US 20220396147A1

(19) **United States**

(12) **Patent Application Publication**

Jeong et al.

(10) **Pub. No.: US 2022/0396147 A1**

(43) **Pub. Date: Dec. 15, 2022**

(54) **METHOD AND APPARATUS FOR CONTROLLING A PERSONAL MOBILITY VEHICLE BASED ON CONGESTION**

(71) Applicants: **HYUNDAI MOTOR COMPANY**, Seoul (KR); **KIA CORPORATION**, Seoul (KR); **KOOKMIN UNIVERSITY INDUSTRY ACADEMY COOPERATION FOUNDATION**, Seoul (KR)

(72) Inventors: **Gu Min Jeong**, Seoul (KR); **Hyun Jung Oh**, Seoul (KR); **Seung Hyeon Lee**, Seoul (KR); **Yo Cheol Jang**, Suwon-si (KR); **Choong Yub Lee**, Seoul (KR); **Jae Jun Ha**, Hwaseong-si (KR)

(21) Appl. No.: **17/520,993**

(22) Filed: **Nov. 8, 2021**

(30) **Foreign Application Priority Data**

Jun. 11, 2021 (KR) 10-2021-0076191

Publication Classification

(51) **Int. Cl.**

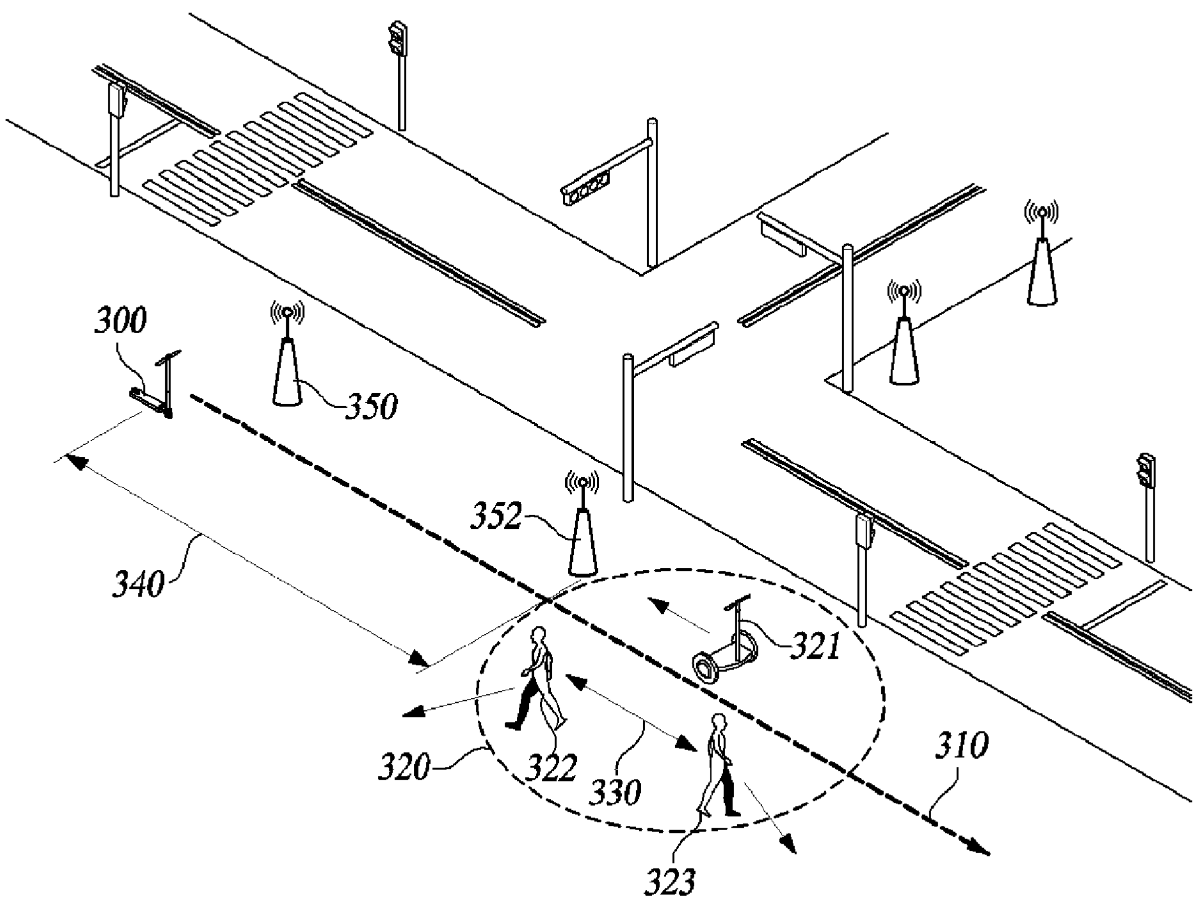
B60K 31/00 (2006.01)
G06K 9/00 (2006.01)
G06T 7/20 (2006.01)
G01C 21/36 (2006.01)

(52) **U.S. Cl.**

CPC ***B60K 31/0008*** (2013.01); ***G06K 9/00778*** (2013.01); ***G06K 9/00362*** (2013.01); ***G06T 7/20*** (2013.01); ***G01C 21/3691*** (2013.01); *G06T 2207/30242* (2013.01); *G06T 2207/30232* (2013.01); *B60K 2031/0016* (2013.01)

(57) **ABSTRACT**

A method and an apparatus for controlling personal mobility device (PMD) depending on congestion includes identifying a target area according to an expected route of the PMD, acquiring a degree of congestion of the target area based on at least one of a type of objects, a movement of the objects, a distance between objects, the number of objects that is expected, and a speed limit of the target area, and controlling speed of the PMD according to the degree of congestion.



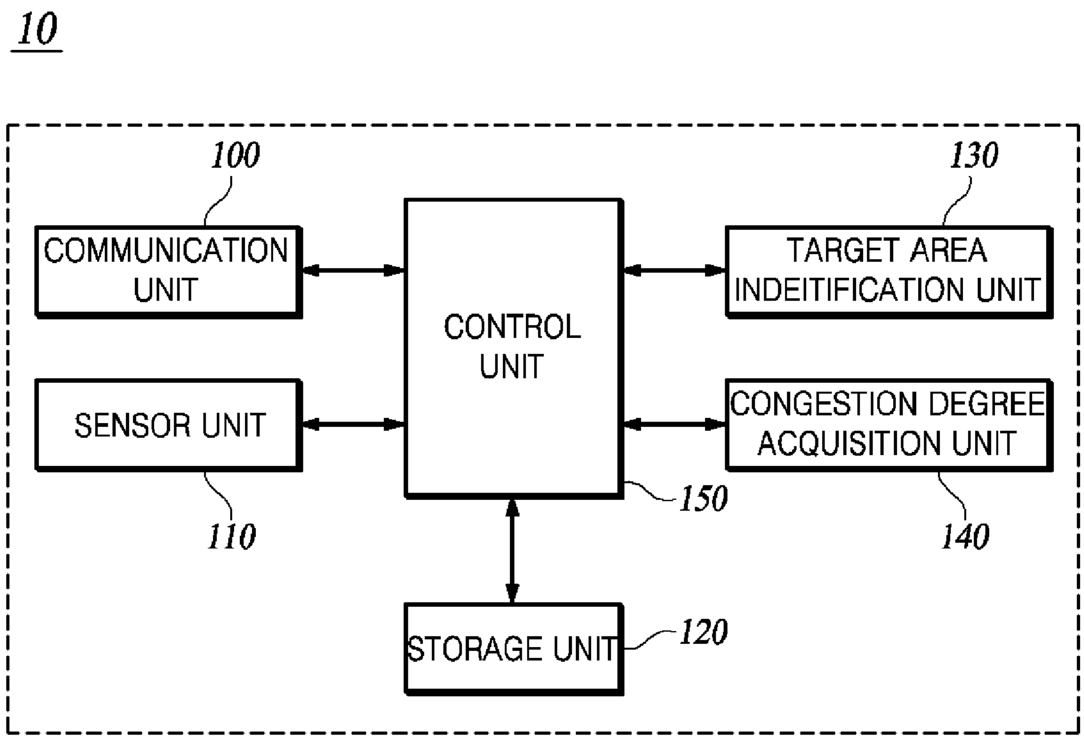

10
100
COMMUNICATION UNIT
SENSOR UNIT
110
CONTROL UNIT
150
STORAGE UNIT
120
130
TARGET AREA INDEITIFICATION UNIT
CONGESTION DEGREE ACQUISITION UNIT
140

FIG. 1

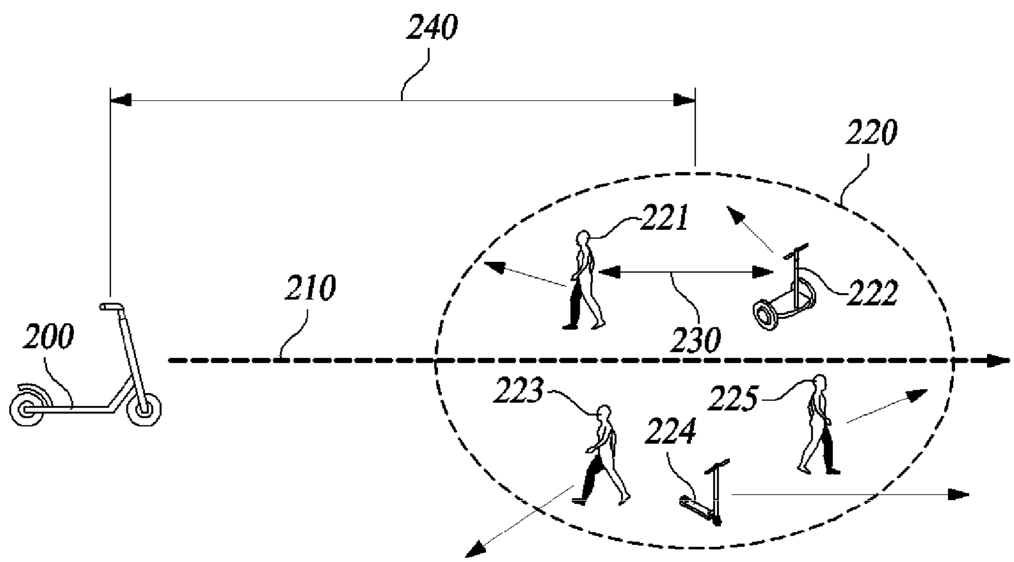


FIG. 2

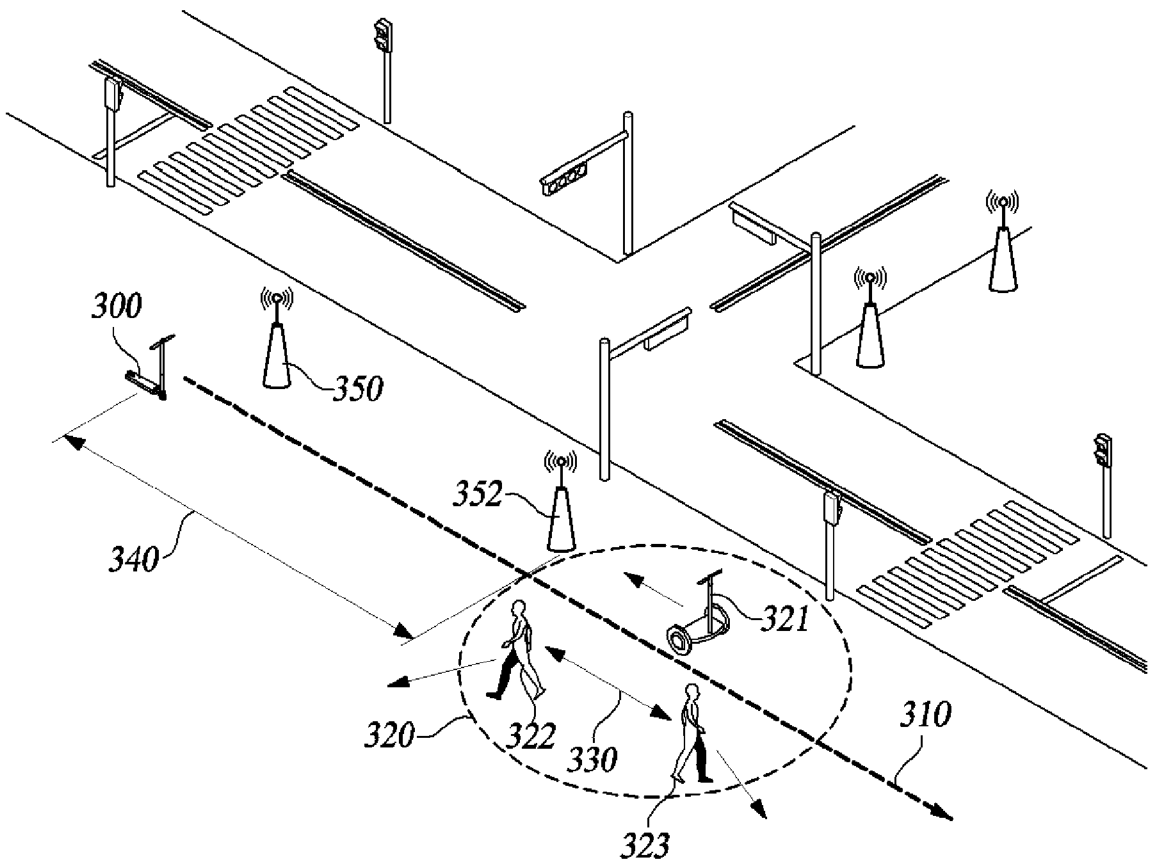


FIG. 3A

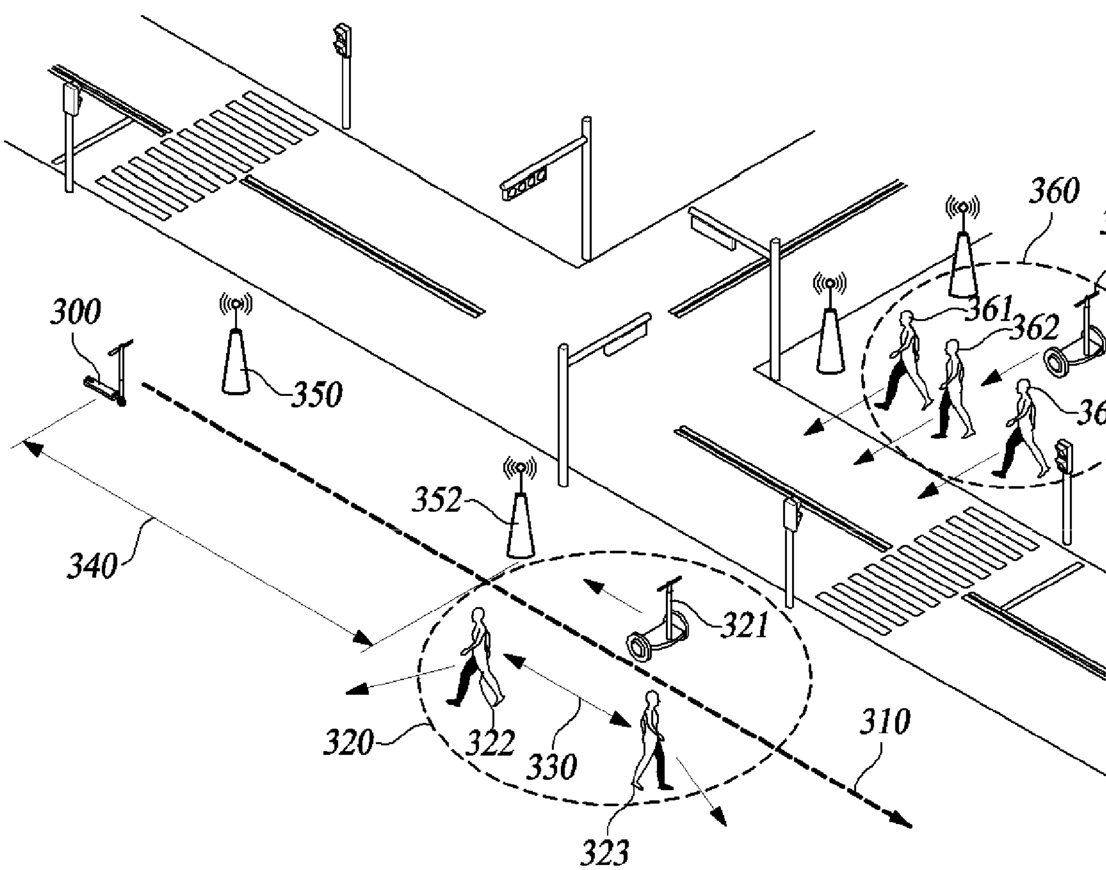


FIG. 3B

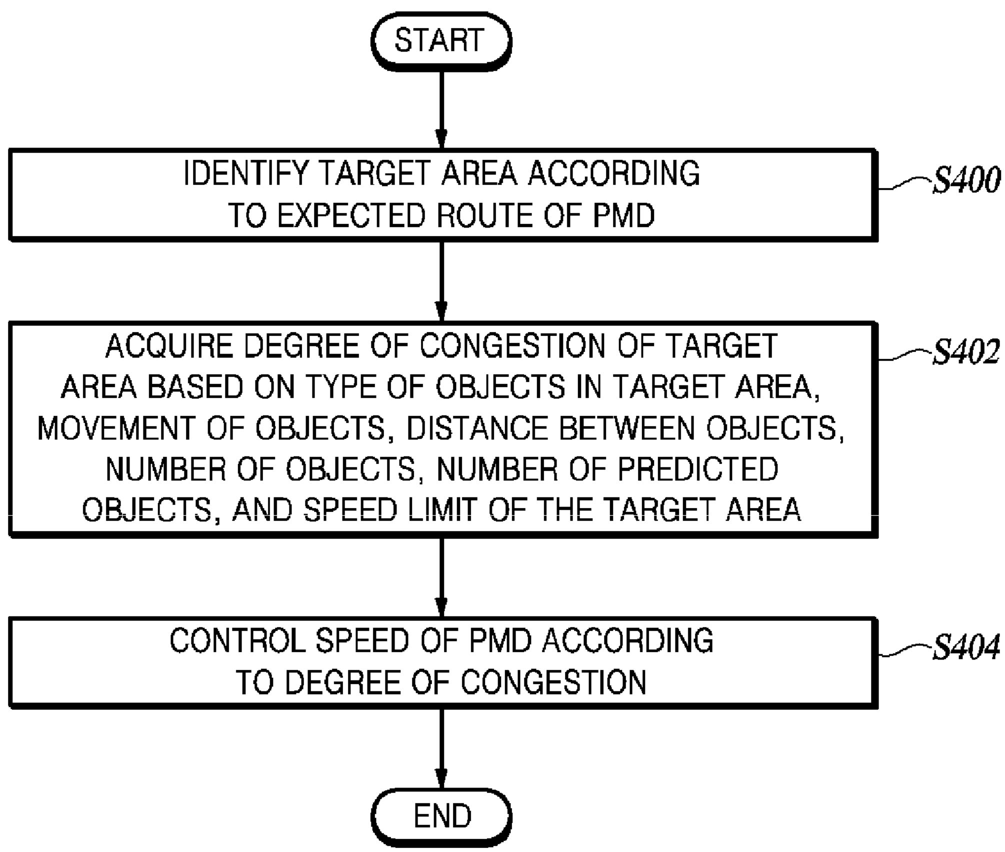

START
IDENTIFY TARGET AREA ACCORDING TO EXPECTED ROUTE OF PMD
S400
ACQUIRE DEGREE OF CONGESTION OF TARGET AREA BASED ON TYPE OF OBJECTS IN TARGET AREA, MOVEMENT OF OBJECTS, DISTANCE BETWEEN OBJECTS, NUMBER OF OBJECTS, NUMBER OF PREDICTED OBJECTS, AND SPEED LIMIT OF THE TARGET AREA
S402
CONTROL SPEED OF PMD ACCORDING TO DEGREE OF CONGESTION
S404
END

FIG. 4

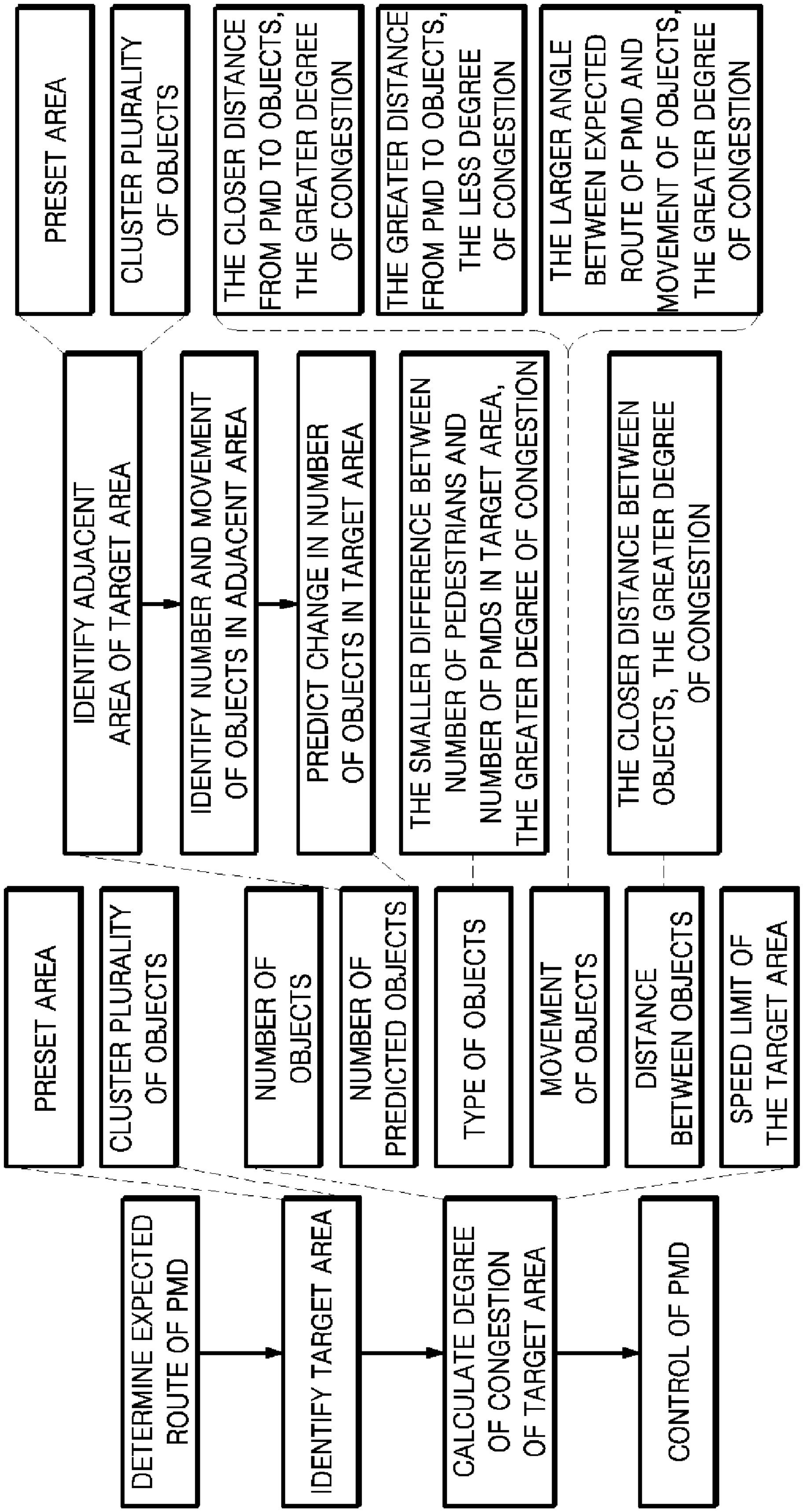

DETERMINE EXPECTED ROUTE OF PMD
IDENTIFY TARGET AREA
CALCULATE DEGREE OF CONGESTION OF TARGET AREA
CONTROL OF PMD
PRESET AREA
CLUSTER PLURALITY OF OBJECTS
NUMBER OF OBJECTS
NUMBER OF PREDICTED OBJECTS
TYPE OF OBJECTS
MOVEMENT OF OBJECTS
DISTANCE BETWEEN OBJECTS
SPEED LIMIT OF THE TARGET AREA
IDENTIFY ADJACENT AREA OF TARGET AREA
IDENTIFY NUMBER AND MOVEMENT OF OBJECTS IN ADJACENT AREA
PREDICT CHANGE IN NUMBER OF OBJECTS IN TARGET AREA
THE SMALLER DIFFERENCE BETWEEN NUMBER OF PEDESTRIANS AND NUMBER OF PMDS IN TARGET AREA, THE GREATER DEGREE OF CONGESTION
THE CLOSER DISTANCE BETWEEN OBJECTS, THE GREATER DEGREE OF CONGESTION
PRESET AREA
CLUSTER PLURALITY OF OBJECTS
THE CLOSER DISTANCE FROM PMD TO OBJECTS, THE GREATER DEGREE OF CONGESTION
THE GREATER DISTANCE FROM PMD TO OBJECTS, THE LESS DEGREE OF CONGESTION
THE LARGER ANGLE BETWEEN EXPECTED ROUTE OF PMD AND MOVEMENT OF OBJECTS, THE GREATER DEGREE OF CONGESTION

FIG. 5

METHOD AND APPARATUS FOR CONTROLLING A PERSONAL MOBILITY VEHICLE BASED ON CONGESTION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on, and claims priority to, Korean Patent Application Number 10-2021-0076191 filed on Jun. 11, 2021, the disclosure of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The present disclosure in some embodiments relates to a method and device for controlling a personal mobility device (PMD) according to a degree of congestion which set a target area in an expected route of a PMD, which is the PMD, calculate the degree of congestion according to characteristics of objects in the target area, and control the PMD according to the degree of congestion.

BACKGROUND

[0003] The statements in this section merely provide background information related to the present disclosure and do not necessarily constitute prior art.

[0004] In recent years, the importance of cars as transportation is decreasing, and the importance of personal mobility devices (PMDs) is increasing. Here, the PMD is a movable object for few people. For example, an electric kickboard, a bike, etc.

[0005] Unlike a car, a PMD can travel on roads that are not built for cars. For example, cars can only travel on a roads built for cars, while the PMD can travel on bicycle lanes or sidewalks. That is, the PMD traveling on various roads has a higher risk of colliding with a pedestrian.

[0006] Mobility of the PMD is better than that of cars on roads that are not built for cars. For example, on narrow roads, it is difficult for cars to travel at a high speed or make sharp turns. Meanwhile, since the PMD is smaller in size, it is easier for PMDs to travel at a higher speed or make sharp turns on narrow roads.

[0007] Certain driving characteristics of the PMD makes it easier to collide with pedestrians or other PMDs. In particular, when roads are crowded with pedestrians and PMDs, a passenger on the PMD has a very high risk of colliding with pedestrians or other PMDs.

[0008] Therefore, researches to prevent collision with pedestrians and other PMDs are much needed.

SUMMARY

[0009] There is provided a control method of a personal mobility device (PMD) depending on congestion, comprising identifying a target area according to an expected route of the PMD, acquiring a degree of congestion of the target area based on at least one of a type of objects, a movement of the objects, a distance between objects, the number of objects that is expected, and a speed limit of the target area, and controlling speed of the PMD according to the degree of congestion.

[0010] There is provided a control device for a personal mobility device (PMD) performing control depending on congestion, comprising a target area identification unit that identifies a target area according to an expected route of the PMD, a congestion degree acquisition unit that acquires a degree of congestion of the target area based on at least one of a type of objects in the target area, a movement of objects, a distance between objects, the number of objects that is expected, and a speed limit of the target area, and a control unit that controls the speed of the PMD according the degree of congestion.

BRIEF DESCRIPTION OF THE FIGURES

[0011] FIG. **1** is a diagram illustrating components of a PMD in accordance with an embodiment of the present disclosure.

[0012] FIG. **2** is a diagram illustrating a control operation of a PMD in consideration of degree of congestion in accordance with an embodiment of the present disclosure.

[0013] FIGS. **3**A and **3**B are diagrams illustrating a control operation of a PMD in consideration of degree of congestion in accordance with an embodiment of the disclosure.

[0014] FIG. **4** is a flowchart illustrating a control step of the PMD in accordance with an embodiment of the present disclosure.

[0015] FIG. **5** is a flowchart illustrating a specific control procedure of the PMD in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0016] Hereinafter, some embodiments of the present disclosure are described with reference to the drawings. It should be noted that in giving reference numerals to components of the accompanying drawings, the same or equivalent components are denoted by the same reference numerals even when the components are illustrated in different drawings. In describing the present disclosure, when determined that a detailed description of related known functions or configurations may obscure the subject matter of the present disclosure, the detailed description thereof has been omitted.

[0017] In addition, in describing the components of the present disclosure, terms such as first, second, A, B, (a), (b), etc. may be used. These terms are used only in order to distinguish any component from other components, and features, sequences, or the like, of corresponding components are not limited by these terms. Throughout the present specification, unless explicitly described to the contrary, “including” and “comprising” any components should be understood to imply the inclusion of other elements rather than the exclusion of any other elements. A term, such as “part,” “module,” or the like described in the specification, means a unit of processing at least one function or operation and may be implemented as hardware or software or a combination of hardware and software. When a component, device, element, or the like of the present disclosure is described as having a purpose or performing an operation, function, or the like, the component, device, or element should be considered herein as being “configured to” meet that purpose or to perform that operation or function.

[0018] In the following, a personal mobility device (hereinafter ‘PMD’) is a movable object or a personal transporter. For example, types of the PMD include personal mobility vehicle (PM vehicle), micro mobility vehicle, electric bicycle, electric kickboard, electric scooter, electric wheelchair, electric bike, 2-wheel drive, smart car, shuttle, personal movement means, personal flight means, smart mobility, shared mobility, First Mile, Last Mile, PAV (Purpose

Built Vehicle), PAV (Personal Air Vehicle), car, electric car, motor vehicle, passenger automobile, alternative fuel vehicle and etc.

[0019] Intelligent Transport System (ITS) includes a road side unit (RSU) or a mobile communication station. The road side unit or the station may all perform broadcasting, and may support communication methods such as unicast, multicast or the like if necessary. In the following, road side units (RSUs) are described with reference to performing Vehicle to Everything (V2X) communication with a PMD. The V2X communication includes LTE-V2X, C-V2X, 5G-V2X, WAVE (Wireless Access In Vehicular Environment), DSRC (Dedicated Short Range Communication), and the like. In addition, communication standards used in Intelligent Transport System (ITS) may be used. In the following, the terms road side unit and station may be used interchangeably.

[0020] The control device of the PMD may be implemented as a server located outside the PMD. The control device may also be implemented by a device, a user terminal, or the like located inside the PMD. The control device may in advance store at least one of a virtual map, identification information of the road side unit, a position coordinate corresponding to the identification information, identification information of a PMD, or subscriber information of a passenger. Here, the position coordinate is latitude and longitude or a two-dimensional or three-dimensional coordinate based on a specific point. In the following, the control device is described as being mounted on the PMD.

[0021] FIG. **1** is a diagram illustrating components of a PMD in accordance with an embodiment of the present disclosure.

[0022] Referring to FIG. **1**, the control device **10** (hereinafter referred to as "control device") of the PMD includes a target area identification unit **130**, a congestion degree acquisition unit **140**, and a control unit **150**. The control device **10** may further include the communication unit **100**, the sensor unit **110**, and the storage unit **120**.

[0023] The control device **10** may generate an expected route of the PMD through the information collected by the sensor unit **110** or may receive the expected route of the PMD from the communication unit **100**. For example, the control device **10** can generate an expected route of the PMD by using the position, speed, direction, route history, acceleration, departure point, destination, or the like of the PMD. The control device **10** may also receive an expected route from an external device or ITS.

[0024] The control device **10** may identify a target area along an expected route through the target area identification unit **130**. Here, the target area is an area in which the degree of congestion is calculated based on the expected route of the PMD. When the target area is identified by the target area identification unit **130**, the control device **10** may collect information about the target area or objects in the target area from the communication unit **100**. The target area may preset a specific area in accordance with the passenger.

[0025] The communication unit **100** is performs wireless communication with an external device or an intelligent transport system (ITS).

[0026] The communication unit **100** can receive information about a target area or objects in the target area from an external device or an ITS. For example, the communication unit **100** may receive an image in a target area captured by a camera of the ITS, or may receive information about objects in the target area processed by a server of the ITS. When an external device calculates the degree of congestion, the communication unit **100** may receive the calculated degree of congestion from the external device. Here, the external device means a server of the ITS or a terminal of the user.

[0027] The sensor unit **110** senses objects near the PMD, and collects driving information of the PMD.

[0028] The sensor unit **110** may include one or more of a camera, a Lidar sensor, a radar sensor, and a vision sensor. In addition, the sensor unit **110** may further include sensors capable of sensing objects near the PMD. Further, the sensor unit **110** may include sensors for collecting driving information. For example, the sensor unit **110** may include a GPS sensor unit, GPS map, etc.

[0029] The storage unit **120** stores information for control of the PMD.

[0030] The storage unit **120** may store information collected by the communication unit **100** and the sensor unit **110**. When the target area is a preset area, the storage unit **120** may store information about the preset area. In addition, the storage unit **120** may further store information for calculating the degree of congestion.

[0031] The target area identification unit **130** identifies a target area in accordance with an expected route of the PMD.

[0032] In accordance with an embodiment of the present disclosure, the target area identification unit **130** identifies a preset area according to an expected route of the PMD. For example, in a case where a preset area is set and stored in advance for each road, which the PMD can travel on, and an expected route of the PMD passes the preset area, the target area identification unit **130** can identify the preset area.

[0033] In accordance with another embodiment of the present disclosure, the target area identification unit **130** may identify an area determined through object clustering according to an expected route of the PMD. For example, when sensor devices such as a camera, a lidar sensor, and a radar sensor of an ITS recognize and cluster objects in a specific area, the target area identification unit **130** may receive information about the clustered area from the ITS through the communication unit **100**, and determine the clustered areas as the target areas. The object clustering may be implemented by a clustering method such as hierarchical clustering, partitioning clustering, k-means clustering.

[0034] In accordance with another embodiment of the present disclosure, the target area identification unit **130** may recognize surrounding objects through the sensor unit **110**, cluster the recognized objects, and determine the area, where the clustered objects exist, as the target area. The object clustering may be implemented by a clustering method such as hierarchical clustering, partitioning clustering, k-means clustering. From the data collected by the sensor unit **110**, information about a target area and an object in the target area may be extracted. The target area identification unit **130** may have a narrower target area identification range but a faster identification speed when identifying a target area through the sensor unit **110** compared to the case when the communication unit **100** identifies the target area.

[0035] The control device **10** identifies a target area through the target area identification unit **130**, and receives information about the target areas or objects in the target area from the ITS by using the communication unit **100**.

[0036] The congestion degree acquisition unit **140** is a component that acquires the degree of congestion of the target area based on the characteristics of the objects in the target area and the characteristics of the target area itself.

[0037] Specifically, the congestion degree acquisition unit **140** acquires a degree of congestion of the target area based on type of objects in the target area, movement of the objects, distance between objects, number of objects, number of predicted objects, and speed limits in a target area. The congestion degree acquisition unit **140** may further acquire the degree of congestion of the target area based on the road width in the target area, the type of the vehicle, the traffic volume of the vehicle, and the like.

[0038] In accordance with an embodiment of the present disclosure, the congestion degree acquisition unit **140** may directly calculate a degree of congestion, or may acquire the calculated degree of congestion from an external device such as a server, a terminal, or the like through the communication unit **100**. Specifically, the congestion degree acquisition unit **140** may acquire a degree of congestion by receiving the calculated degree of congestion, based on type of objects in the target area, movement of the objects, distance between objects, number of objects, predicted number of objects, and speed limits in a target area, from the external device.

[0039] In the following, a description will be given with reference to an embodiment in which the congestion degree acquisition unit **140** directly calculates the degree of congestion.

[0040] In accordance with an embodiment of the present disclosure, the congestion degree acquisition unit **140** identifies objects in the target area as pedestrians or PMDs, and calculates the degree of congestion based on the difference between the number of the pedestrians and the numbers of the PMDs. The congestion degree acquisition unit **140** may calculate the degree of congestion to be lower when the difference between the number of the pedestrians and the number of the PMDs is large, and calculate the degree of congestion to be higher when the difference is small. That is, if there are equal number of pedestrians and PMDs, it is determined that traffic in the target area is high.

[0041] In accordance with an embodiment of the present disclosure, the congestion degree acquisition unit **140** calculates distance between the PMD and the objects based on movement of the objects, and calculates the degree of congestion based on the distance between the PMD and the objects. The congestion degree acquisition unit **140** may calculate a higher degree of congestion as the distance between the PMD and the objects is close, and calculate a lower level of congestion when the distance is far. The congestion degree acquisition unit **140** may calculate the distance between the PMD and the objects for each of the objects, and may calculate the sum of the distances. At this time, the degree of congestion may be calculated according to each distance or the summed distance. In addition, the congestion degree acquisition unit **140** may calculate a degree of congestion according to a distance between the center position of the target area and the PMD. The congestion degree acquisition unit **140** may calculate the degree of congestion according to the distance between the center position of the objects and the PMD.

[0042] In accordance with an embodiment of the present disclosure, the congestion degree acquisition unit **140** calculates the degree of congestion based on the moving direction of objects in the target area. The congestion degree acquisition unit **140** calculates the degree of congestion to be higher as the objects move in a direction perpendicular, or nearly perpendicular, to the expected route, and calculates the degree of congestion lower as the objects move in a direction horizontal, or nearly horizontal, to the expected route. Directions nearly vertical and nearly horizontal may be referenced at an angle relative to the expected route. The congestion degree acquisition unit **140** may calculate an angle difference between the expected route and a movement direction for each of the objects, and may calculate a sum of the angle differences. Alternatively, the congestion degree acquisition unit **140** may acquire a sum of movement vectors or velocity vectors of objects, and calculate a degree of congestion with the sum of the vectors.

[0043] In accordance with an embodiment of the present disclosure, the congestion degree acquisition unit **140** calculates a higher degree of congestion as the distance between objects is close. Conversely, lower degree of congestion is calculated when the distance between the objects is far. That is, when the distance between the objects in the target area is far, density of the objects is low and it is determined that traffic is low.

[0044] In accordance with an embodiment of the present disclosure, the congestion degree acquisition unit **140** calculates a higher degree of congestion as the speed limit of the target area is lower. Specifically, in areas as a children protection zone, a school zone, an elderly protection zone and a disabled protection zone.

[0045] In accordance with an embodiment of the present disclosure, the congestion degree acquisition unit **140** calculates higher degree of congestion when there are higher number of objects in the target area.

[0046] In accordance with an embodiment of the present disclosure, the congestion degree acquisition unit **140** identifies a surrounding area of the target area, predicts a change in the number of objects in the target area based on the number and movement of the objects in a surrounding area, and calculates a degree of congestion based on the change of the predicted number of object in the target area. This is for the congestion degree acquisition unit **140** to calculate a higher degree of congestion when objects in the surrounding area are expected to move to the target area.

[0047] The control unit **150** controls the speed of the PMD according to the acquired degree of congestion.

[0048] The control unit **150** lowers the speed of the PMD when the degree of congestion of the target area is high. The control unit **150** may maintain or increase the speed of the PMD when the degree of congestion of the target area is low. The control unit **150** may control the deceleration rate differently depending on the degree of congestion. The control unit **150** can increase deceleration when the degree of congestion is higher. In addition, the control unit **150** can limit the speed of the PMD, and can raise the speed limit of the personal mobility device when the degree of congestion of the target area is low. Thus, the user can control the speed of the PMD in a wide range.

[0049] In addition, the control unit **150** can control the direction of the PMD according to the degree of congestion. For example, when the degree of congestion of the target area is high, the control unit **150** can control the direction of the PMD so that the device does not pass the target area.

[0050] The control device **10** identifies a target area according to an expected route of the PMD, calculates the degree of congestion in consideration of various characteristics of objects in the target area, and controls the PMD, so that it is possible to prevent collision and maximize operation efficiency with safety.

[0051] In accordance with an embodiment of the present disclosure, the control device **10** can be implemented as an external device of a PMD. In this case, the control device **10** may collect information about objects in the target area from the sensor unit **110**, calculate the degree of congestion, and send command to the PMD. Speed and direction of the PMD, receiving the control command, may be controlled, or the speed limit may be raised.

[0052] FIG. **2** is a diagram illustrating a control operation of a PMD in consideration of congestion in accordance with an embodiment of the present disclosure.

[0053] FIG. **2** shows PMD **200**, expected route **210**, target area **220**, objects **221**, **222**, **223**, **224**, **225**, first distance **230** between the objects, and second distance **240** between the personal mobility and objects. The unidirectional arrows in FIG. **2** mean either a movement vector or a velocity vector.

[0054] The control device **10** generates the expected route **210** of the PMD **200**. The expected route **210** may be generated by GPS or driving information of the PMD **200**.

[0055] The control device **10** identifies the target area **220** according to the expected route. In accordance with an embodiment of the present disclosure, the control device may identify the preset area or the area determined through object clustering as the target area **220** according to the expected route **210**.

[0056] The control device **10** collects information about the objects **221**, **222**, **223**, **224**, **225** in the target area **220**.

[0057] The control device **10** acquires the degree of congestion of the target area **220** based on the features of the objects **221**, **222**, **223**, **224**, **225** in the target area **220** and the feature of the target area **220**.

[0058] In accordance with an embodiment of the present disclosure, the control device **10** acquires the degree of congestion of the target area **220** based on type of objects in the target area **220**, movement of the objects, distance between objects, number of objects, expected number of objects, and speed limit of the target area.

[0059] The control device **10** may acquire the degree of congestion based on the type of the objects **221**, **222**, **223**, **224**, **225** in the target area **220**. In FIG. **2**, there are two PMDs among the objects **221**, **222**, **223**, **224**, **225**, and there are three pedestrians among the objects **221**, **222**, **223**, **224**, **225**. The control device may divide the objects **221**, **222**, **223**, **224**, **225** into PMDs and pedestrians, and acquire the degree of congestion based on a difference between the number of the PMDs and the number of the pedestrians.

[0060] The control device **10** may acquire the degree of congestion based on movement of the objects **221**, **222**, **223**, **224**, **225** in the target area **220**. In FIG. **2**, objects **221**, **222**, **223**, **224**, **225** have respective positions, directions and speeds of movement. The control device may calculate a second distance **240**, which is a distance between the objects **221**, **222**, **223**, **224**, **225** and the PMD, and acquire the degree of congestion based on the second distance **240**. The second distance **240** may be respective distances between the PMD **200** and the objects **221**, **222**, **223**, **224**, **225**, the sum of the respective distances, or may be either the center of the objects **211**, **222**, **232**, **224** or **225**, or the target area **220**.

[0061] Further, the control device **10** may acquire the degree of congestion in accordance with moving directions of the objects **221**, **222**, **223**, **224**, **225**. The control device may acquire the degree of congestion based on the angle at which the movement vector or velocity vector of the objects **221**, **222**, **223**, **224**, **225** makes with the expected route **210**. For example, a higher degree of congestion would be calculated when the movement vector or velocity vector of objects **221**, **222**, **223**, **224**, **225** is perpendicular, or nearly perpendicular, to the expected route. This is because there is a high probability that the objects **221**, **222**, **223**, **224**, **225** collide with the PMD **200** or interfere with driving.

[0062] The control device **10** may acquire the degree of congestion based on the first distance **230**, which is a distance between objects in the target area **220**. The control device may calculate a higher degree of congestion for each object as the first distance **230** is shorter.

[0063] The control device **10** may acquire the degree of congestion based on the speed limit of the target area **220**, and may calculate a higher degree of congestion as the speed limit is lower.

[0064] The control device **10** may calculate a higher degree of congestion as the number of objects **221**, **222**, **223**, **224**, **225** in the target area **220** is greater.

[0065] The control device **10** may acquire the degree of congestion of the target area **220** based on objects in the surrounding area in addition to the objects **221**, **222**, **223**, **224**, **225** in the target area **220**. Detailed description will come with FIG. **3**B.

[0066] FIGS. **3**A and **3**B are diagrams illustrating a control operation of a PMD in consideration of the degree of congestion in accordance with an embodiment of the disclosure.

[0067] FIG. **3**A shows PMD **300**, expected route **310**, target area **320**, objects **321**, **322**, **323**, first distance **330** between objects, second distance **340** between the PMD **300** and the objects, and road side units **350**, **352**.

[0068] FIG. **3**B further shows surrounding area **360** and surrounding area objects **361**, **362**, **363**, **364**.

[0069] The control device **10** may acquire the degree of congestion of the target area **320** by further considering the surrounding area **360** of the target area **320**.

[0070] The control device **10** identifies a target area **320** along an expected route **310** of the PMD **300** and identifies a surrounding area **360** of the target area **320**. The control device predicts change in the number of objects **321**, **322**, **323** in the target area **320** based on the number and movement of surrounding area objects **361**, **362**, **363**, **364**. The control device **10** acquires the degree of congestion based on a change in the number of predicted objects in the target area **320**. For example, when it is determined that the surrounding area objects **361**, **362**, **363**, and **364** move towards the target area **320**, the control device may determine that the number of objects in the target area **320** will increased, and may calculate a higher degree of congestion in the target area **320**. Further, the control device **10** may predict a change in objects in the target area **320** in consideration of movement data of an object between the target area **320** and the surrounding area **360** for each time zone.

[0071] By further considering the surrounding area **360**, the control device **10** can accurately calculate the degree of congestion and improve the safety and the mobility of the PMD **300**.

[0072] FIG. **4** is a flowchart illustrating a control process of the PMD in accordance with an embodiment of the present disclosure.

[0073] Referring to FIG. **4**, the control device **10** identifies the target area according to the expected route of the PMD at S**400**.

[0074] In accordance with an embodiment of the present disclosure, the control device **10** identifies a preset area or an area determined through object clustering, according to an expected route of the PMD.

[0075] The control device **10** acquires the degree of congestion of the target area based on type of objects in the target area, movement of the objects, distance between objects, number of the objects, number of predicted objects, and speed limit of the target area at S**402**.

[0076] In accordance with an embodiment of the present disclosure, the control device identifies the type of objects in the target area as pedestrians or a PMDs, and acquires the degree of congestion based on the difference between the number of the pedestrians and the numbers of the PMDs.

[0077] In accordance with an embodiment of the present disclosure, the control device **10** acquires the distance between the PMD and the objects based on movement of the objects, and acquires the degree of congestion based on the distance between the PMD and the objects.

[0078] In accordance with an embodiment of the present disclosure, the control device acquires the degree of congestion based on an angle difference between the expected route and a movement direction for each of the objects.

[0079] In accordance with an embodiment of the present disclosure, the control device **10** calculates a higher degree of congestion as the distance between objects is closer. Conversely, the greater the distance between control device objects, the lower the degree of congestion.

[0080] In accordance with an embodiment of the present disclosure, the control device **10** calculates the degree of congestion higher as the speed limit of the target area is lower.

[0081] In accordance with an embodiment of the present disclosure, the control device **10** calculates higher degree of congestion with higher number of objects in the target area.

[0082] In accordance with an embodiment of the present disclosure, the control device **10** identifies a surrounding area of a target area, predicts a change in the number of objects in the target area based on the number of the objects and movement of the object in the surrounding area, and acquires a degree of congestion based on the change of the predicted number of objects in the target region.

[0083] The control device **10** controls the speed or the speed limit of the PMD in accordance with the degree of congestion at S**404**. The control device can further control the direction of the PMD.

[0084] Speed or speed limit for the PMD can be controlled differently depending on the type of the PMD, the ratio of pedestrians, and the number of elders, children, disabled and the like. The speed or speed limit for each PMD can be controlled differently even if the PMDs are in the same target area.

[0085] For example, on roads with large vehicles or on sidewalks with a large number of pedestrians or elders, the speed of the PMD can be further decelerated or the speed limit can be set lower. As another example, it is possible to control the speed of the large vehicle in the target area to be lower than the speed of the electric kickboard.

[0086] In accordance with an embodiment of the present disclosure, when the PMD moves out of the target area, the speed control or the speed limit setting of the PMD can be stopped. The speed control or the speed limit setting may be stopped as soon as the PMD leaves the target area, or may be stopped when after certain time or a certain distance has passed.

[0087] FIG. **5** is a flowchart illustrating a specific control procedure of the PMD in accordance with an embodiment of the present disclosure.

[0088] Although it is described in FIG. **4** that operations S**400** to S**404** are sequentially executed, this merely illustrates the technical idea of an embodiment of the present disclosure. In other words, those having ordinary skill in the technical field to which an embodiment of the present disclosure belongs may change the order described in FIG. **4** within a range that does not deviate from the essential characteristics of an embodiment of the present disclosure. Alternatively, those having ordinary skill in the technical field may apply various modifications and variations to execute one or more of the operations S**400** to S**404** in parallel. Thus, FIG. **4** is not limited to a time-series order. The above modifications and variations should be within the scope of the present disclosure.

[0089] Meanwhile, the operations illustrated in FIG. **4**, as well as the apparatus including the various units identified above and in FIG. **1**, can be implemented as computer-readable codes on a computer-readable recording medium. The computer readable recording medium may include all kinds of recording apparatuses in which data that may be read by a computer system is stored. In other words, the computer-readable recording medium may be a non-transitory medium, such as a read-only memory (ROM), a random-access memory (RAM), a compact disc (CD)-ROM, a magnetic tape, a floppy disk, and an optical data storage device. The computer readable recording medium may further include a transitory medium such as a carrier wave (for example, transmission over the Internet) and a data transmission medium. In addition, the computer readable recording media may be distributed in computer systems connected to each other through a network such that the computer readable codes may be stored and executed in the computer readable recording media in a distributed scheme.

[0090] In addition, components of the present disclosure may use an integrated circuit structure, such as a memory, a processor, a logic circuit, a look-up table, and the like. These integrated circuit structures execute each of the functions described herein through the control of one or more microprocessors or other control devices. In addition, components of the present disclosure may be specifically implemented by a program or a portion of a code that includes one or more executable instructions for performing a specific logical function and is executed by one or more microprocessors or other control devices. In addition, components of the present disclosure may include or be implemented as a Central Processing Unit (CPU), a microprocessor, and the like that performs respective functions. In addition, components of the present disclosure may store instructions executed by one or more processors in one or more memories.

[0091] Although embodiments of the present disclosure have been described for illustrative purposes, those having ordinary skill in the art should appreciate that various modifications, additions, and substitutions are possible, without departing from the idea and scope of the present disclosure. Therefore, embodiments of the present disclosure have been described for the sake of brevity and clarity. The scope of the technical idea of the present embodiments is not limited by the illustrations. Accordingly, those having ordinary skill should understand the scope of the present disclosure should not be limited by the above explicitly described embodiments but by the claims and equivalents thereof.

[0092] As described above, according to the embodiment of the present disclosure, it is possible to prevent a PMD from collision by controlling the speed of the PMD in consideration of the degree of congestion according to the expected route of the PMD.

[0093] As described above, according to another embodiment of the present disclosure, it is possible to maximize the operation efficiency while promoting the safety of a PMD by identifying the target area according to the predicted route of the PMD and calculating the congestion level in consideration of various characteristics of objects in the target area, and controlling the PMD.

1. A control method of a personal mobility device (PMD) depending on congestion, comprising:

identifying a target area according to an expected route of the PMD;

acquiring a degree of congestion of the target area based on a plurality of objects using at least one of: a type of each of the objects, a movement of each of the objects, a distance between objects, a number of objects that is expected, and a speed limit of the target area; and

controlling speed of the PMD according to the degree of congestion.

2. The method of claim **1**, wherein identifying the target area includes identifying a preset area or an area determined through an object clustering according to an expected route of the PMD.

3. The method of claim **1**, wherein acquiring the degree of congestion includes:

identifying the type of each of the objects in the target area as a pedestrian or a PMD; and

acquiring the degree of congestion based on difference between the number of pedestrians and the number of PMDs.

4. The method of claim **1**, wherein acquiring the degree of congestion includes:

calculating a distance between the PMD and the plurality of objects based on movement of each of the objects; and

calculating the degree of congestion based on the distance between the PMD and each of the objects.

5. The method of claim **1**, wherein acquiring the degree of congestion includes calculating the degree of congestion based on angle difference between the expected route and a movement direction for each of the objects.

6. The method of claim **1**, wherein acquiring the degree of congestion includes calculating the degree of congestion to be higher as the distance between each of the objects is shorter.

7. The method of claim **1**, wherein acquiring the degree of congestion includes calculating the degree of congestion to be higher as the speed limit of the target area is lower.

8. The method of claim **1**, wherein acquiring the degree of congestion includes calculating the degree of congestion to be higher as the number of objects in the target area is greater.

9. The method of claim **1**, wherein acquiring the degree of congestion includes:

identifying a surrounding area of the target area;

predicting a change in the number of objects in the target area, based on the number of the plurality of objects and the movement of the plurality of objects in the surrounding area; and

calculating the degree of congestion based on the change in the number of the objects within the target area.

10. The method of claim **1**, wherein acquiring of the degree of congestion includes receiving the degree of congestion calculated by an external device, based on at least one of the type of each of the objects in the target area, the movement of each of the objects, the distance between objects, the number of objects, the predicted number of objects, and the speed limit of the target area.

11. A control device for a personal mobility device (PMD) performing control depending on congestion, comprising:

a target area identification unit that identifies a target area according to an expected route of the PMD;

a congestion degree acquisition unit that acquires a degree of congestion of the target area based on a plurality of objects, using at least one of: a type of each of the objects in the target area, a movement of each of the objects, a distance between objects, a number of objects that is expected, and a speed limit of the target area; and

a control unit that controls the speed of the PMD according the degree of congestion.

12. The apparatus of claim **11**, wherein the target area identification unit identifies a preset area or identifies an area determined through an object clustering according to an expected route of the PMD.

13. The apparatus of claim **11**, wherein the congestion degree acquisition unit identifies the type of objects in the target area as a pedestrian or a PMD, and calculates the degree of congestion based on a difference between the number of pedestrians and the number the PMDs.

14. The apparatus of claim **11**, wherein the congestion degree acquisition unit calculates a distance between the PMD and the plurality of objects based on a movement of each of the objects, and calculates the degree of congestion based on the distances between the PMD and each of the objects.

15. The apparatus of claim **11**, wherein the congestion degree acquisition unit calculates the degree of congestion based on an angle difference between the expected route and a movement direction for each of the objects.

16. The apparatus of claim **11**, wherein the congestion degree acquisition unit calculates the degree of congestion to be higher as the distance between each of the objects is shorter.

17. The apparatus of claim **11**, wherein the congestion degree acquisition unit calculates the degree of congestion to be higher as the speed limit of the target area is lower.

18. The apparatus of claim **11**, wherein the congestion degree acquisition unit calculates the degree of congestion to be higher as the number of objects in the target area is greater.

19. The apparatus of claim **11**, wherein the congestion degree acquisition unit identifies a surrounding area of the target area, predicts a change in the number of objects in the target area based on the number of the plurality of objects and movement of the plurality of objects within the surrounding area, and calculates the degree of congestion based on a change of the predicted number of objects in the target area.

20. The apparatus of claim **11**, wherein the congestion degree acquisition unit receives the degree of congestion calculated by the external device based on at least one of a type of objects in the target area, a movement of the objects, a distance between objects, the number of objects, and a speed limit of the target area.

* * * * *