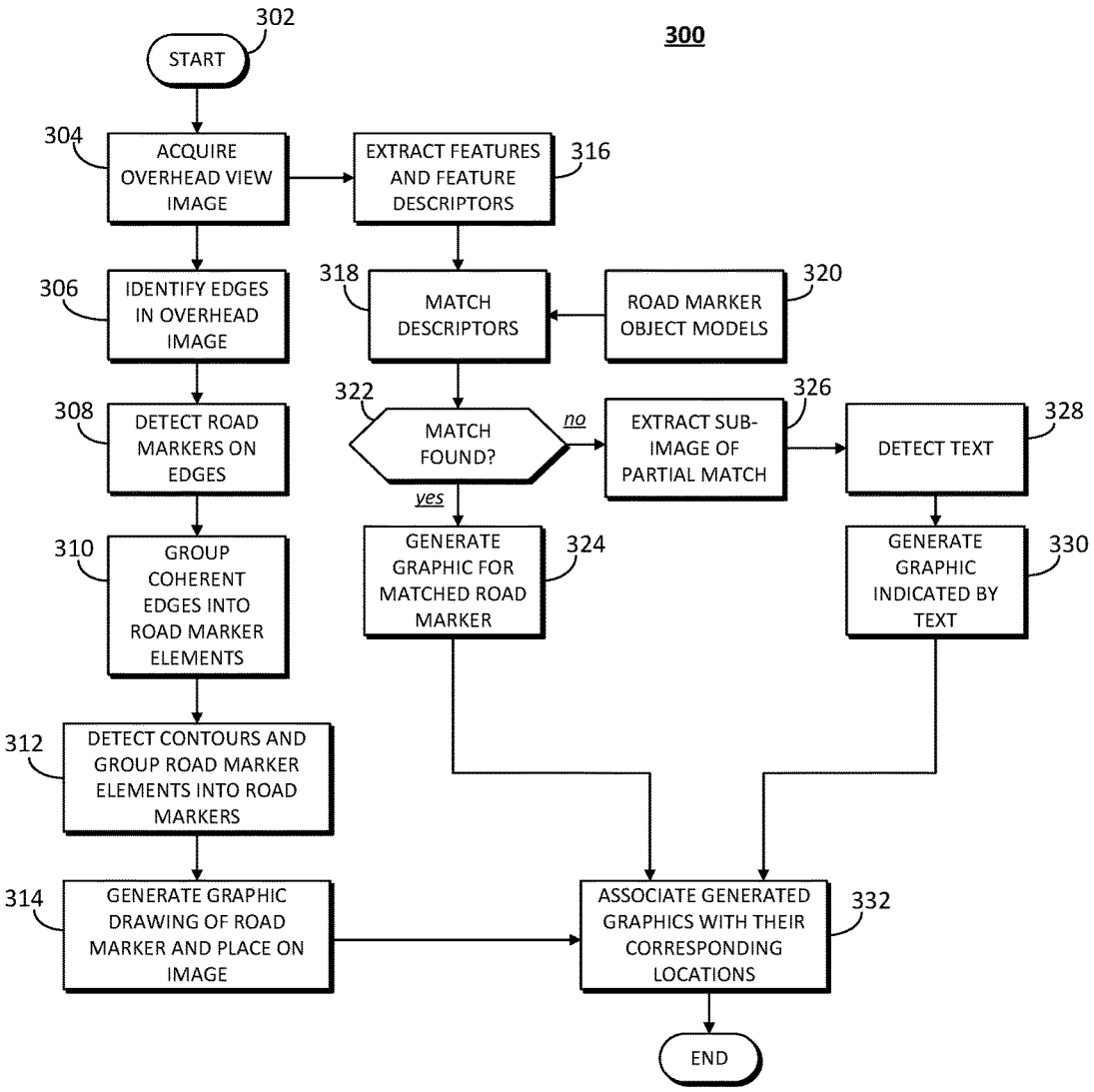

300
302
START
304
ACQUIRE OVERHEAD VIEW IMAGE
306
IDENTIFY EDGES IN OVERHEAD IMAGE
308
DETECT ROAD MARKERS ON EDGES
310
GROUP COHERENT EDGES INTO ROAD MARKER ELEMENTS
312
DETECT CONTOURS AND GROUP ROAD MARKER ELEMENTS INTO ROAD MARKERS
314
GENERATE GRAPHIC DRAWING OF ROAD MARKER AND PLACE ON IMAGE
316
EXTRACT FEATURES AND FEATURE DESCRIPTORS
318
MATCH DESCRIPTORS
320
ROAD MARKER OBJECT MODELS
322
MATCH FOUND?
no
yes
324
GENERATE GRAPHIC FOR MATCHED ROAD MARKER
326
EXTRACT SUB-IMAGE OF PARTIAL MATCH
328
DETECT TEXT
330
GENERATE GRAPHIC INDICATED BY TEXT
332
ASSOCIATE GENERATED GRAPHICS WITH THEIR CORRESPONDING LOCATIONS
END

FIG. 3

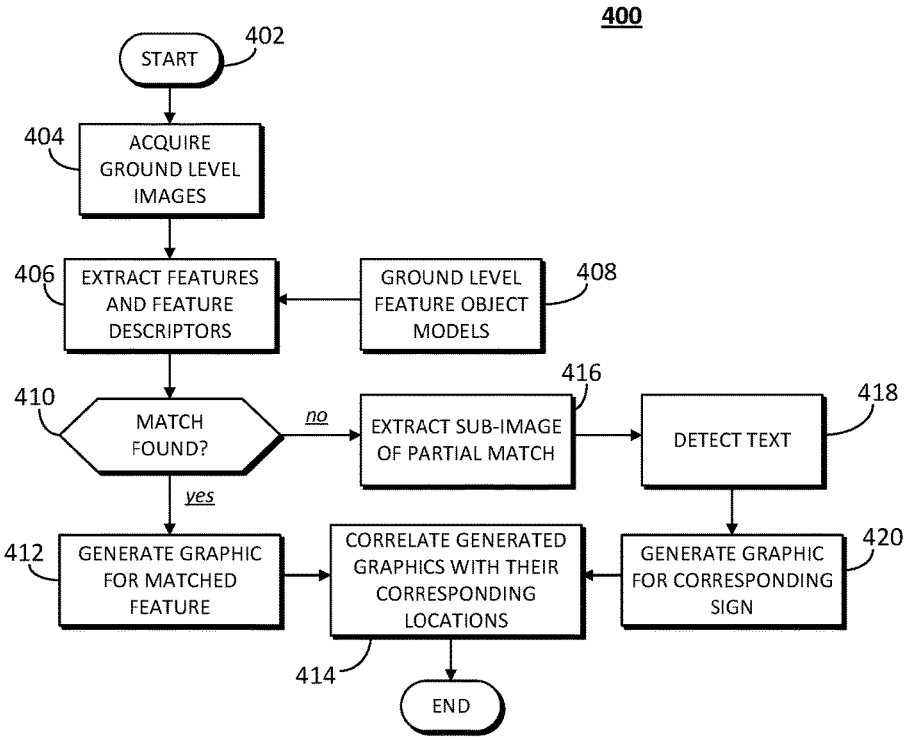

400
START
402
ACQUIRE GROUND LEVEL IMAGES
404
EXTRACT FEATURES AND FEATURE DESCRIPTORS
406
GROUND LEVEL FEATURE OBJECT MODELS
408
MATCH FOUND?
410
no
yes
EXTRACT SUB-IMAGE OF PARTIAL MATCH
416
DETECT TEXT
418
GENERATE GRAPHIC FOR MATCHED FEATURE
412
CORRELATE GENERATED GRAPHICS WITH THEIR CORRESPONDING LOCATIONS
GENERATE GRAPHIC FOR CORRESPONDING SIGN
420
414
END

FIG. 4

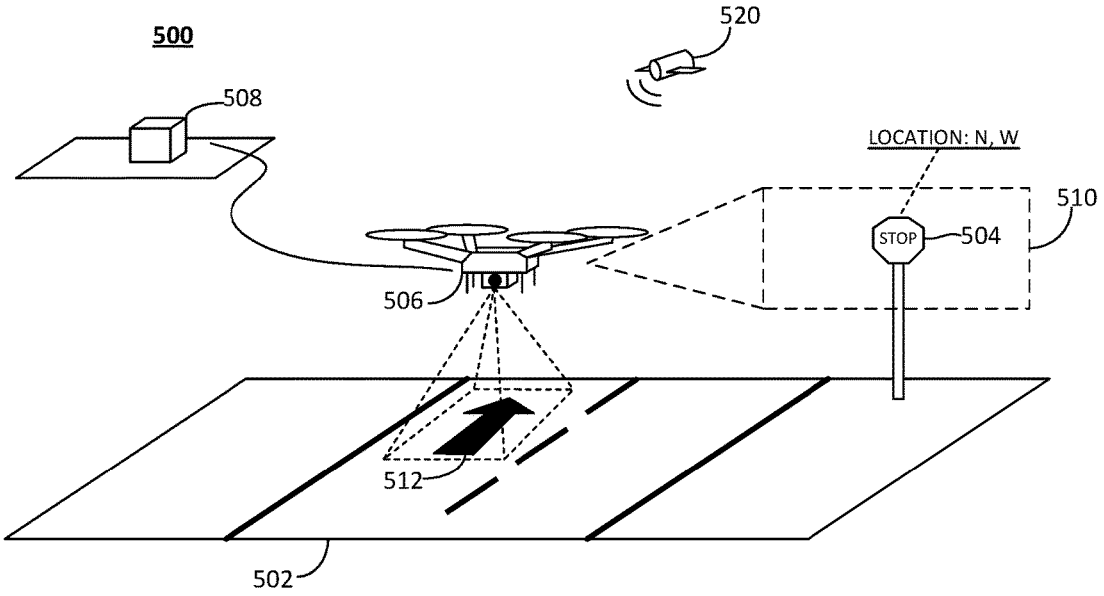

500
520
508
LOCATION: N, W
510
STOP
504
506
512
502

FIG. 5

METHOD AND APPARATUS FOR TRAFFIC CONDITION DIAGRAM GENERATION

FIELD OF THE DISCLOSURE

The present disclosure relates generally to the generation of traffic condition diagrams, and more particularly to the automated generation and verification of traffic condition diagrams.

BACKGROUND

Traffic condition diagrams represent the field conditions for roadways and roadway intersections and are relied upon by government agencies and others to indicate the conditions of an intersection and the surrounding area as it currently exists. Condition diagrams show intersection alignment, traffic lanes, traffic lane flow requirements (e.g. left or right turn only lanes), as well as signage, sidewalks, lighting positions, water hydrants, buildings and turn-offs for parking lot access, etc. Accordingly, condition diagrams are used in traffic planning, as well for other official purposes, including collision reports that are to be potentially relied upon in legal proceedings, and as such must be kept up to date.

The conventional method of generating traffic condition diagrams is by survey. That is, personnel go to the section of roadway for which the traffic condition diagram is to be created, and then observe and measure the locations of various roadway features and surrounding related features, and then use this collected information to generate a condition diagram. Typically a computer aided drawing (CAD) program is used to create the traffic condition diagram, using the collected data to select appropriate symbols to represent the roadway, lanes, lane markings, signage, and so on. That means that generation of a condition diagram requires the efforts of likely several people, and the time it takes to survey a location and then create a drawing including information representing the features observed by the survey.

Accordingly, there is a need for a method and apparatus for generating traffic condition diagrams without having to rely on surveys conducted by people and drawing generated from the survey results.

BRIEF DESCRIPTION OF THE FIGURES

In the accompanying figures like reference numerals refer to identical or functionally similar elements throughout the separate views, together with the detailed description below, and are incorporated in and form part of the specification to further illustrate embodiments of concepts that include the claimed invention and explain various principles and advantages of those embodiments.

FIG. **1** is a block diagram including a roadway condition diagram generation system, in accordance with some embodiments;

FIG. **2** is a flow chart diagram of processes performed by a roadway condition diagram generation system, in accordance with some embodiments;

FIG. **3** is a flow chart diagram of a method for processing overhead images in the generation of traffic condition diagrams, in accordance with some embodiments;

FIG. **4** is a flow chart diagram of a method for processing ground level images in the generation of traffic condition diagrams, in accordance with some embodiments; and

FIG. **5** illustrates the use a drone to acquire independent image media for verification of the results of overhead and ground level image processing in the generation of traffic condition diagrams, in accordance with some embodiments.

Those skilled in the field of the present disclosure will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the present invention.

The apparatus and method components have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein. The details of well-known elements, structure, or processes that would be necessary to practice the embodiments, and that would be well known to those of skill in the art, are not necessarily shown and should be assumed to be present unless otherwise indicated.

DETAILED DESCRIPTION

Some embodiments of the disclosure can include a roadway condition diagram generation system that includes at least one data storage in which is stored overhead roadway images and ground level images, and a computing system operably coupled to the at least one data store and configured to receive a roadway location input corresponding to a roadway location. The computing system can be further configured to obtain an overhead roadway image from the data store including a depiction of a roadway at the roadway location and to identify a plurality of roadway features and the locations relative to the roadway in the overhead roadway image and generate graphic artifacts to represent each of the plurality of roadway features in a roadway condition diagram. The computing system can be further configured to obtain ground level images from the data store corresponding to the roadway location, identify a plurality of ground level features and their locations relative to the roadway features in the ground level images and generate graphic artifacts to represent each of the identified ground level features. The computing system can be further configured to arrange the graphic artifacts that represent the plurality of roadway features and the ground level features in the traffic condition diagram in accordance with their relative locations.

FIG. **1** is a block diagram **100** including a roadway condition diagram generation system **102**, in accordance with some embodiments. The system **102** is used to generate a traffic condition diagram that represents a roadway **130**. A condition diagram captures the field conditions of a portion of roadway, such as an intersection, and indicates intersection alignment, roadway directional markings, adjacent buildings, sidewalks, trees, lighting poles, water hydrants, traffic signs, distances, and so on. Since condition diagrams are used for official purposes, such as to record collision incidents, their format is typically standardized by an authority such as a department of transportation. Certain existing standards may be adopted as well, such standard 10303-242 of the International Standards Organization (ISO), also known as the Standard for the Exchange of Product (STEP) model data.

The system **102** includes a computing device **104** or **107** that includes one or more processors which can be housed together or distributed among several devices. The computing system can further include random access memory (RAM), read only memory (ROM), and bus accessible bulk storage such as one or more hard drives. Computing device **104** can be, for example, a laptop or desktop computer, and computing device **107** can be a mobile device such as a tablet computer or cellular phone device. Program code can be stored on the bulk storage of the devices **104**, **107** which can be instantiated and run by the one or more processors. The computing devices **104** can further include input devices such as a keyboard and mouse, and output devices such as a display **106**, in some embodiments the output may be viewed on a mobile device such as a smartphone or tablet **107**. The computing devices **104**, **107** can be connected to a network such as an intranet **108** or local area network, which can be further connected to a public wide area network **122** such as the Internet. The computing devices **104**, **107** are operably connected to one or more data stores, which can include a hard drive housed in the computing device **104**, as well as, or alternatively, an external data store **110** such as a database or server, as well as a publicly accessible data store **124** that can be accessed by devices connected to the public wide area network **122**.

The computing devices **104**, **107** instantiate and execute program code for image processing and performing recognition of objects depicted in images. In particular the program code identifies objects relevant to generating condition diagrams such as roadway markings, traffic lights, vegetation, medians, and traffic signs. The program code includes a code **116** for processing overhead images, code **118** for processing ground level images, and can further include data structures **120** representing models of objects to be recognized in overhead and ground level images. The code sections **116**, **118** can be provided in the form of modules and can share code resources such as objects, methods, libraries, and so on.

Data stores **110**, **124** can store overhead images **112**, **126**, and/or ground level images **114**, **128**. Overhead images are images taken from an overhead perspective, such as aerial and satellite images of roadways and other terrain. They are generally taken from a high angle perspective relative to the generally horizontal plane of the Earth. Ground level images are images taken from a ground level perspective looking generally parallel to the ground level. Thus, while it may be possible to see there is a traffic sign present at an intersection in an overhead view, the text or graphics shown on that sign can't be seen, but the text and/or graphics can be seen in a ground level image including the sign. In some embodiments publicly accessible data store **124** can include publicly accessible satellite images **126**, such as those made available by Google Earth service, and it can further include publicly accessible ground level images **128** such as those made available by the Google Street View service. To access those publically accessible images **126**, **128** the code modules **116**, **118** can call an application programming interface (API) to retrieve specific images corresponding to an input location from the overhead and ground level image stores **126**, **128** from public accessible data storage **124**, or from more locally accessible data store **110**.

The overhead images **112**, **126** and ground level images **114**, **128** include images of many different roadway portions. Publicly accessible overhead images **126** include relatively high resolution images of roadways in virtually every significant municipality on Earth. The publicly accessible ground level images **128** are nearly as comprehensive. Roadway portions such as roadway **130** (an intersection) is an example of a roadway portion that can be shown in overhead images **112**, **126**. The roadway **130** includes lanes such as lane **132**, and roadway markings such as directional arrows **134**. Lane **132** is defined by edges which are often marked by painted stripes, or by curbs, or merely the line along which the roadway meets the adjacent terrain. Roadway markings such as arrow **134** can be painted on the roadway, and can indicate allowed turning directions, crosswalks, rail road crossings, and numerous other markings. Other features can be seen as well, such as, for example, traffic lights **136**, buildings **138**, parking lot **140**, and traffic sign **142**. Similarly, such features above the roadway surface can be seen in corresponding ground level images.

In operation, the image processing modules **116**, **118** can fetch images from a designated data store **110**, **124** using an appropriate API to indicate the desired location and zoom level. The zoom level can be selected so that standardized roadway widths will have a given image width to facilitate feature and object recognition. Generally, edge processing is performed, followed by contour detection and integrating contours to form objects visible in the selected image. The detected objects can be compared to model objects in the models **120** to recognize roadway features. In some embodiments, the publicly accessible overhead images **126** can have associated metadata that indicates a roadway, and other objects visible in the picture. Such metadata can be used, for example, when rendering image views in an image rendering application such as, for example, the Google Earth client application, to indicate roadways that may be obscured due to a low zoom level, overhead trees, and so on. Once an object is recognized (i.e. pattern matched to one of the models **120**), the modules **116**, **118** select a graphical artifact to represent the identified featured to be overlaid on a roadway representation in the traffic condition diagram at the corresponding locations. The graphic artifacts can be placed in a file as the output of processing the images by the modules **116**, **118**. After the images are fully processed, the traffic condition diagram can be generated and rendered by placing all graphic artifacts in the corresponding locations relative to the roadway (i.e. road edges, markings, buildings, traffic signs, etc.). In some embodiments, in addition to ground level images **114** or **128** being processed, an independently produced image file **115** of ground level images can be processed to ensure the ground level images **114**, **128** are up to date. In some embodiments the independently produced image file **115** can be obtained from a drone equipped with a camera that has been dispatched to the roadway location to record images or video of the roadway region. Any variations between the independently produced image file **115** are resolved by what is visible in the independently produced image file. That is, for example, a sign that is seen in the independently produced image file **115** that is not seen in the ground level images results in a graphic artifact being produced for the sign and placed in the traffic condition diagram. The resulting traffic condition diagram can be rendered on a display **106**.

FIG. **2** is a flow chart diagram **200** of processes performed by a roadway condition diagram generation system, in accordance with some embodiments. At the start **202** a computing device (e.g. **104**) is powered on and has instantiated program code to perform image processing, graphic artifact selection, and condition diagram generation. In step **204** a user inputs a location of a roadway. The location can be provided as an intersection (i e naming two or more roadways), as a set of geolocation coordinates, or some other location input. The location informed is used in steps **206**

and **214** to fetch corresponding overhead and ground level images from services like google Earth and Google Street View, respectively. When accessing publicly accessible image stores (e.g. **124**), an API can be used to provide the location information to the data store (acting as a server), and the data store can return the corresponding images. For ground level images, several images can be fetched showing each side of each roadway, as well as views approaching and leaving the indicated location. In steps **208**, **216**, the fetched overhead and ground level images are processed to identify features to be shown in the traffic condition diagram. In steps **210**, **218** the system generates graphic artifacts to represent identified features of interest and the locations of the identified features are noted. In some embodiments the graphic artifacts are matched with the standard traffic signs published by the Department of Transportation or road marker object models. In steps **212**, **220**, the graphic artifacts generated in steps **210**, **218** are added to a working file such as a STEP file that lets CAD applications save files from their native format to a universal one, and hence allowing them to be opened by different CAD applications. The STEP files retain geometric and dimensional tolerances information, as well as other actionable specifications information. The algorithm keeps files in editable mode for alignment with CAD tool compatibility. Steps **206**, **208**, **210**, and **212** can be performed by, for example, an overhead image processing module such as module **116**. Steps **214**, **216**, **218**, and **220** can be performed by, for example, a ground level image processing module such as ground level image processing module **118**.

In steps **221***a* and **221***b* the system can align the overhead images and ground level images by identifying common features shown in both sets of images, including, for example, road lane markers, signs, roadway traffic directional indicators (e.g. arrows), pedestrian walkways, and so on. The locations of these markers can be obtained by, for example, interpolating from a boundary of the image, where the location coordinates of the image boundaries are given in metadata of the overhead image database. Once the corresponding features of the images are found and initial combined STEP file can be generated using the location coordinates and matching the locations of objects and features identified in the overhead images with the corresponding depiction in the ground level images of those objects and features.

In step **222** the system can compare the processing results with an independently produced image file of the roadway location. The independently produced image file can be, for example, a video produced by a drone that has been dispatched to the roadway location. If fetched images match the independently produced images, then in step **224** the working files can be finalized to generate the traffic condition diagram in step **226**. The graphic artifacts are placed in relation to the roadway features based on their location and orientation. If in step **222** the fetched images do not match the independently produced images, then in step **228** the independently produced images are used to identify and generate graphic artifacts, creating a working file that is finalized in step **230** with the file created in step **212** to generate the traffic condition diagram in step **226**.

FIG. **3** is a flow chart diagram **300** of a method for processing overhead images in the generation of traffic condition diagrams, in accordance with some embodiments. The method can be a more detailed process description of steps **206-212**. At the start **302** the computing device performing the method is powered on and configured with suitable program code. In step **304** the computing device acquires one or more overhead images of a roadway as indicated by a location input received from a user of the computing device. The method can be split into two major branches with one branch proceeding at step **306** to identify roadway locations (i.e. lanes), and another major branch commencing at step **316** to identify markers and other roadway features.

Commencing at step **306**, the method proceeds to identify edges in the overhead image. An edge is a border between adjacent regions in an image, where the regions are defined as areas of substantially uniform color, darkness and other characteristics of similarity. In step **308** the image processing method identifies road markers along edges. In step **310** the method groups coherent edges into road marker elements, such as, for example, lanes, directional markers that indicate a direction of travel (e.g. straight, left turn only, right turn only, cross walks, and so on). In step **312** the method detects contours and groups road marker elements into road markers. The road markers are graphic artifacts that are associated with a location and an orientation for placement in a traffic condition diagram in step **314**.

Returning to step **316**, computing device processing the overhead images extracts features and feature descriptors from the image or image metadata. In step **318**, a matching process is performed using road marker object models to match the extracted descriptors to models in a recognition process. The matching process can include a graphical correlation assessment where a detected object is compared to an established model to determine a similarity metric indicating how well the detected object correlates to the model or models. When the correlation is high enough, and exceeds a predetermined threshold, the detected object is then recognized as an object corresponding to the model. The matching process can also be performed by a machine learning process that uses a look-up table, Bayesian classifiers and/or multiple stage classifiers.

In step **322** the method determines if there has been a match. When a match occurs, in step **324** a graphic for a matching road marker is generated. If no match occurs in step **322**, then in step **326** the method can recognize partial matches. In some cases a roadway marker may be obscured from view in an overhead image by trees or vehicles, or other obstructions, leaving a partial segment of the roadway marker visible. In step **328** a text recognition process can be attempted to detect text in a sub-portion or sub-image of the overhead image. Any recognized text can be used to identify the roadway marking and generate a graphic artifact for the detected text in step **330**. In step **332**, the generated graphic artifacts of steps **314**, **324**, and **330** are associated with their corresponding locations for placement in the traffic condition diagram. In step **334** the STEP file is then created and available for use in generating condition diagram.

FIG. **4** is a flow chart diagram of a method **400** for processing ground level images in the generation of traffic condition diagrams, in accordance with some embodiments. The method **400** can be an implementation of steps **214-220** of FIG. **2**. At the start **402** the computing device is powered on and the program code to perform the method **400** is loaded. At step **404** the ground level images for an indicated roadway location are obtained. The ground level images can be obtained from a proprietary image database, or from a publicly accessible ground level image database such as the Google Street View image service. In requesting the ground level images the computing device performing the method **400** can access an API of the publicly accessible service, specifying locations and orientations for ground level images, as well as a zoom level. In step **406** the method **400**,

upon receiving the ground level images, extracts features and feature descriptors from the ground level images, using ground level feature object models **408** as references for identifying the features. In step **410** the method **400** compares each feature with models in order to determine if the identified feature matches any of the known models. The models represent traffic signs and other traffic common traffic control features. If, for a given feature, a match is found, then the method **400** proceeds to step **412** where a graphic artifact is generated. Generation of a graphic artifact includes selecting a stock graphic image that represents the identified feature, and associating it with metadata that indicates its location and orientation with respect to the roadway. When, in step **410**, a full match is not found, then in step **416** a partial match is attempted. For example, a street sign or traffic control sign may be partially obscured in the ground level image. The viewable partial image can be extracted, and may include some text. In step **418** any viewable text can be recognized and used to determine the sign or other feature. For example, a detection of "OP" where the image to the left of the text is blocked can be inferred to be "STOP," indicating the presence of a stop sign. In step **420** a graphic artifact is generated for the corresponding sign. In step **414** the generated graphics are correlated with the corresponding positions in the traffic condition diagram, and once the ground level images are fully processed the method creates a STEP file in step **415** that will be used for generating a condition diagram. In some embodiments, the traffic condition diagram can be generated using only ground level images, and without using overhead images. In some embodiments use of either the overhead images or ground level images can be omitted if, for example, any of those images are indicated to be older than a preselected time.

FIG. **5** illustrates the use a drone to acquire independent image media for verification of the results of overhead and ground level image processing in the generation of traffic condition diagrams, in accordance with some embodiments. A drone **506** can operate in a given region **500** that includes a roadway section **502**. A traffic condition diagram is to be generated for a roadway that includes roadway section **502**. At, or near the roadway section **502** can be features such as a sign **504**, and roadway markings **512**, that should appear in overhead or ground level roadway images. The drone **506** is equipped with a camera and is dispatched to generate independent images (i.e. independent of the sources primarily relied upon for overhead and ground level images). The drone can be, for example, a multi-rotor copter type unmanned aircraft, and can further include a location determination circuit, such as a location satellite radio signal receiver for receiving location signals from location satellites **520**. The location determination circuit allows the drone **506** to fly to the location of the roadway section **502** autonomously, and acquire ground level images such as an image frame **510** including sign **504**, and/or an image of roadway features. The drone **506** can be dispatched from a remote location **508**, or brought to the site of the roadway portion **502** and flown under control of an operator. While taking images the drone **506** also records its location and heading at the time of taking the image. In embodiments where the drone **506** records video, the camera can overlay location and heading on the video as the video is being recorded, or the camera can generate an associated synchronized file that indicates location and heading during recording of the video. Once the drone **506** has recorded the images, it can return to a point of origin or some other location to deliver the recorded images which can then be used to verify recognition of roadway features as in step **222** of FIG. **2**. Multiple features such as stop sign **504**, **512**, and sign **513** may be used to validate (or invalidate) the working files generated from the overhead image and ground level images. The presence or absence of these features are checked against the overhead and ground level images. Any differences can indicate that the overhead or ground level images do not accurately represent the roadway's present condition. When the drone images indicate differences, the features shown in the drone images are used to modify the STEP file to reflect their current existence as indicated in the drone images.

Embodiments of the disclosure provide the benefit of allowing rapid generation of traffic condition diagram that are timely and reflect current features and conditions of a section of roadway. The embodiments substantially reduce the cost of generating such diagrams by eliminating the need for onsite surveying, and manual generation of a condition diagram using a CAD drawing tool. These benefits are achieved by drawing on publicly available resources such as overhead images and ground level images, and processing these images to identify features that are to be represented in the a traffic condition diagram. A drone can also be used to acquire images representing the presence of features presently or substantially recently, in order to validate or edit information provided by the overhead and ground level images based on whether features shown in the drone images are also present in the overhead and ground level images.

In the foregoing specification, specific embodiments have been described. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the invention as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present teachings.

The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims. The invention is defined solely by the appended claims including any amendments made during the pendency of this application and all equivalents of those claims as issued.

Moreover in this document, relational terms such as first and second, top and bottom, and the like may be used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms "comprises," "comprising," "has", "having," "includes", "including," "contains", "containing" or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises, has, includes, contains a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element proceeded by "comprises . . . a", "has . . . a", "includes . . . a", "contains . . . a" does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises, has, includes, contains the element. The terms "a" and "an" are defined as one or more unless explicitly stated otherwise herein. The terms "substantially", "essentially", "approximately", "about" or any other version thereof, are defined as being close to as understood by one of ordinary skill in the art, and

in one non-limiting embodiment the term is defined to be within 10%, in another embodiment within 5%, in another embodiment within 1% and in another embodiment within 0.5%. The term "coupled" as used herein is defined as connected, although not necessarily directly and not necessarily mechanically. A device or structure that is "configured" in a certain way is configured in at least that way, but may also be configured in ways that are not listed.

It will be appreciated that some embodiments may be comprised of one or more generic or specialized processors (or "processing devices") such as microprocessors, digital signal processors, customized processors and field programmable gate arrays (FPGAs) and unique stored program instructions (including both software and firmware) that control the one or more processors to implement, in conjunction with certain non-processor circuits, some, most, or all of the functions of the method and/or apparatus described herein. Alternatively, some or all functions could be implemented by a state machine that has no stored program instructions, or in one or more application specific integrated circuits (ASICs), in which each function or some combinations of certain of the functions are implemented as custom logic. Of course, a combination of the two approaches could be used.

Moreover, an embodiment can be implemented as a computer-readable storage medium having computer readable code stored thereon for programming a computer (e.g., comprising a processor) to perform a method as described and claimed herein. Examples of such computer-readable storage mediums include, but are not limited to, a hard disk, a CD-ROM, an optical storage device, a magnetic storage device, a ROM (Read Only Memory), a PROM (Programmable Read Only Memory), an EPROM (Erasable Programmable Read Only Memory), an EEPROM (Electrically Erasable Programmable Read Only Memory) and a Flash memory. Further, it is expected that one of ordinary skill, notwithstanding possibly significant effort and many design choices motivated by, for example, available time, current technology, and economic considerations, when guided by the concepts and principles disclosed herein will be readily capable of generating such software instructions and programs and ICs with minimal experimentation.

The Abstract of the Disclosure is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in various embodiments for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description as part of the original disclosure, and remain so even if cancelled from the claims during prosecution of the application, with each claim standing on its own as a separately claimed subject matter. Furthermore, subject matter not shown should not be assumed to be necessarily present, and that in some instances it may become necessary to define the claims by use of negative limitations, which are supported herein by merely not showing the subject matter disclaimed in such negative limitations.

We claim:

1. A roadway condition diagram generation system, comprising:

a display;

a computing system including a processor operably coupled to the display, and further operably coupled to at least one data store having stored therein overhead roadway images and ground level images;

the processor operable in accordance with executed programmatic instructions to:

receive a roadway location input corresponding to a roadway location, the at least one data store;

obtain an overhead roadway image from the data store including a depiction of a roadway at the roadway location and to identify a plurality of roadway features and the locations relative to the roadway in the overhead roadway image and generate graphic artifacts to represent each of the plurality of roadway features in a roadway condition diagram;

obtain ground level images from the data store corresponding to the roadway location, identify a plurality of ground level features and their locations relative to the roadway features in the ground level images and generate graphic artifacts to represent each of the identified ground level features; and

arrange the graphic artifacts that represent the plurality of roadway features and the ground level features in the traffic condition diagram in accordance with their relative locations; and to

display the traffic condition diagram on the display.

2. The roadway condition diagram generation system of claim **1**, wherein the data store is a publicly accessible data store that includes location information for the overhead and ground level images.

3. The roadway condition diagram generation system of claim **1**, wherein the processor, in accordance with executed programmatic instructions, is further operable to represent the plurality of roadway features and the ground level features in the traffic condition diagram in a file format compatible with Standard for the Exchange of Product (STEP) model data application protocol **242**.

4. The roadway condition diagram generation system of claim **3**, wherein the processor, in accordance with executed programmatic instructions, is further operable to maintain the roadway condition diagram in an editable format.

5. The roadway condition diagram generation system of claim **1**, further comprising:

the processor, in accordance with executed programmatic instructions, is further operable to verify the identification of the plurality of roadway and ground level features against an independently sourced image file of the roadway location.

6. The roadway condition diagram generation system of claim **5**, further comprising a drone that is configured to produce the independently sourced image file, wherein the drone includes a self-location determination system and annotates its location in the image file as it is produced.

7. The roadway condition diagram generation system of claim **6**, wherein the processor, in accordance with executed programmatic instructions, is further operable to:

identify features in the independently sourced file and compare them against at least one of the overhead image or the ground level images; and to

validate the overhead and ground level images when roadway features of the independently sourced file matches corresponding features in the overhead or ground level images, and to generate graphic artifacts

matching those of the independently sourced file when there is a discrepancy in the roadway feature.

8. The roadway condition diagram generation system of claim **1**, wherein the processor, in accordance with executed programmatic instructions, is further operable to detect roadway signs by language matching in order to generate the graphic artifacts.

9. A method of generating a traffic condition diagram, comprising:

receiving an input indicating a roadway location for which the traffic condition diagram is to be generated;

acquiring a plurality of ground level images that have been taken at the location indicated by the received input;

processing the plurality of ground level images to identify a plurality of ground level features and their locations relative to roadway features shown in the ground level images;

generating graphic artifacts to represent each of the identified ground level features;

arranging the graphic artifacts that represent the plurality of roadway features and the ground level features in the traffic condition diagram in accordance with their relative locations; and

displaying the traffic condition diagram on a display of a computing system.

10. The method of claim **9**, further comprising:

acquiring an overhead image of the roadway location;

processing the overhead image to identify roadway features and the relative locations;

generating graphic artifacts that correspond to the roadway features identified in the overhead image; and

merging the generated graphic artifacts corresponding to the roadway features identified in the overhead image with the graphic artifacts that represent the plurality of roadway features and the ground level features from the ground level images to generate the traffic condition diagram.

11. The method of claim **9**, further comprising:

identifying features in an independently sourced file produced from images taken by a drone at the roadway location;

comparing the identified features of the independently sourced file against the ground level images; and

validating the ground level images when roadway features of the independently sourced file matches corresponding features in the overhead or ground level images, or generating graphic artifacts matching those of the independently sourced file when there is a discrepancy in the roadway features.

12. The method of claim **9**, wherein arranging the graphic artifacts that represent the plurality of roadway features and the ground level features in the traffic condition diagram is performed in accordance with a standardize computer aided drawing format.

13. The method of claim **9**, wherein arranging the graphic artifacts that represent the plurality of roadway features and the ground level features in the traffic condition diagram comprises representing the plurality of roadway features and the ground level features in the traffic condition diagram in a file format compatible with Standard for the Exchange of Product (STEP) model data application protocol **242**.

14. The method of claim **13**, wherein the graphic artifacts that represent the polarity of roadway features and the ground level features in the traffic condition diagram are each respectively annotated with their location coordinates in metadata respectively associated with each graphic artifact.

15. The method of claim **14**, further comprising generating the location coordinates for each graphic artifact by surveying the plurality of roadway features and ground level features using a Global Positioning System (GPS) receiver.

16. The method of claim **9**, wherein processing the plurality of ground level images to identify the plurality of ground level features comprises identifying traffic signs by language matching the text on the signs in order to generate graphic artifacts for those signs that indicate a meaning of the text.

17. A method for generating a traffic condition diagram for a roadway location, comprising:

acquiring, by a processor operably coupled to at least one data store responsive to the processor executing programmatic instructions, a plurality of ground level images that have been taken at the location indicated by the received input;

the processor processing the plurality of ground level images to identify a plurality of ground level features and their locations relative to roadway features shown in the ground level images;

the processor generating graphic artifacts to represent each of the identified ground level features;

the processor arranging the graphic artifacts that represent the plurality of roadway features and the ground level features in the traffic condition diagram in accordance with their relative locations; and

the processor displaying the traffic condition diagram on a display of a computing system.

18. The method of claim **17**, further comprising:

the processor identifying features in an independently sourced file produced from images taken by a drone at the roadway location;

the processor comparing the identified features of the independently sourced file against the ground level images; and

the processor validating the ground level images when roadway features of the independently sourced file matches corresponding features in the overhead or ground level images, or generating graphic artifacts matching those of the independently sourced file when there is a discrepancy in the roadway features.

19. The method of claim **17**, further comprising:

the processor acquiring an overhead image of the roadway location;

the processor processing the overhead image to identify roadway features and the relative locations;

the processor generating graphic artifacts that correspond to the roadway features identified in the overhead image; and

the processor merging the generated graphic artifacts corresponding to the roadway features identified in the overhead image with the graphic artifacts that represent the plurality of roadway features and the ground level features from the ground level images to generate the traffic condition diagram.

20. The method of claim **17**, wherein arranging the graphic artifacts that represent the plurality of roadway features and the ground level features in the traffic condition diagram comprises representing the plurality of roadway features and the ground level features in the traffic condition

diagram in a file format compatible with Standard for the Exchange of Product (STEP) model data application protocol **242**.

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