



- (51) **International Patent Classification:**
G06Q 10/06 (2012.01)
- (21) **International Application Number:**
PCT/EP2015/061180
- (22) **International Filing Date:**
20 May 2015 (20.05.2015)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
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- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM,

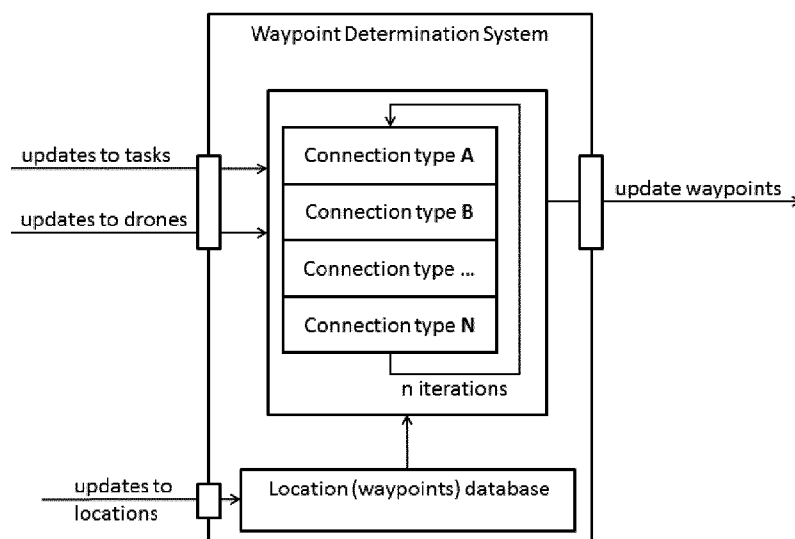
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- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

- (54) **Title:** METHOD FOR PROVIDING LOCATIONS FOR PERFORMING TASKS OF MOVING OBJECTS



(57) **Abstract:** The present invention relates to a method for providing locations for performing tasks of moving objects, performed in a memory available to one or more computation devices, wherein said moving objects are scheduled to one or more locations to perform one or more of said tasks using one or more connections, and wherein one or more of said locations are updated according to an location update procedure, wherein for each type of connection said location update procedure reassigns or not a selected task from its initial position to an alternate position based on a stochastic calculation including connection information of tasks.

Fig. 1

METHOD FOR PROVIDING LOCATIONS FOR PERFORMING TASKS OF MOVING OBJECTS

5 The present invention relates to a method for providing locations for performing tasks of moving objects, performed in a memory available to one or more computation devices.

10 The present invention further relates to a system for providing locations for performing tasks of moving objects.

Although applicable in general to any kind of moving objects, the present invention will be described with regards to drones as moving objects.

15 Although applicable in general to any kind of scenarios the present invention will be described in the context of smart cities.

20 Although applicable in general to any kind of locations, the present invention will be described with regard to locations represented by three dimensional coordinates, i.e. x-, y- and z-coordinates representing a location.

25 Nowadays the term “smart city” is used to enhance for example performance and well-being, to reduce costs and resource consumption and to engage actively with its citizens by using digital technologies. In this context the following 3D scenarios are appearing: Urban environment often comprises high buildings and thus small deep “canyons”, i.e. roads, that obstruct the line of sight required for many types of communication. These “canyons” highly influence for example the placement of wireless access network routers or base stations, because the “shadow” cast by buildings can massively impact the area of coverage and create blind spots with
30 no reception for a user equipment. The same applies also for wireless retrieval of data from populations of sensors and analogously the wireless control of actuators that are distributed throughout an urban environment.

Falling costs as well as the technical evaluation makes the broader use of semi-autonomous aerial devices like drones, also by private persons, possible. These can be used for surveillance, for example by a drone mounted camera or for delivery and retrieval of and the data collection from environmental sensors like temperature, humidity, radioactivity, etc.. Such applications are known to be affected by the aforementioned urban “canyons”.

In more detail, when for example a scenario is considered where an automated system or a human operator dynamically assigns or cancels tasks such as a collection of data from a specific sensor or the triggering of an actuator, to a system operating a fleet of semi-autonomous drones determining locations to which to dispatch individual drones to execute these tasks. The existence of “shadows”, cast by objects such as high rise buildings or other urban infrastructure is a problem: These “shadows” might reduce the quality of the connection between a drone and a sensor actuator or even make the connection between them impossible. When for example a massive number of wireless devices such as smart meters in households, pollution sensors in chimneys, filling sensors in pins, load sensors in bins, load sensors in vending machines, road toll tags in vehicles, long-term observation stations, or any smart device with the ability to run self-diagnostic or the like, are attended to be accessed at regular intervals, and a fleet of drones is used for this purpose, the corresponding connections between the wireless devices and the drones may be required in certain intervals, for example a residential smart meter should be read at least once in six months, or only under certain conditions, for example environmental measurement stations, or the like.

Another example is when drones are equipped, for example with cameras, to use them to read a license plate of a car or measure pedestrian traffic density. However, a problem arises for the connections when urgent drone-based surveillance connection requests may be a priority but massive amounts of other connection requests are to be scheduled. The high priority tasks may be scheduled alongside them to make a more efficient use of the available hardware. This increases however the complexity and may as such lead to a number in the range of tens of thousands of connections in a smart city. In the latter example locations may be seen as virtual objects that do not require any actual hardware

and this might lead to much larger settings: While in the first example 100 cameras may be distributed over a city and drones are sent to specific way points to connect to these cameras, in a second example the number of drones may be reduced to ten with cameras but the number of possible locations to point these cameras might increase to tens of thousands of possible locations.

In US 2013/0173802 A1 a method and system for determining allocation of clients to servers is shown. Mobile clients such as mobile telephones or software agents are assigned to mainly stationery servers such as mobile network base stations or computer servers with the objective for reducing or minimizing the number of active servers. A weighted stochastic decision function is used to reallocate mobile clients between stationery servers, wherein servers with a high load are more likely to receive additional clients. When the number of interactions is large, the number of required access points is reduced because all mobile clients are allocated to subset of the available access points.

The non-published patent application US 14/250,470 shows a method for assigning tasks to a plurality of agents. Static locations are allocated to the schedule of agents that have to visit all locations.

However, the method and system of US 2013/0173802 A1 suffers from the problem that even though the number of active servers is reduced, "bad" servers are selected for example providing only bad overall connection quality or having bad backhaul links or the like. Further it only addresses mobile clients. The method and system of US 14/250,470 suffer also from the problem that due to the load balancing of tasks, a non-optimal selection of locations is obtained.

Embodiments of the invention address the problem to determine a good set of locations wherein the term "good" is related to the connections at said location.

An objective is to provide a method and system for providing locations for performing tasks of moving objects which is flexible in types of moving objects and which determines a good locations for moving objects.

In an embodiment the invention provides a method for providing locations for performing tasks of moving objects, performed in a memory available to one or more computation devices, wherein said moving objects are scheduled to one or more locations to perform one or more of said tasks using one or more connections, and wherein one or more of said locations are updated according to an location update procedure, wherein for each type of connection said location update procedure reassigns or not a selected task from its initial position to an alternate position based on a stochastic calculation including connection information of tasks.

In an embodiment the present invention provides a system for providing locations for performing tasks of moving objects, wherein said moving objects are scheduled to one or more locations to perform one or more of said tasks using one or more connections, wherein one or more of said locations are updated according to an location update procedure, and said system comprising one or more receiving interfaces for receiving task information, moving object information and location information and being connectable to one or more databases, at least one output interface to output updated locations, and a computation entity adapted to perform said location update procedure reassigning or not for each type of connection a selected task from its initial position to an alternate position based on a weighted stochastic decision.

The term “task” is to be understood in the broadest sense for example a task may include one or more actions which are performed when a task is executed. Actions may include but are not limited to establishing a connection, exchanging data with one or more devices, or the like.

The term “moving object” is to be understood in the broadest sense. For example a moving object can be any movable mechanical or electrical device which can change its position either manually or automatically. For example a moving object may include, but is not limited to, a drone, a car, a tablet, a user equipment, a mobile user device, a cell-phone, a tablet computer, a personal computer, a truck, a boat, a car, a plane, or the like.

The term "location" is to be understood in its broadest sense and is to be understood as defining a position of a moving object at least in space, for example a location represents a position defined by Cartesian coordinates or any other measure or parameters defining a position within a three dimensional space. A location may also be having a forth component, e.g. the time so that a location includes not only for example Cartesian coordinates x, y and z but also a time parameter indicating the time on which for example a moving object at that position is scheduled.

At least one embodiment of the invention provides the advantage of determining a good set of locations such that these suffices to achieve all required connections given a changing list of connection requests possibly with a required minimum connection quality and permissible locations, for example using a matrix that defines which connection is possible from which location and what that specific connection quality is.

At least one embodiment provides the advantage of enhanced flexibility: For example different types of devices can be used for, for example, data collection, i.e. devices with different functionalities that can perform different types of jobs or tasks, so that some jobs or tasks can only be performed by special devices.

At least one embodiment provides the advantage of facilitating a high level of dynamicity and robustness. Dynamicity for example relates to the real time adding of new jobs or tasks possibly on the basis of triggering events. The term "robustness" refers, for example to the ability to handle the locations becoming no-go-zones or the like.

Further features, advantages and further embodiments are disclosed or may become apparent from the following:

Said location update procedure may be iterated n-times for each type of connection. This ensures a sufficient measure of optimization prior to updating the locations.

Said location updates may be performed for a limited number of specific types of tasks. This streamlines the process of providing location updates: Only for corresponding task types the locations are updated. Thus, a fast location update for these tasks is provided.

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Said location updates may be performed separately and/or parallel for each type. This may also be performed for each type differently. This ensures a high flexibility when updating locations: For example this may depend on the underlying hardware: For example an octa-processor can handle eight tasks in parallel while the others are handled sequentially.

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Information of previous location updates may be used during the following location updates. This enhances the reassigning of task to a new or alternate location or more general enhances the position of location updates.

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A location update may comprise the task steps of picking task, picking an alternate location, perform said stochastic calculation and reassign said task to the alternate location or not. This allows in an easy and fast way to obtain a location update.

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Said task steps may be performed continuously as long as a termination constraint is not satisfied. This enables a sufficient measure of optimization for the location updates in a flexible way.

Said termination constraint may represent at least one of the following: Maximum number of iterations, number of iterations without reassignment of a task to an alternate location. This allows in a flexible way to obtain a fast location update since for example the number of iterations can be limited and/or an inefficient optimization, for example when a number of iterations without a reassignment of a task to an alternate location is performed, can be avoided.

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Said tasks may be picked during a location update according to at least one of the following: random probability, priority information of tasks, choosing a location first based on the number of assigned tasks in descending or ascending order to a location or choosing a location having a larger probability and then choosing from

the tasks assigned to said location. This enables an enhanced flexibility of the method since the tasks can be chosen in a flexible way, for example randomly or according to priority information or more general metadata information assigned to the tasks. The stochastic calculation provides a probability for each location with respect to the task to be performed of said location. Said probability indicates a measure how “good” or “bad” the location is for performing said task.

Said connection information may include one of the following: number of connections of a task, connection quality. This enables to include not only the connectedness of the task but also the connection quality required for said tasks. Thus, robustness of the connections may be ensured. For instance a minimum required connection quality may be defined to ensure a certain Quality of Service.

At least one tuning parameter may be used during said stochastic calculation. This further enhanced the flexibility of the method since by tuning the tuning parameter for said stochastic calculation, for example convergence of the method can be ensured while further adaptation to external influences or requirements can also be included into the calculation.

One or more locations which are related to each other may be grouped together forming a single location. This allows in an easy and flexible way to combine locations having for example one information, one characteristic or the like in common. For example locations may be grouped to one location if one of the Cartesian coordinates, for example the z-coordinate is the same for a number of locations. This might be the case, for example when moving objects in form of drones are scheduled to an (x,y)-coordinate but for performing the task via connections the z-coordinate is not important. Then all these locations having the same x-, y-coordinate can be grouped together. Thus, flexibility is enhanced.

Said stochastic calculation may be based on a weighing between different parameters. For example weighing may be performed between the number of tasks allocated to a certain position and the connectedness of individual tasks at this position. Thus, an operator might chose in a flexible way which parameters

are more important than others for assigning tasks of moving objects with locations.

There are several ways how to design and further develop the teaching of the present invention in an advantageous way. To this end it is to be referred to the patent claims subordinate to the independent patent claims on the one hand and to the following explanation of embodiments of the invention by way of example, illustrated by the figure on the other hand. In connection with the explanation of the embodiments of the invention by the aid of the figure, generally embodiments and further developments of the teaching will be explained.

In the drawings

Fig. 1 shows a system according to an embodiment of the invention; and

Fig. 2 shows part of the embodiment of Fig. 1 in more detail.

In Fig. 1 a so-called waypoint determination system is shown having input interfaces for updates to tasks and updates to drones as well as updates to locations. The waypoint determination system further comprises a location or waypoint database. Databases for the tasks and for the drones comprise all relevant aspects of tasks and drones and the updates can occur anytime and with any frequency. Furthermore, said location database of the waypoint determination system is maintained comprising all locations, for example positions in three dimensional space, that drones may be scheduled to. Also the topology of a network comprising of locations and tasks can be updated frequently. These updates can be on the basis of information provided from the outside or could be the result of measurements taken by the mobile objects and its peers. The waypoint determination system outputs then a list of active waypoints and may include if required the respective types of waypoints. Inside the waypoint determination system a continuous optimization process is taken place.

This optimization process by potential re-allocation of tasks to waypoints may always determined between two locations only, However the number of participating agents (here: locations) does not have to be restricted to two. After a number n of iterations, where n can be a fixed parameter, a variable updated by the system or even a value depending on some performance measure, an update is sent to an external database of waypoints. This optimization process, described below, can be restricted to tasks of a specific type. If there are multiple different types considered then the optimization is performed for all types separately serially, as shown, or in parallel, though the individual optimization may include information about the outcome / state of the other optimizations.

Fig. 2 shows part of the embodiment of Fig. 1 in more detail.

In Fig. 2 the operational flow for an optimization of tasks of a certain connection type is shown. First a task is picked out of the task database. This task is allocated to a position A. Then an alternate location A' is picked. Then a weighted stochastic decision is made, where it is checked if the task which is allocated to location A should be reassigned to the alternate location A'. Based on said weighted stochastic decision either the task is reassigned to the alternate location A' and then the termination constraint is checked or if no reassignment is performed based on said weighted stochastic decision then directly said termination constraint is checked again and if a termination constraint is not fulfilled then again a task is picked and checked again. The alternate location A' is picked from the location database. The task which is allocated to location A is checked with the location database.

The termination constraint and the way in which a task is picked are likely to be application dependent. Examples for termination constraints are: a certain number of iterations, a threshold for how many iterations can be performed without a re-assignment occurring, etc. Example methods for choosing tasks are random choice, ordering the tasks by some priority and then picking the top one, picking locations with few tasks first or with a larger probability and then choosing only from the tasks assigned to a specific (chosen) location, etc..

Said weighted stochastic decision refers to a stochastic choice being made which uses a number of parameters belonging either to the task or to the two locations, i.e. the current one location A and the potential alternate location A'.

- 5 For said stochastic decision a decentralized stochastic approach is used which are loosely based on a mathematical model for the nest building behavior of termites. In this model the decision to reassign a task from one location/waypoint to another is determined through the calculation of fitness values for both positions and a probabilistic assignment of the target on the basis of these values.

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All tasks currently assigned to either of the two locations. The values $fitness_{location\ 1}$ and $fitness_{location\ 2}$ are calculated considering a number of parameters for each location:

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1. The number of tasks allocated to a position is considered. The reason behind this may be that locations with many tasks may be likely to be good positions and this should therefore be reinforced.

$$fitness_{location\ i}^{tasks} = \text{number of tasks allocated to location } i$$

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2. The connectedness of the individual tasks. This is to account for cases where tasks can only be performed from a small number of locations, possibly just a single one. In this case these / that location(s) are emphasized since they are likely / guaranteed to end up becoming a

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$$fitness_{location\ i}^{connectedness} = \min_{j \in T_i} (\text{connectedness of } j)$$

with $T_i = \text{the set of all tasks assigned to locations } i$

The fitness value of a location i is then calculated through e.g.:

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$$fitness_{location\ i} = \frac{(fitness_{location\ i}^{tasks})^\alpha}{(fitness_{location\ i}^{connectedness})^\beta}$$

The parameters α and β are control parameters to affect the convergence properties of the method or to place extra emphasis on the connectedness of a location. There are many ways on which such control parameters can be used and the suggested use above is merely an example. The decision to use e.g. α as a power, a multiplier etc, and whether these values are fixed parameters, variables or performance measure depending is highly scenario specific.

The probability $P_{1 \rightarrow 2}$ of assigning a task that is currently assigned to *location 1* to a new location *location 2* is calculated as follows:

$$P_{1 \rightarrow 2} = \frac{fitness_{location\ 2}}{(fitness_{location\ 1} + fitness_{location\ 2})}$$

Depending on the scenario and the exact way in which the above values are calculated some framing conditions may be added to ensure that the outcome of the probability is always between 0 and 1. In the same way, the scenario may impose further restrictions on which values we have to constrain $fitness_{location\ i}^{tasks}$ and $fitness_{location\ i}^{connectedness}$ to.

This enforces a so-called rich gets richer paradigm where a location with many tasks is likely to gain more. Due to this the system will, if tuned correctly, converge towards a small number of locations having all tasks assigned to them. Tuning the parameters correctly enables the system/method or calculation to overcome local maxima. The n iterations the process is repeated before the way points are updated do depend on the speed with which this happens. It would not be beneficial to report any update to the list of locations since this changes a lot. Higher values for n may be considered or some measure of convergence towards a stable outcome may be determined when a new update is provided.

The locations can be represented by coordinates in a three dimensional space, for example by Cartesian coordinates. This may be based due to the nature of the problem with respect to urban canyons. However, small groups of locations may be combined and can be treated as single location in the context of the location update. For example a case where this is might be useful is when a number of

- locations only differ in their z-value, i.e. are on top of each other. This might be beneficial to schedule a drone to specific (x,y)-location and then once the drone is there to allow it to ascent during the data collection process, i.e. the task. In the case of large residential buildings this may have a beneficial effect on the time it takes to collect readings from, for example smart meters in households. This avoids the case that locations can be treated as separate waypoints the spatial proximity of them might have been lost, for example the drone might have been sent to different (x,y)-locations instead.
- Further a measure of the individual connection quality may be included into the stochastic decision calculation procedure. This may be based on a better connection quality which likely results in some sort of operational benefit, for example less time will be required to complete the connection task or the like.
- At least one embodiment of the present invention enables to use said topology comprising of the connection between tasks and the locations from which these tasks can be performed to decompose the update of waypoints into sub-problems, i.e. finding a location for every task.
- At least one embodiment enables to use said topology to generate partial solutions, i.e. locations connected to one or more tasks. Said solution may then any mapping of subset of the partial solutions to said partial problems such that there is exactly one partial solution for all partial problems.
- At least one embodiment enables to use a weighted stochastic decision function which continuously and iteratively improves said mapping.
- At least one embodiment enables to include connection quality and other properties in the decision making process whether to assign a task to an alternate location or not.
- At least one embodiment provides a method comprising the steps of

1) Generate a complete list of all target locations / sensor locations / actuator locations.

2) Maintain a list of permissible locations which the drones may occupy.

3) Maintain a matrix (called topology above) that determines which target can be accessed from a location, and what the expected / resulting connection quality will be.

At least one embodiment has the advantage that a precise determination of waypoints given a changing list of connection requests and permissible locations is enabled that suffice to achieve all required connections.

At least one embodiment enables using of different types of mobile objects or devices for the data collection.

At least one embodiment enables a high level of dynamicity, for example the real time adding of new jobs, possibly on the basis of triggering events as well as robustness, i.e. the ability to handle the locations becoming no-go-zones.

Many modifications and other embodiments of the invention set forth herein will come to mind to the one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing description and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Claims

1. A method for providing locations for performing tasks of moving objects,
5 performed in a memory available to one or more computation devices, wherein
said moving objects are scheduled to one or more locations to perform one or
more of said tasks using one or more connections, and wherein
one or more of said locations are updated according to an location update
10 procedure, wherein
for at least one type of connection said location update procedure reassigns or not
a selected task from its initial position to an alternate position based on a
stochastic calculation including connection information of tasks.
2. The method according to claim 1, wherein said location update procedure is
15 iterated n times for said at least one type of connection.
3. The method according to one of the claims 1-2, wherein said location
updates are performed for a limited number of specific types of tasks.
4. The method according to claim 3, wherein said location updates are
20 performed separately and/or parallel for each type.
5. The method according to one of the claims 1-4, wherein information of
previous location updates is used during following location updates.
25
6. The method according to one of the claims 1-5, wherein a location update
comprises the steps of picking a task, picking an alternate location, perform said
stochastic calculation and re-assign said task to the alternate location or not.
7. The method according to claim 6, wherein said steps are performed
30 continuously as long as a termination constraint is not satisfied.

8. The method according to claim 7, wherein said termination constraint represents at least one of the following: maximum number of iterations, number of iterations without reassignment of a task to an alternate location.

5 9. The method according to one of the claims 1-8, wherein said tasks during a locations update are picked according to at least one of the following: random probability, priority information of tasks, choosing a location first based on the number of assigned tasks in descending or ascending order to that location or
10 choosing a location having a larger probability and then choosing from the tasks assigned to said location.

10. The method according to one of the claims 1-9, wherein said connection information includes at least one of the following: number of connections of a tack, connection quality.

15 11. The method according to one of the claims 1-10, wherein at least one tuning parameter is used during said stochastic calculation.

20 12. The method according to one of the claims 1-11, wherein one or more locations which are related to each other are grouped together forming a single location.

25 13. The method according to one of the claims 1-12, wherein said stochastic calculation is based on a weighing between different parameters.

30 14. A system for providing locations for performing tasks of moving objects, wherein said moving objects are scheduled to one or more locations to perform one or more of said tasks using one or more connections, wherein one or more of said locations are updated according to an location update procedure, and said system comprising one or more receiving interfaces for receiving task information, moving object information and location information and being connectable to one or more databases, at least one output interface to output updated locations, and a computation entity adapted to perform said location update procedure reassigning or not for at least one type of connection a selected task from its initial position to

an alternate position based on a stochastic calculation including connection information of tasks.

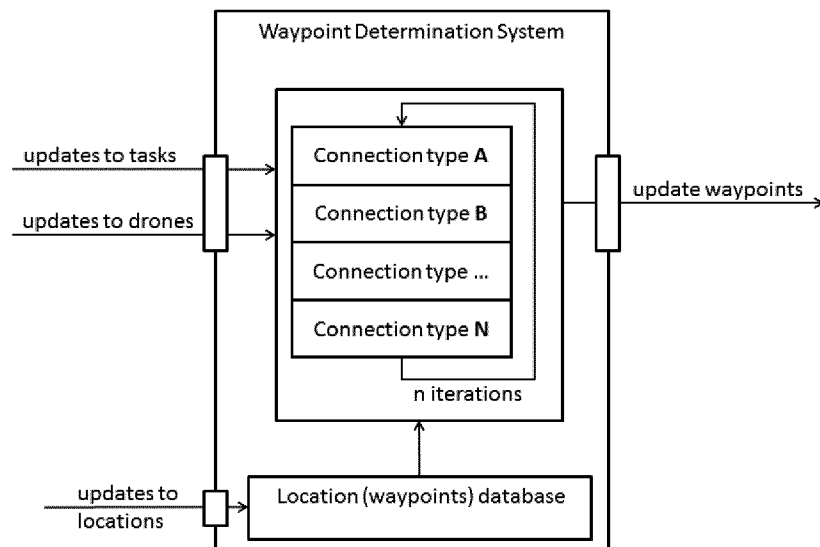


Fig. 1

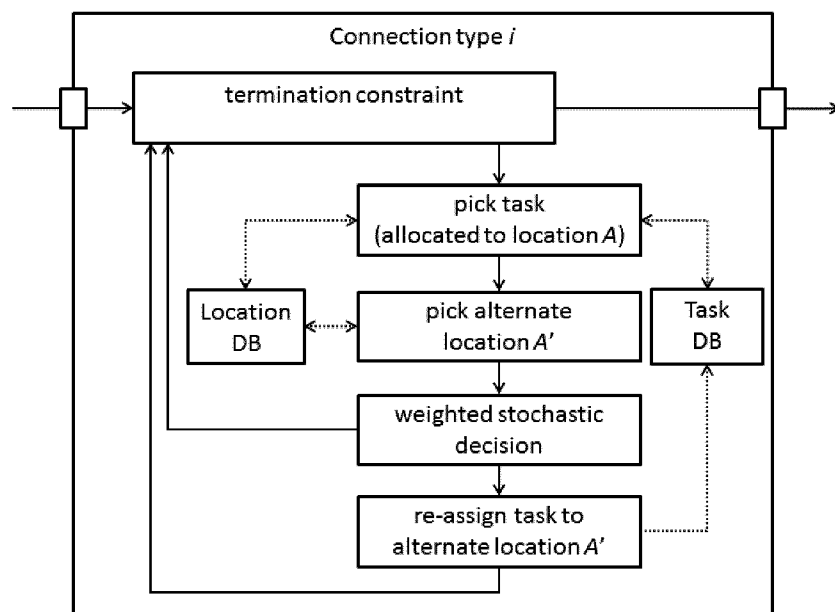


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2015/061180

A. CLASSIFICATION OF SUBJECT MATTER

INV. G06Q10/06

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 850 617 A (LIBBY VIBEKE [US]) 15 December 1998 (1998-12-15) column 1, line 5 - column 3, line 56 column 4, line 39 - column 5, line 28 column 5, line 59 - column 8, line 52 column 9, line 64 - column 11, line 35 column 12, line 4 - column 12, line 50 column 13, line 54 - column 14, line 42 -----	1-14
X	US 2004/068416 A1 (SOLOMON NEAL [US]) 8 April 2004 (2004-04-08) paragraph [0012] - paragraph [0014] paragraph [0018] - paragraph [0022] paragraph [0155] - paragraph [0158] paragraph [0166] - paragraph [0169] paragraph [0200] - paragraph [0201] paragraphs [0230], [0233] ----- -/-	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

6 January 2016

Date of mailing of the international search report

14/01/2016

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2015/061180

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/039963 A1 (AUGENSTEIN SEAN [US] ET AL) 6 February 2014 (2014-02-06) paragraph [0003] - paragraph [0009] paragraph [0024] - paragraph [0027] paragraph [0033] - paragraph [0035] paragraph [0038] - paragraph [0039] paragraph [0042] - paragraph [0043] paragraph [0070] - paragraph [0071] paragraph [0084] - paragraph [0094] paragraph [0097] - paragraph [0098] paragraph [0106] paragraph [0110] - paragraph [0111] -----	1-14
X	US 2009/099897 A1 (EHRMAN KENNETH S [US] ET AL) 16 April 2009 (2009-04-16) paragraph [0009] - paragraph [0013] paragraph [0207] - paragraph [0215] paragraph [0234] - paragraph [0263] -----	1-14
A	WO 2015/021159 A1 (TROPE WINSTON [US]) 12 February 2015 (2015-02-12) page 5, line 21 - page 7, line 15 page 9, line 3 - page 13, line 8 -----	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2015/061180

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5850617	A	15-12-1998	NONE
US 2004068416	A1	08-04-2004	NONE
US 2014039963	A1	06-02-2014	CN 104885104 A 02-09-2015 EP 2880606 A2 10-06-2015 US 2014039963 A1 06-02-2014 US 2014040282 A1 06-02-2014 WO 2014022810 A2 06-02-2014
US 2009099897	A1	16-04-2009	US 2009099897 A1 16-04-2009 US 2009099898 A1 16-04-2009 WO 2009052210 A2 23-04-2009
WO 2015021159	A1	12-02-2015	NONE