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# CERTIFICATE OF GRANT
# INNOVATION PATENT

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The Commissioner of Patents has granted the above patent on 5 August 2020, and certifies that the below particulars have been registered in the Register of Patents.

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**Title of invention:**

GUIDANCE ALGORITHM FOR UGV USING IOE SYSTEMS AND FOG COMPUTING

**Name of inventor(s):**

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**Term of Patent:**

Eight years from 21 July 2020

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Commissioner of Patents

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**PATENTS ACT 1990**

# Guidance algorithm for ugv using ioe systems and fog computing

## Abstract

GUIDANCE ALGORITHM FOR UGV USING IOE SYSTEMS AND FOG COMPUTING. Abstract: The advancement of unmanned systems as a defensive measure in the military services has also been garnering dynamism in current decades. This seems to be primarily due to the expeditious ought to mitigate the deployable threats posed by soldiers in a variety of situations inside the different shows of war. This proposal examines the framework for evaluating a UGV that might be capable of interacting spontaneously in an intricately cramped atmosphere. This approach employed an analytical process model to recognize the associated parameters influencing the efficiency of the UGV to be evaluated to develop and implements the requisite UGV guidance and control algorithms. The methodologies for avoiding obstacles and automatic path planning using simultaneous mapping and localization SLAM algorithm as the primary guidance and control algorithm for the UGV movement. The guidance algorithm directs the vehicle to the desired destination. This proposal demonstrates the reliable effectiveness of the guidance algorithm and needs a relatively low computation process. 11 P a g e GUIDANCE ALGORITHM FOR UGV USING IOE SYSTEMS AND FOG COMPUTING. Diagram CLOUD RemoteUser GdneActuators Contrc.1 AloVAlu FOG Layer Unomaned Grounkd Vehicles Onboard Sensors, GPS reveiver Fig 1: Dataflow diagram 1| P a g e

## Classifications

G05D1/0274 Control of position or course in two dimensions specially adapted to land vehicles using internal positioning means using mapping information stored in a memory device

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**Worldwide applications**

2020 • AU

**Application AU2020101429A events**

**2020-07-21** • Application filed by Aditya Nag Mannepalli Venkata Mr, K Loheswaran Dr, L Srinivasan Dr, M Pavithra Ms, M Ramanan Dr, N Prasath Dr, P N Periyasamy Mr, P Ragupathy Mr, Ph D Miste, Siva Prasad Balusupati Veera Venkata Dr

**2020-07-21** • Priority to AU2020101429A

**2020-08-20** • Application granted

**2020-08-20** • Publication of AU2020101429A4

**Info:** Legal events, Similar documents, Priority and Related Applications

**External links:** Espacenet, Global Dossier, Discuss

## Claims (6)

Hide Dependent

GUIDANCE ALGORITHM FOR UGV USING IOE SYSTEMS AND FOG COMPUTING. claims We claim that,

1. An electronic device with a touch screen such as a smartphone, laptop, tablet, etc. with high-speed internet or Wi-Fi.

2. Onboard sensors, GPS receiver, and smartphones are considered as the internet of Everything devices access via a wireless connection that collects the information like steering angle, the position of UGV, and location using GPS.

3. The guidance algorithm is computed in the fog layer based on the sensing information to direct the vehicle towards the desired location.

4. The obstacle avoidance method utilizes the sensing information to detect the obstacle location and diverts the direction of UGV.

5. Cloud services such as IBM, AWS to store the computed data in an encrypted format.

6. Actuators are used to direct and control the UGV based on the computation information.

1| P a g e

GUIDANCE ALGORITHM FOR UGV USING IOE SYSTEMS AND FOG 21 Jul 2020

COMPUTING.

Diagram 2020101429

Fig 1: Dataflow diagram

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Fig 2: guidance and control algorithm

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## Description

GUIDANCE ALGORITHM FOR UGV USING IOE SYSTEMS AND FOG COMPUTING.

Diagram

CLOUD

RemoteUser

GdneActuators

Contrc.1 AloVAlu

FOG Layer

Unomaned Grounkd Vehicles

Onboard Sensors, GPS reveiver

Fig 1: Dataflow diagram

1| P a g e

GUIDANCE ALGORITHM FOR UGV USING IOE SYSTEMS AND FOG COMPUTING

Description

Field of Invention:

This proposal provides an efficient guidance algorithm for UGV by using the Internet of Everything (IoE) devices and fog computing. Unmanned ground vehicles (UGVs) include a tremendous capacity for maritime actions and perform the significant task in assisting the Marine Corps combat that also facilitates the logistics operations. IoE devices such as smartphones, sensors, and actuators are used to sense the information from Unmanned ground vehicles. Fog computing includes the process, things, physical devices, and people which is located in between the information sources and cloud.

Background and prior art of the invention:

Riisgaard et al. proposed simultaneous localization and mapping (SLAM) method that compelled an unmanned system to be configured in a foreign surrounding with negligible client information coded into the framework. The UGV perception, training, and retaining situational consciousness abilities have generated enormous concern owing to the high level of the peer-awareness exhibited device and have developed the base for future Artificial Intelligence. But the higher delay of the conceptually strenuous operation contributes to a method that does not function with the reliability demanded of the warfare system.

Barros dos Santos et al. employed loop simulation software to investigate algorithms of guidance and control. The major limitation of this method is that the computation time will be entirely distinctive from the real-time system. Diversely, the equipment in the loop simulation is concerned with recreating the environment where the embedded application runs. It is typically among the last steps of the review process, perhaps before configuration and device testing. Because of encouragement, HIL

1| P a g e simulations are implemented to resolve these issues and reinforce a guidance algorithm to analyze their pitfalls and efficiency.

Kundak et al., an empirical model is recommended to investigate the efficiency of guidance and control methods for a compact unmanned helicopter. Testbed installation consequently demands a high amount of time and resources to develop a specific conceptual model and incorporate detectors and manufacturers.

Dissanayake et al. promoted the innovation of SLAM in the research area of robotic systems is being generated the dramatic change in notable analysis on the different algorithms used, the conceptual uncertainty correlated between them is indeed drastically constrained to the remedy of large-area SLAM processing.

Vandapel et al. described the need for specific three-dimensional (3D) surface laser information tracking with global 3D airborne details to distinguish unnavigable regions for UGV as a medium for corresponding route selection. This function evaluates its plausible routes by extracting the greenery and topography relevant data of soil and airborne to collaborative the map.

Sundar et al. formalized the Fuel Constraint, UAV Routing Problem (FCURP), which is a combined generalized form of the TSP focused on the identification of the best possible UAV route between control points using alternate recharging oil refineries. Moreover, FCURP relies only on UAV navigation via a collection of static repositories, and there is no collaborative navigation because it does not detect the UGV direction or robotic collaboration.

Maini et al. defined the Fuel Constraint UAV Refueling Issue with Mobile Refueling Station (FCURP-MRS). With this scenario, the UAV route is via a mobile refueling station rather than a fixed refueling station. This approach includes a preliminary substitution phase to choose an optimum level of fueling points for the mobile refueling station. Nevertheless, the path of the remote fuel depot is through the road infrastructure established, but there is still no navigation for the remote fuel depot.

Li et al. emphasize its research on a multi-robot system oriented on vision-guided quad-rotor autonomy. They illustrated a method to fly away, landing, and ride over the UGV, where the UGV is configured with two LEDs and a smooth layout on the

21Page substrate. Even so, the quad-rotor couldn't offer the UGV with relevant data about the landscape.

Rao, R suggested an efficient approach called a motion-planning and control system associated with visual actuators in a UGV despite digital camera on board, but never precisely with a UAV.

Intharawijitr et al. devised a fog network based on a mathematical model and significant relevant parameters to explain the delay in computation and communication of fog architecture.

Deng et al. concentrated on the interaction and coordination among the edge devices and the kernel. They formulated a tentative strategy to dissolve the significant challenge to three subparts that accommodate between power usage and latency in a cloud-fog computing environment.

Summary of the invention:

Unmanned ground vehicle (UGV) is an independent device that behaves on the earth's crust as well as that it schedules its path and detects obstacles by itself. The UGV should have a peculiar ability to track its position on a partly surveyed map or to decide that it has penetrated unfamiliar lands. For that purpose, the GPS Global Positioning System is interfaced with the controller.

The unknown environment is assigned as static and planar, so the different kinds of sensors are used based on the range of regions. The UGV is configured with envision launchers that construct the mapping process, and an accurate location is detected. Finally, based on the constructed map, the optimal path is selected and provided to the device via actuators.

SLAM technique based on equations of two-point distance wherein geometric parameters is needed as insight for UGV inhibition to encompass a significant distance. UGV necessitates x / y directions as parameters, and that automatically pinpoints the specific land region on its own. An intruder or obstacle which is detected and repositioned, then it can be reached at the preferred destination.

The proposal includes three modules, such as navigation, guidance, and control, which are computed in the fog layer. Fog computing defines as end devices for

31 P a g e computing, storing, and other services. The sensors, GPS receivers are used for sensing the information, and that is feeding to the navigation module for generating awareness about the location. The information is given as input to the guidance algorithm for path selection, and that is given to the control module. The controllers get the data from guidance algorithms and processed, and allocators provide the signal to the actuators for further updates regarding directions, even if there is the presence of obstacles. The computed information is stored in the cloud via the internet. The fog can be used as an interface between the physical devices and cloud storage. The remote servers can access the control information via the internet from the cloud server.

The objective of the invention:

The main objective is to provide an efficient guidance algorithm for UGV using fog computing.

• To offer low power consumption and low delay facilities. • To govern sovereign navigation, avoidance of impediments, and scene analysis.

Statement of the invention:

This proposal explains the effective guidance algorithm for unmanned ground vehicles using the Internet of Everything devices and fog computing. At present, fog computing plays a significant role in recent technologies, along with cloud mechanisms. The fog computing layer computes guidance, navigation, and control algorithm to yield the desired trajectory of UGV, and actuators are used to direct the UGV based on the computation information. Cloud and fog layers communicated via the internet, and remote users can access the information across the internet.

Brief description of the Drawings:

Fig 1: Data flow Diagram

Fig 2: guidance algorithm

A detailed description of the drawing:

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Figure 1 explains the working flow of guidance algorithm for UGV based on the Internet of Everything devices and fog computing. The IoE devices such as sensors, GPS receivers are used to sense the information of position and localization of UGV. The UGV is considered a fog node in the fog layer and feeds the sensed information for computation purposes. The guidance algorithm called localization SLAM is used for identifying the trajectory paths that direct the vehicles in a specific direction. It also helps to detect and avoid the hurdles while movements of UGV. The mapping algorithm is proposed for avoidance obstacles. The final control signals are retrieved from a controller that is fed to the actuators for further modifications. The directions can be changed automatically based on the actuator information. The computed information is stored in the cloud server for remote users to access.

Figure 2 illustrates the working of the guidance algorithm. The localization SLAM algorithm is to select the appropriate location and mapping process is to detect the obstacles.

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### Similar Documents

| Publication | Publication Date | Title |
|---|---|---|
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| Cesetti et al. | 2010 | A vision-based guidance system for UAV navigation and safe landing using natural landmarks |
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| AU2020101429A4 | 2020-08-20 | Guidance algorithm for ugv using ioe systems and fog computing |
| Paar et al. | 2012 | PRoViScout: a planetary scouting rover demonstrator |
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| Kania et al. | 2014 | Dismounted soldier autonomy tools (dsat)—from conception to deployment |
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### Priority And Related Applications

### Priority Applications (1)

| Application | Priority date | Filing date | Title |
|---|---|---|---|
| AU2020101429A | 2020-07-21 | 2020-07-21 | Guidance algorithm for ugv using ioe systems and fog computing |

### Applications Claiming Priority (1)

| Application | Filing date | Title |
|---|---|---|
| AU2020101429A | 2020-07-21 | Guidance algorithm for ugv using ioe systems and fog computing |

## Legal Events

| Date | Code | Title | Description |
|---|---|---|---|
| 2020-08-20 | FGI | Letters patent sealed or granted (innovation patent) | |

## Concepts

machine-extracted

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| Name | Image | Sections | Count | Query match |
|---|---|---|---|---|
| diagram | | claims,abstract,description | 7 | 0.000 |
| method | | abstract,description | 8 | 0.000 |
| localization | | abstract,description | 5 | 0.000 |

Show all concepts from the description section