

2017

Korea

Aerospace

Research Institute

Promising Technologies for Commercialization



**We are conducting research and
development to realize the dreams and
values of Korea in regards to the sky and outer space.**



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About the Institute



Research Area Intriduction



Technology Introduction



I

About the Institute

Korea Aerospace Research Institute(KARI)



Korea Aerospace Research Institute(KARI) was established on October 10,1989 as national aerospace research institution with the purpose of "contributing to solid development of the national economy and enhancement of national life through a new exploration and technological advancements, development. and dissemination tn the field of aerospace science and technology." Ever since its inception, KARI has achieved significant accomplishments, despite its rather short history, as we have successfully secured advanced satellite technology for the development of multi-purpose satellites, developed Korea's 1st space launch vehicle 'Naro' and established the NARO Space Center, as well as obtained aviation technology through the Korean Helicopter Program and Smart UAV(Unmanned Aeria Vehicle, In the future, we plan to build up our own indigenous launch capability, strengthen national safety and public service, industrialize satellite information and applications technology, explore the moon through our own technology, and develop environmentally-friendly and highly-efficient cutting-edge aircraft and core aerospace technology so as to fulfill the aspirations and values that Korea holds toward space and beyond.



Major Functions

contributing to solid development of the national economy and enhancement of national life through a new exploration and technological advancements, development, and dissemination in the field of aerospace science and technology.

Mission

01



Research & development in systems and core technology for aircraft, satellites and space launch vehicles

02



Support development of national aerospace policies, Supply, distribution and dissemination of information regarding aerospace technology

03



Joint utilization of test and assessment facilities with the industry, academy and research institutes, Support collaboration with aerospace related small and medium companies and the commercialization of technology

04



R&D cooperation and technical outsourcing activities with the government, private sector, corporate bodies and other groups, Training of professional human resources in the major mission fields

Vision & Goals

Vision

To enhance the status and position of Korea and to contribute to the nation's economic development by strengthening independent space development capability

Goals

01. Continued increase of the space budget within the government's R&D budget
02. Procurement of independent launch capabilities through a Korean launch vehicle
 - ※ Development of Korean launch vehicle (by 2020), medium earth orbit and geostationary orbit launch vehicles (by 2030), and large scale geostationary orbit launch vehicle (by 2040)
03. Continued development of satellites through participation of private sector
 - ※ Additional launches of 11 satellites (2020), 40 satellites (2030), and 64 satellites (2040)
04. Procurement of level of competitiveness of space development of advanced nations
 - ※ Top 7 level of competitiveness of space development (2020), Top 5 level of competitiveness of space development (2030), Top 4 level of competitiveness of space development (2040)

Goals

Korea's dreams
"towards the sky and outer space"
and the attainment of
new areas of value

Security Construction of Integrated System

Integration of Aerospace System

- Construction of systematized and integrated security system consisting of geostationary orbit satellites, low-orbit satellites, UAV, NSS, Aerostat, small aerostat, etc.
- Construction of integrated disaster management system
- Construction of integrated environment management system

Development Enhancement of Quality of Life

Proliferation of Aerospace Technology

- Leading role in development of ST/NT/IT convergence technology
- Construction of convenient and eco-friendly logistics system
- Leading role in establishing a future science society
- Development and proliferation of aerospace technology

Exploration Increase of Spatial Ability

Leadership in the Field of Aerospace Technology

- Moon and planet probes
- Manned and unmanned space probes
- Increase of space access capability
- Development of innovative aircraft

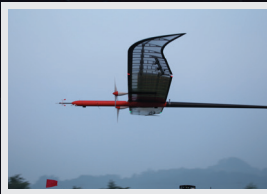
Results of Research & Development

2010's (2010 – Present)



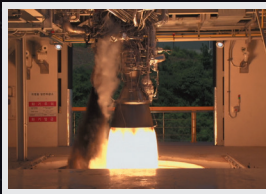
2016.12

Designated as a National Space Development Agency



2016.08

Successful 18.5 kilometer long flight of high altitude (stratosphere) long-term electrically-powered unmanned air vehicle (EAV)-3



2016.07

Successful firing test of 75-ton class liquid rocket engine during burning test task



2015.12

The completion of KSLV-II's engine combustion test facility



2015.08

EAV-3 development



2015.03

Launch of Korea Multi-Purpose Satellite (KOMPSAT)-3A



2014.05

OPV Development



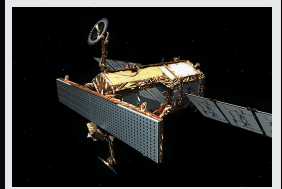
2013.12

4KC-100 Development



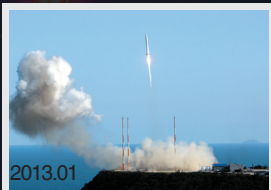
2013.11

STSAT (Science and Technology Satellite)-3 Development



2013.08

Launch of Korea Multi-Purpose Satellite (KOMPSAT)-5



2013.01

The 3rd launch of Korea's 1st space launch vehicle KSLV-I



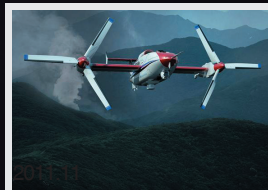
2012.06

Korean Utility Helicopter Surion Development



2012.05

Launch of Korea Multi-Purpose Satellite (KOMPSAT)-3



2011.11

Smart UAV Development



2010.06

Launch of COMS

2000's (2000 – 2009)



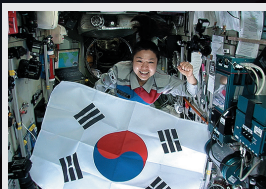
2009.06

The completion of Naro Space Center



2008.12

Medium Aero stats Development



2008.04

The first Korean astronaut



2006.07

Launch of Korea Multi-Purpose Satellite (KOMPSAT)-2



2003.10

Multi-Purpose Stratosphere unmanned-airship Development



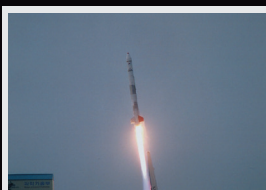
2003.09

Launch of STSAT (Science and Technology Satellite)-1



2003.08

The break ground of Naro Space Center



2002.11

Launch of Liquid-propellant Rocket (KSR-III)



2001.09

Canard Aircraft Development

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I

About the Institute

II

Research Area Intriduction

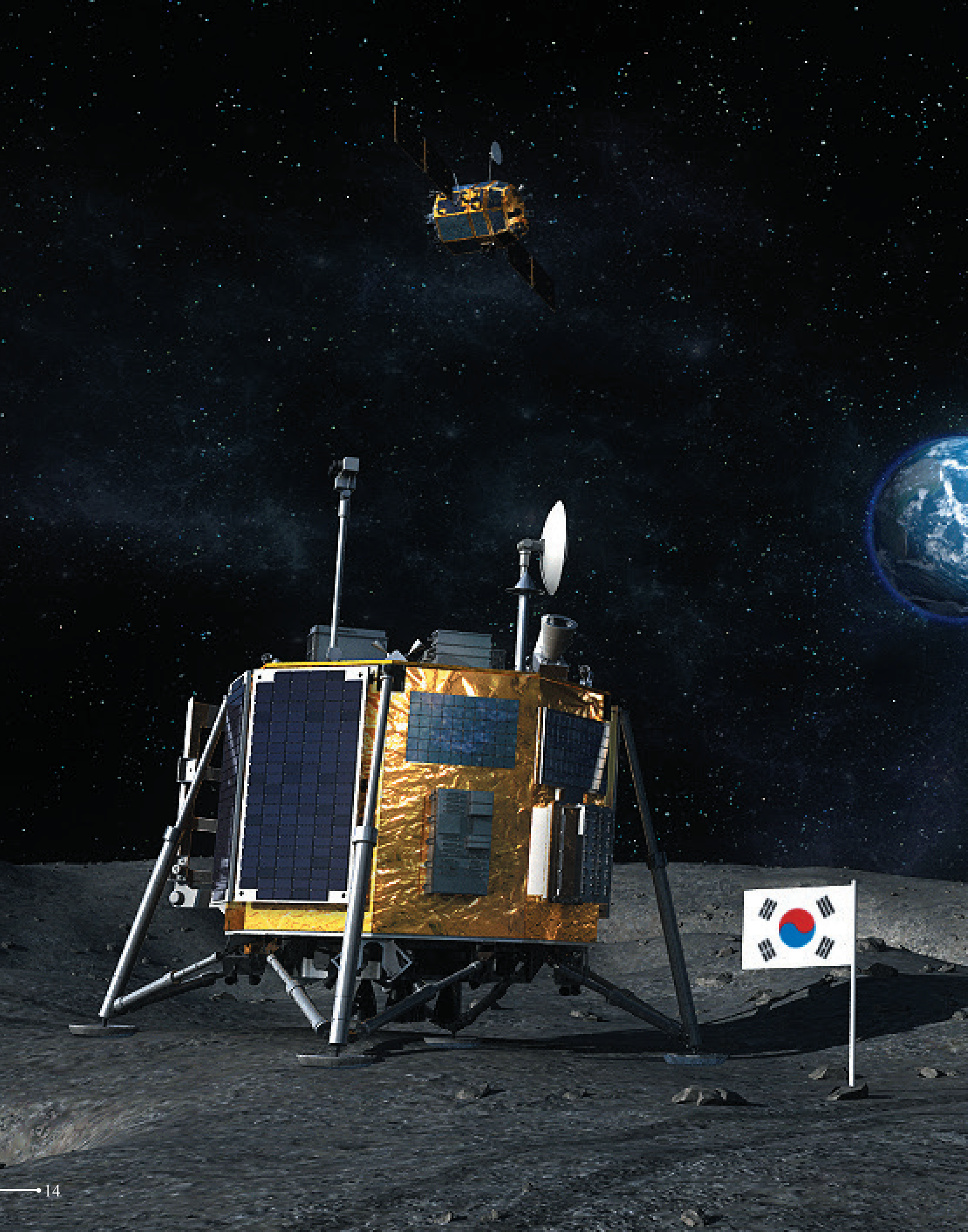
III

Technology Introduction

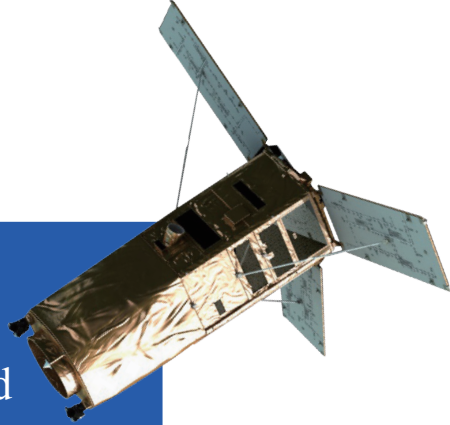
II

Research Area Introduction

1. Satellites
2. Aeronautics
3. Space Launch Vehicle
4. Utilization of Satellite Images
5. Satellite Navigation



Satellites



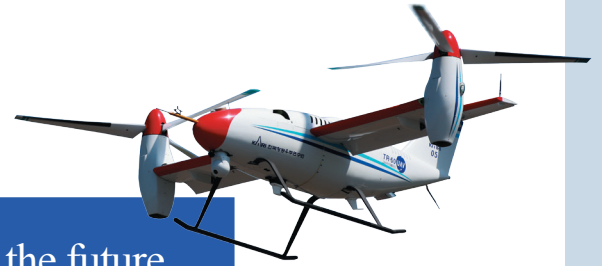
Korea's advanced
satellites for
global monitoring

Ever since the development of Arirang-1 (Korea Multi-Purpose Satellite-1, KOMPSAT-1), Korea has been securing advanced satellite development technologies and establishing infrastructure for space industries through the development of world-class earth observation satellites on low earth orbit and geo-stationary orbit. Korea has secured high resolution optical and radar images through Arirang series satellites (low earth orbit observation satellites) and conducts meteorological and ocean monitoring missions and test communication mission through a geo-stationary satellite (COMS). Furthermore, Korea is developing satellites which secure leading edge high resolution images in low earth orbit and perform environmental monitoring in geo-stationary orbit.

Meanwhile, the next-generation, medium-sized satellites are also being developed to meet various needs of satellite application, which ultimately act as a stepping-stone lifting Korea to the next level in the space industry.



Aeronautics



Spearheading the future
aviation
industry through
development of next-
generation key aeronautics
technology

The Korea Aerospace Research Institute is a developer of the canard aircraft technology and core components of the helicopter 'Surion' for the Korean Armed Forces and, most notably, the Smart UAV, a tilt-rotor UAV which can achieve autonomous intelligence flight, collision avoidance and vertical takeoff and landing. Currently, KARI is working on development projects for key aeronautics technology in preparation of an eco-friendly and highly-efficient aircraft era.



Space Launch Vehicle

Securing indigenous
satellite launch capability
through
Korea Space Launch
Vehicle development



The Korea Aerospace Research Institute has secured key technologies through development of the Korea Science Rocket series and the Naro space launch vehicle. Currently, the Korea Space Launch Vehicle-II program is in progress to fulfill the emerging needs for domestic satellite launches. The KSLV-II can lift a 1.5-ton satellite into low Earth orbit from 600 to 800 km in altitude. After development, KARI plans to use KSLV-II on launching domestic lunar probe exploration. Once KARI has achieved successful lunar missions, launch vehicle reliability and technical expertise will be recognized globally and through further commercialization development, KARI plans to enter the global satellite launch service market.



Utilization of Satellite Images

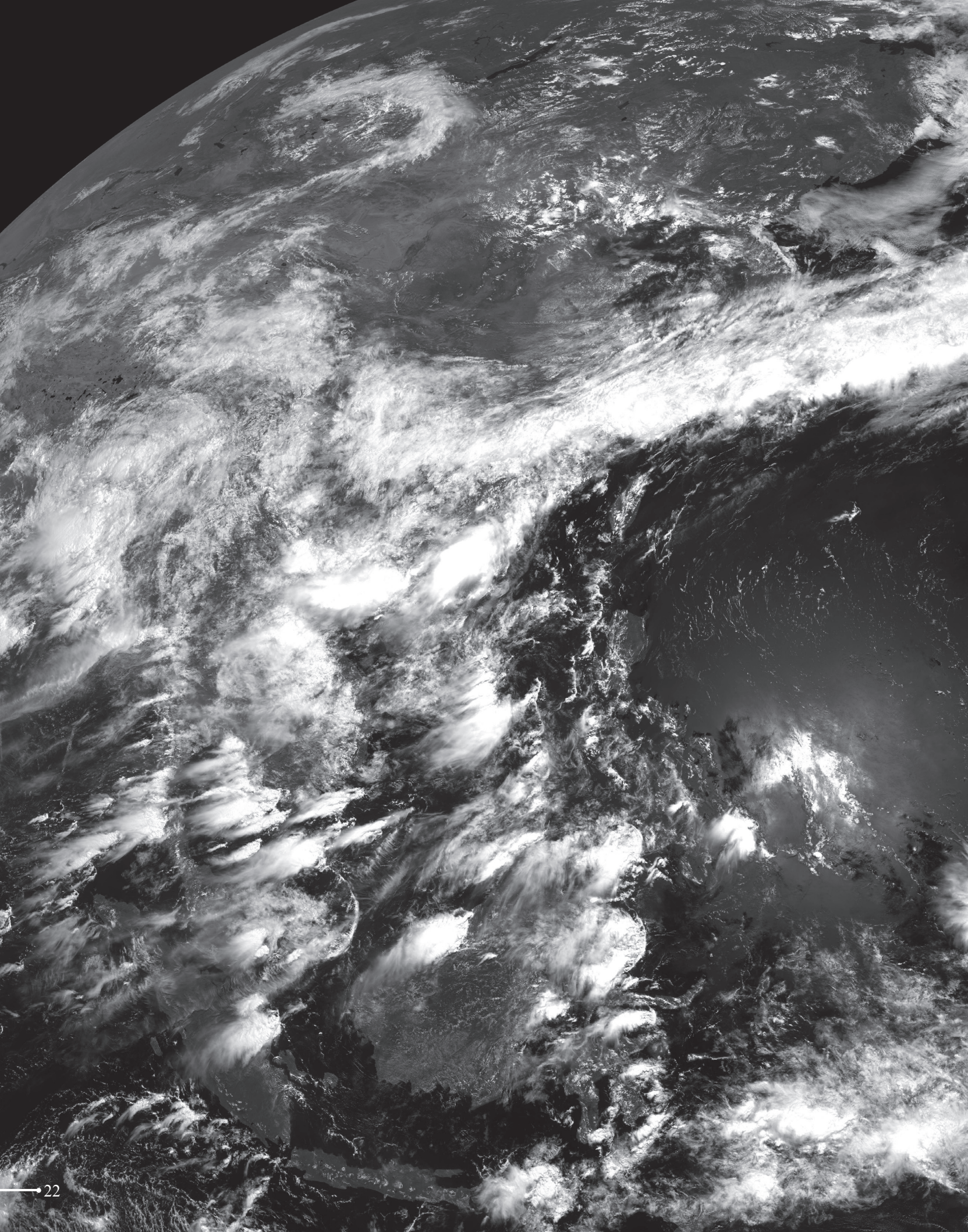
High value-added satellite information for public safety and improvement of quality of life



Satellite images are utilized in a wide range of areas and applications such as national land management, natural disaster monitoring, marine resource management, agriculture and forestry, environmental weather observation, and national security to create huge added values.

Satellite images also help to enhance the status of Korea in the international community.

KARI joined the International Charter on Space and Major Disasters in 2011 and is now providing satellite data to help international efforts to detect major disasters and analyze damages as part of its provision of satellite data for application humanitarian programs worldwide.



Satellite Navigation

Satellite Based
Augmentation
System (SBAS) for
reinforcing entry into the
G7

The Korea Aerospace Research Institute is currently undergoing research and development activities for the Satellite Based Augmentation System (SBAS) in concert with the Electronics and Telecommunications Research Institute, the Korea Research Institute of Ships and Ocean Engineering, and the Telecommunications Technology Association. GPS-based systems are often reported with errors and poor reliability, thus its usage has been limited in fields where a high degree of safety is required. On the contrary, the SBAS boasts of high reliability and accurate positioning performance, which underscores why it is being used as one of the standard navigation systems for the next generation CNS/ATM. Bolstered by this R&D activity, we believe Korea will become the world's 7th powerhouse with the SBAS by 2022 after the US, Europe and Japan.

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Technology Introduction

1. Method of determining driving lane
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7. Power supply system having an emergency power supply cutoff function
8. Apparatus and Method for Playing Video in Real Time
9. Three Dimensional Rigid Ball driving System
10. Method of determining road lane

01

Method of determining driving lane



Inventor

Senior Researcher Wooyong KANG
(Department of Satellite Navigation)

Registration (Filing) No.

- US : 8204685
- US : 8401787

Title

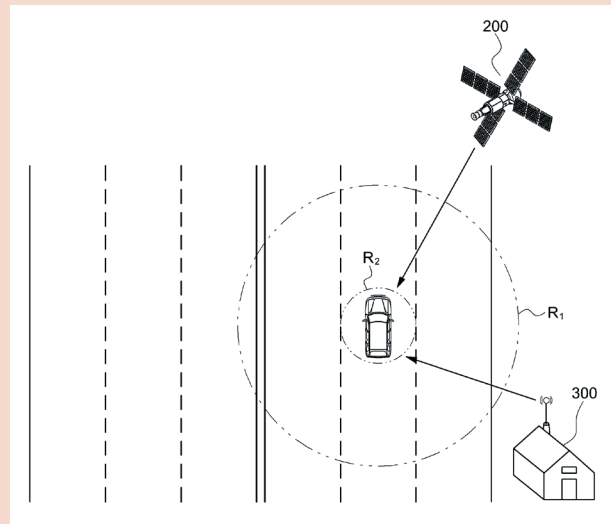
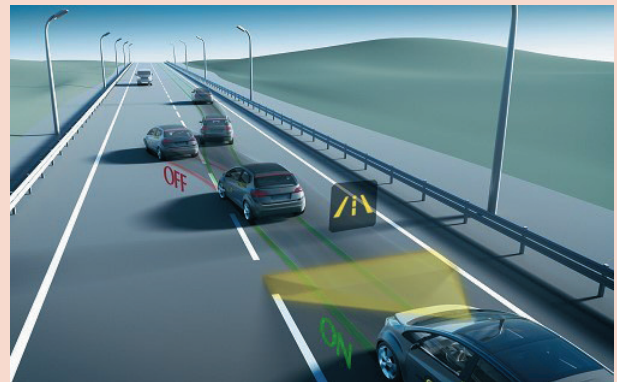
- NAVIGATION DEVICE AND ROAD LANE RECOGNITION METHOD THEREOF
- METHOD OF DETERMINING DRIVE LANE USING STEERING WHEEL MODEL

TLO of the KARI

Person-in-charge
Senior Administrator Moon-Hee, Cho
E-mail : moonyp@kari.re.kr
R&D Performance Diffusion Division

Outline of Technology

Using a vehicle dynamics model, a heading changing rate of a vehicle and a location changing rate are compared to match them to a driving lane of an actual vehicle.



Technical features and advantages

Distinctiveness

- A driving lane is determined by determining whether a location is appropriate based on a comparison of steering angle information and a GPS azimuth of a vehicle. An accuracy of tolerance is 30 cm or less, which is very precise.
- In detecting an abnormality of a satellite navigation, a driving lane is determined by estimating an azimuth of a vehicle and then using the relationship between the estimated azimuth and the driving lane, which leads to high safety.

Technical effects

- A driving lane is distinguished by reflecting features of a driving lane, and safety and accuracy are improved.

Problem of competitive technique

- A satellite navigation system in the field of land traffic is utilized to collect location information for individual driving lanes, levy driving taxes depending on driving distance, monitor driving lane compliance of a hazardous article transport car, and charge differential fees for each driving lane, however it is not distinguished by a lane on which a vehicle drives.
- Currently, a technique of maintaining a lane through recognition of driving lanes has been developed.

Solution

- A location on a road on which a vehicle is currently driving is analyzed using differential GPS information based on carrier waves and a precise digital map in which each lane is distinguished, rather than a typical digital map, and then a driving lane is determined.



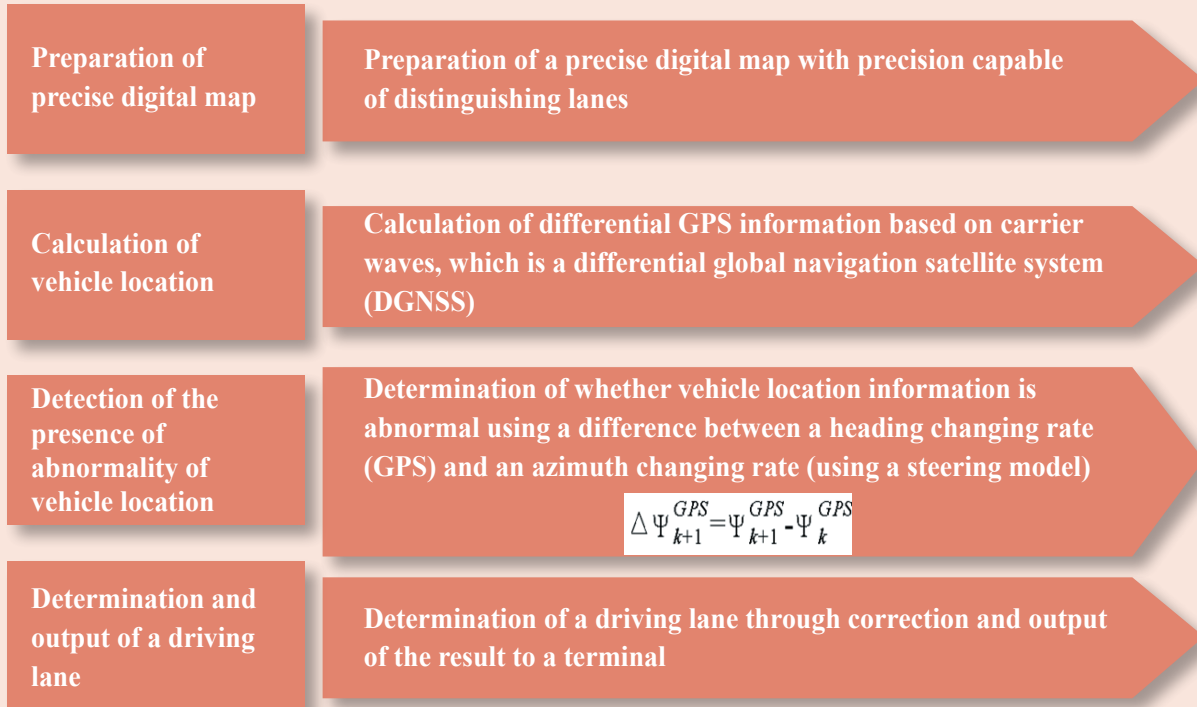
Method of determining driving lane

Technical features and advantages

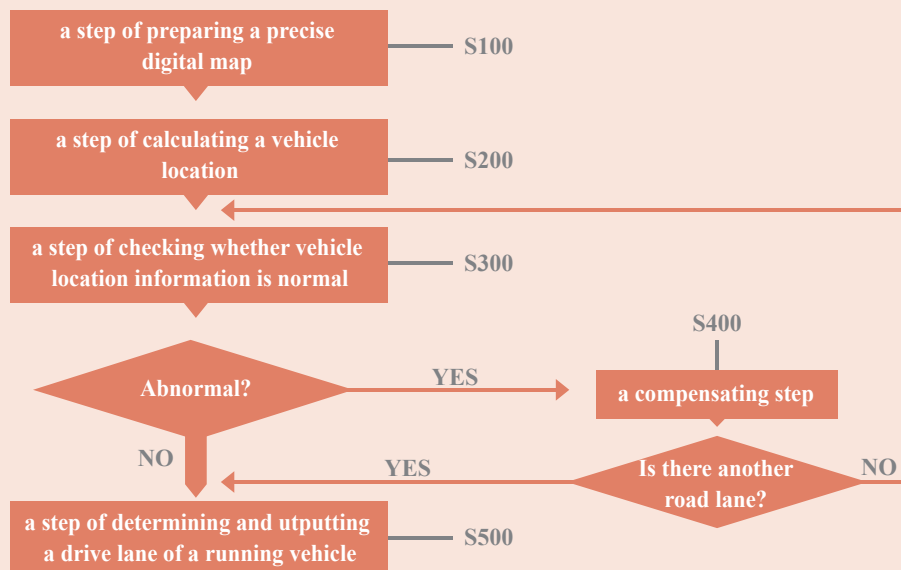
Problem of competitive technique	Solution
■ In the United States, research on determining a driving lane using a digital map capable of distinguishing location information and lanes has been conducted, however it does not distinguish a driving lane by reflecting features of the lane, but only determines a driving lane based on location information and a trajectory of a vehicle. ■ Therefore, a driver needs to recognize and determine circumstances around a vehicle and a lane in which he/she is currently driving by himself/herself in order to change a driving lane, which leads to lack of safety.	■ Provided is a method of determining a driving lane for largely improving driving lane recognition performance which is correctable when there is an abnormality found after an abnormality check based on GPS information using information related to a steering direction of a vehicle in determination of a driving lane.

Technical detail

Method of determining drive lane using steering wheel model



- According to a method of determining a driving lane using a steering model, when abrupt tolerance occurs and a driving lane is inappropriately recognized in matching of lanes for distinguishing lanes, a heading changing rate and a location changing rate of a vehicle are compared using a vehicle dynamics model, and therefore a driving lane of an actual vehicle is matched.



Method of determining driving lane

Technical detail

NAVIGATION DEVICE AND ROAD LANE RECOGNITION METHOD THEREOF

Calculation of location

A vehicle location is calculated using a satellite signal including carrier waves and correction information.

Range of distinguishing driving lane

A driving direction is determined using location and lane information.

Calculation of lateral istance

A lateral distance between a vehicle location and a central line of each lane in a driving direction is calculated.

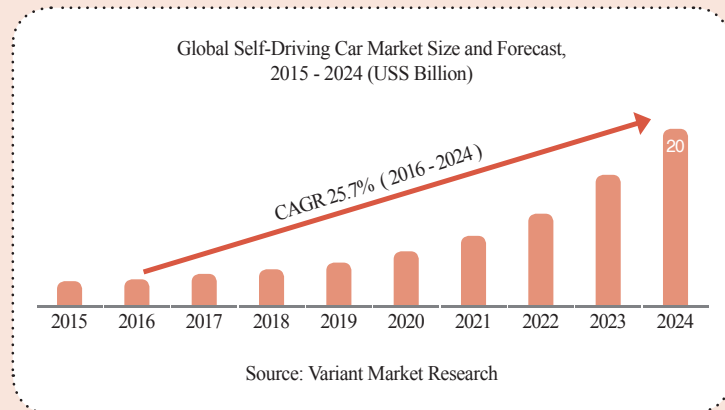
Division of driving lane

A lane with a minimum lateral distance is classified as a driving lane of a vehicle.

- Technique for distinguishing a driving lane using correction information of GPS and driving lane information embedded in a digital map
- Signaling time can be flexibly controlled by traffic for each driving lane
- When using precise location information based on division of driving lanes, information related to driving circumstances and a signal system of each lane can be provided.

Market and future prospects

- A market of autonomous driving vehicles is expected to show an average annual growth rate of 25.7% from 2016 to 2024, and reach 20 billion dollars by 2024.



- Further, a supplying size of autonomous driving vehicles is expected to grow 95.4 million in 2035 from 8000 in 2020, which is an average annual growth rate of 85%. The circumstances of complete autonomous driving will be adapted all over the world.



Applications

- The technique can be utilized in various fields such as by developers of navigation devices, navigation manufacturers, vehicle manufacturers, etc.
- Applicable in the fields of traffic control systems, road maintenance, next generation navigation systems, self-driving vehicles, etc.

02

High performance tilt rotor aircraft in which a nacelle tilt angle and a flaperon angle mechanically interwork with each other



Inventor

Chief researcher Myeong-gyu LEE

Department

Flight systems

Registration (Filing) No.

• US : 8544787

Title

• HIGH PERFORMANCE TILT ROTOR AIRCRAFT IN WHICH NACELLE TILT ANGLE AND FLAPERON ANGLE MECHANICALLY INTERWORK WITH EACH OTHER

TLO of the KARI

Person-in-charge
Senior Administrator Moon-Hee, Cho
E-mail : moonyp@kari.re.kr
R&D Performance Diffusion Division

Outline of Technology

In a tilt rotor aircraft, a nacelle and a flaperon are mechanically connected by a power transmission mechanism such as a linkage system, and therefore the flaperon moves in connection with changes of a nacelle angle.

The present invention is designed to provide a result in which a lift-to-drag ratio of a flying vehicle increases as an aspect ratio of wings increases so that endurance performance is improved, and also to complement and improve a concept of mounting an extension wing which has previously invented (Korean Patent Document No. 10-0822366).

< Helicopter Mode >



< Conversion Mode >



< Airplane Mode >



Technical features and advantages

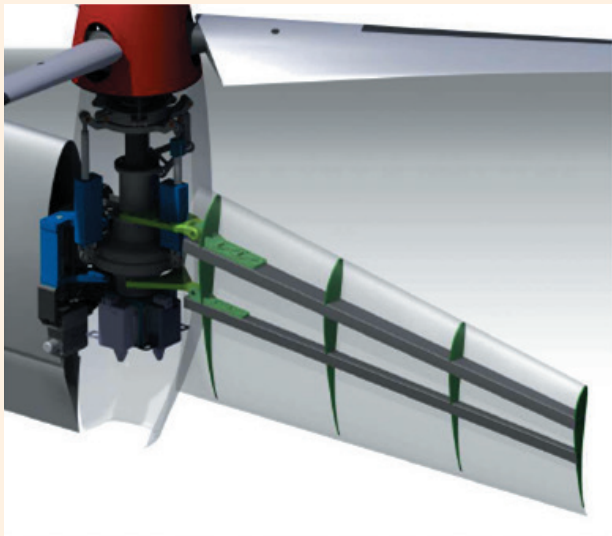
Distinctiveness

- A separate flaperon operator is not required, and therefore the flaperon can be alternatively used to adjust an angle of the extension wing so that an auxiliary angle of the extension wing is independently adjusted from the nacelle angle depending on a flight mode.

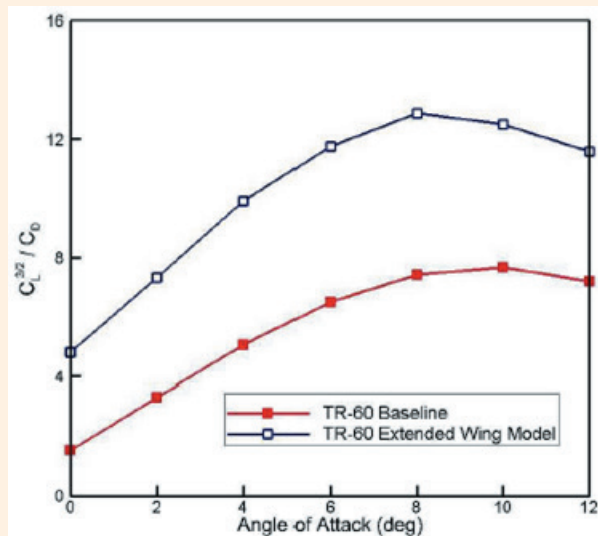
Technical effects

- In the aspect of the flying vehicle as a whole, the present invention is directed to providing a tilt rotor aircraft in which an endurance time and a flight distance are improved without an increase in the number of separate driving operators.
- A downward load acting on an auxiliary wing by propeller wash of a rotor is minimized through relative adjustment of the auxiliary wing so that performance degradation may be prevented in a rotary wing flight mode, and a drag acting on the extension wing may be reduced in forward flight of the rotary wing flight mode and a transition flight mode. In addition, in a fixed wing flight mode, the endurance time and the flight distance can be largely improved.

< Design of Extended Wing and Supporting Structures >



< Life to Drag Ratio
(Baseline vs Extended Wing Model) >



High performance tilt rotor aircraft in which a nacelle tilt angle and a flaperon angle mechanically interwork with each other

Technical detail

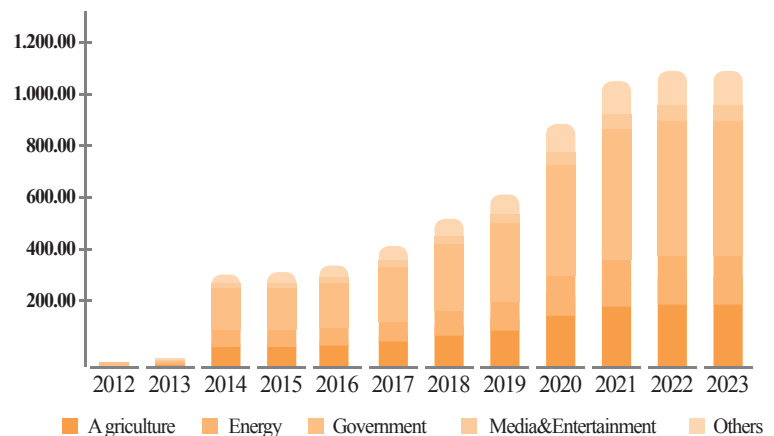
In order to confirm effects of performance improved by mounting an extended wing, a computational flow analysis is conducted for the entire body of a TR60 basic model and an extended wing-mounted model, and endurance time and a lift-to-drag ratio increased about 68% in the results.

<Performances and Physical Properties of TR60 & TR100>

	TR60	TR100
Body length	3m	5m
Maximum speed	250km/h	500km/h
Endurance time	6 hours	5 hours
Weight on board	30 kg	40~100 kg
Maximum weight	200 kg	1,000 kg

Market and future prospect

The global commercial UAV market is expected to reach \$2.07 billion by 2022, according to a new study by Grand View Research Inc.



In view of the size of the market, it is expected that high performance tilt rotor unmanned aerial vehicles could conquer a global UAV market which is a blue ocean.

Market and future prospect

The endurance performance is affected by various factors besides a lift-to-drag ratio. In the purpose of substantial comparison of endurance performance, as a result of measuring engine power through a flight test and comparing fuel consumption of two models through a static test, fuel reduction of about 30% is shown when an extended wing is mounted, and thereby the improvement of endurance performance of the extended wing was indirectly confirmed from this result.

<Flight Test of Extended Wing Model>



Applications

- When a tilt rotor unmanned aerial vehicle is operated on a battleship, real-time surveillance by navy or maritime police is improved.
- When an automatic aviation technique of a tilt rotor UAV is applied to a compact trigger aircraft, a personal air vehicle (PAV) which automatically lands on a helipad of a destination based on a destination which is input into the PAV on a helipad of an apartment rooftop can be developed.
- The PAV automatically flies on a sky highway so that it can be flown to a destination with the driving skill of an automobile driving license.



03

Flow control valve



Inventor

senior researcher à principal researcher, Tae-gyu Jung

Team

Department of launch vehicle propulsion control

Status of right

- US : 9092032
- JP : 4870799

Title

- FLOW CONTROL VALVE
- FLOW CONTROL VALVE

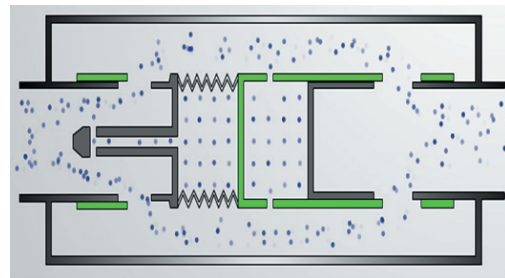
TLO of the KARI

Person-in-charge
Senior Administrator Moon-Hee, Cho
E-mail : moonyp@kari.re.kr
R&D Performance Diffusion Division

Outline of Technology

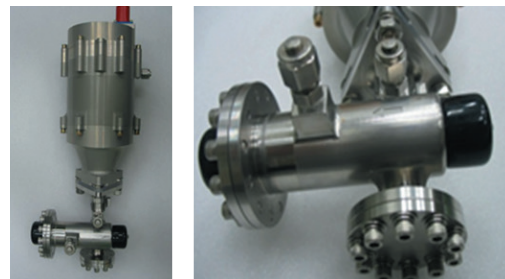
The technique can control a flow of a desired fluid as necessary, and control an amount of flow to be maintained constant at all times regardless of abrupt system load changes.

<Schematic view of flow control valve>



Technique for not only adjusting flowrate but also maintaining a constant flowrate regardless of system load changes

<Prototype of an ultralight pressure-compensating flow control valve>



Manufacturing a prototype of ultralight pressure-compensating control valve by applying the flow control technique

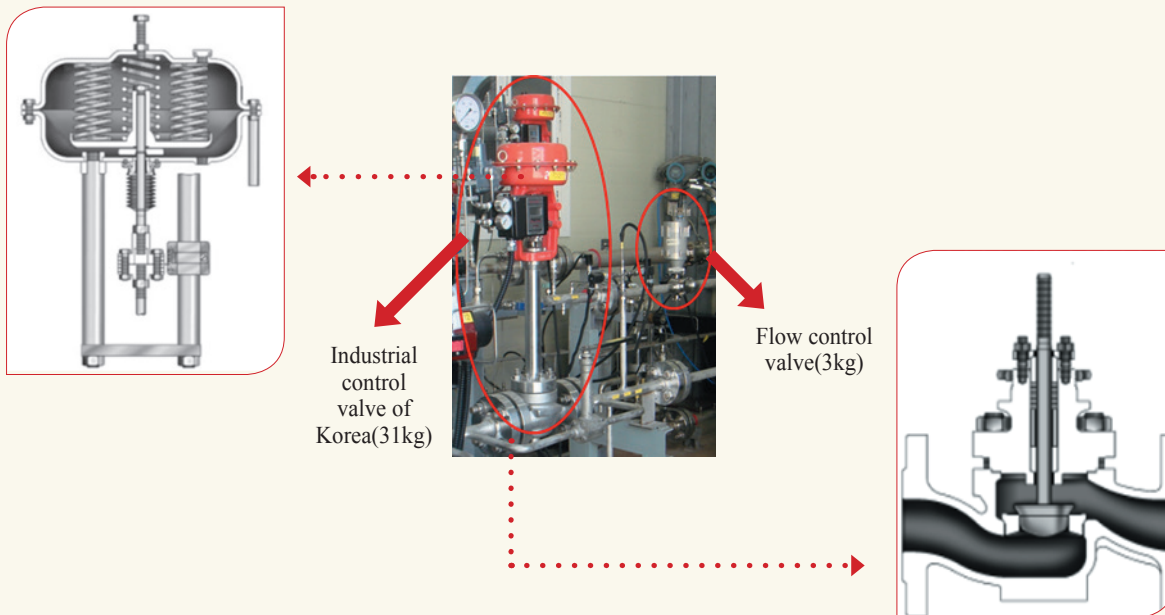
Technical features and advantages

Distinctiveness

- Even when a system load of a flow control valve is abruptly changed, an amount of flow is always constantly maintained, and a weight and size of the valve is reduced to about a tenth that of the conventional technique.

Technical effects

- Simple constitutions, easy control, less frequent malfunctions



Technical detail

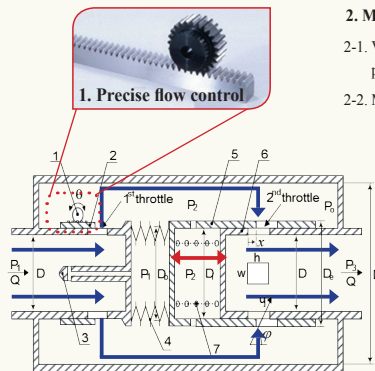
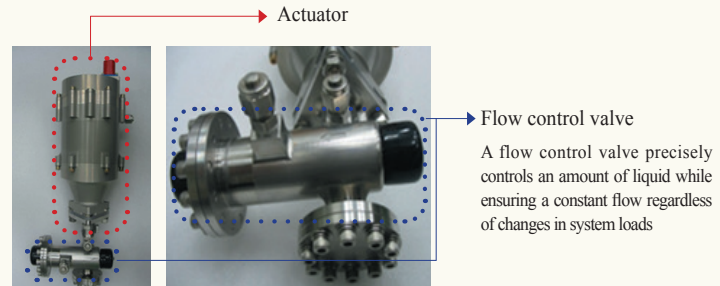
A prototype is manufactured based on this technique, and a modified technology is under development for improving manufacturing efficiency.

- While many conventional researches were conducted on using a mechanical feedback structure (mechanical compensation mechanism) to absorb a change in flow to maintain a constant amount of flow at all times, no technique has been found so far in which a simple constitution of an actuator reduces a weight and maintains a constant flow even when a pressure abruptly changes as disclosed in the subject technique.

Flow control valve

Technical detail

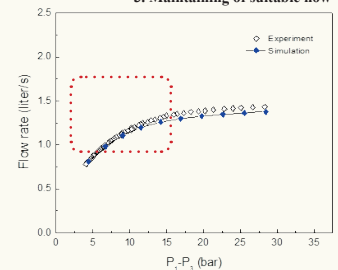
- Reduction of a driving force of an actuator leads to its size reduction, and therefore the entire valve is reduced in weight. Furthermore, an abrupt pressure change occurring at an inlet or outlet of the valve is absorbed by a mechanical feedback structure (compensation mechanism) so that it is possible to maintain a constant flow.



2. Miniaturization/ electronic control

- 2-1. Valve parallel to a flow path $\rightarrow$ Resistance pressure, operational torque
- 2-2. Miniature valve can be manufactured

3. Maintaining of suitable flow



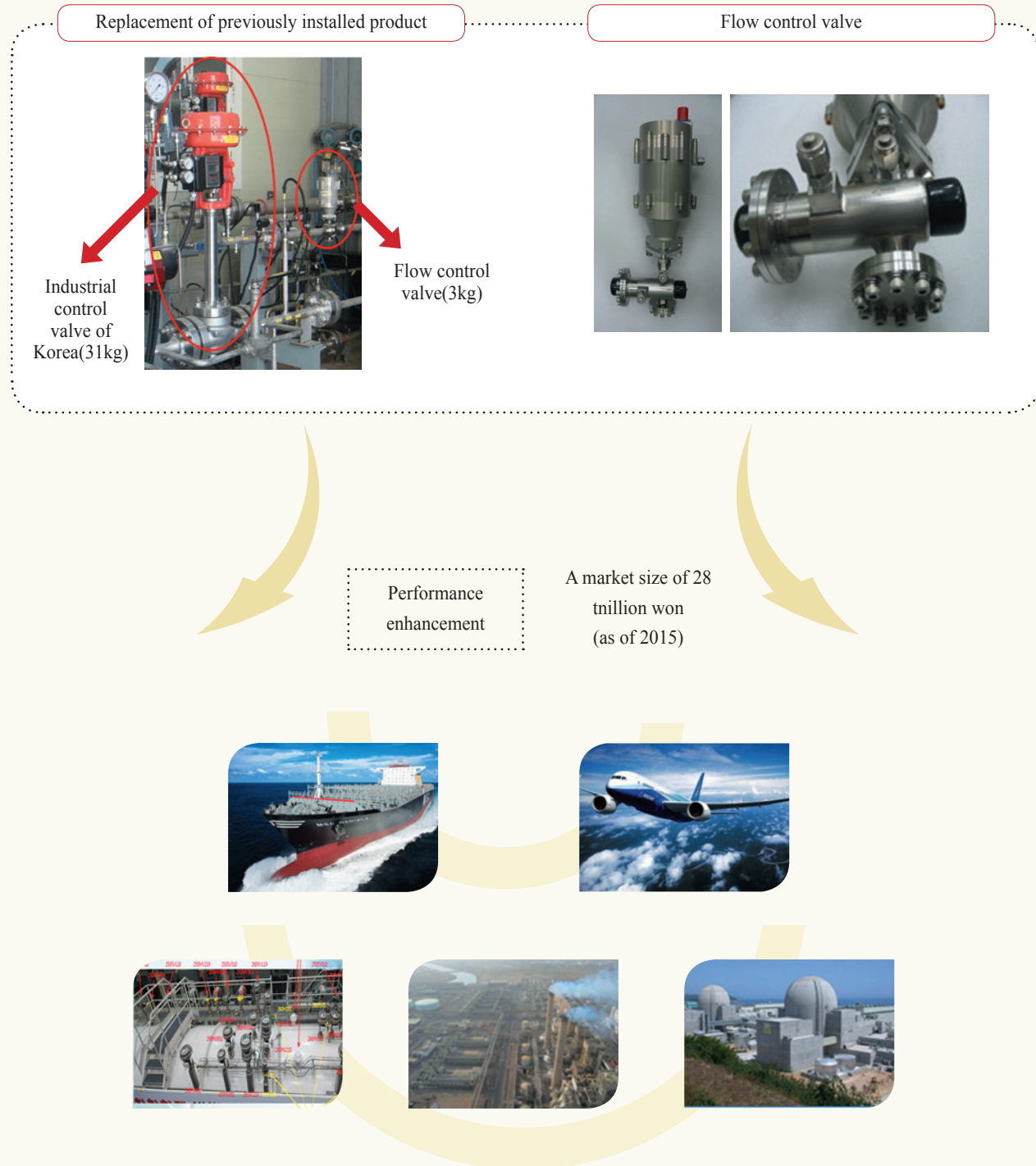
Market and future prospect

- The global market of industrial valves and actuators was 28.1 trillion won in 2015, and is expected to reach 40.6 trillion won in 2021. A market of specific valves will reach about 4 trillion won, which is a tenth of the global market.
- The market of specific valves is monopolized by a few companies in the United States, Europe, and Japan.

Classification		Reference	Estimation					
		2015	2016	2017	2018	2019	2020	2021
Marker (Unit hundred millionwon)	Size	238,448	252,667	267,981	283,294	299,701	317,202	335,796
	Growth rate	5.87%	5.87%	5.87%	5.87%	5.87%	5.87%	5.87%

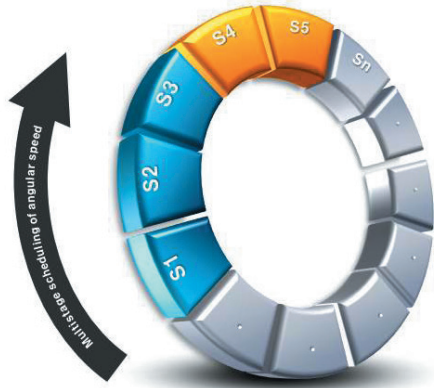
Applications

- Applicable to various fields of industrial valves such as marine shipbuilding, aviation, plants, construction, mechanics, etc.



04

Multistage control method of flow control valve using DC motor



Division of individual angular speed limit areas depending on stages of DC motor

Precise flow rate control

Inventor

Senior Researcher Jung-yeop Lee

Team

Department of launch vehicle propulsion control

Status of right

• US : 9395703

Title

• MULTISTAGE CONTROL METHOD OF FLOW CONTROL VALVE USING DC MOTOR

TLO of the KARI

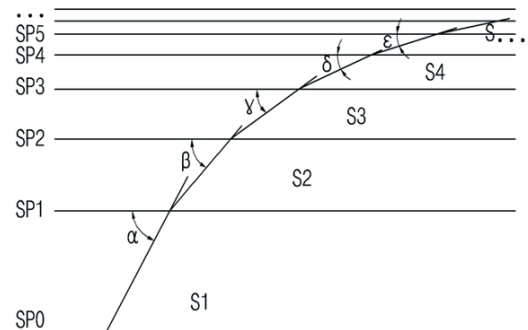
Person-in-charge
Senior Administrator Moon-Hee, Cho
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R&D Performance Diffusion Division

Outline of Technology

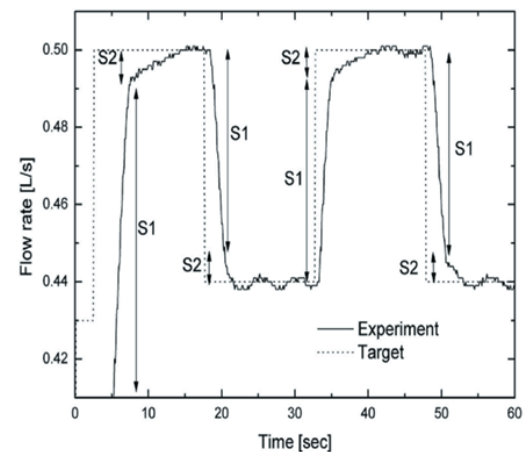
A technique for controlling a flow rate control valve by setting each limit value depending on stages according to angular speed components of a drive voltage that is applied during angular speed control over the DC motor and using a reference value of controlling target

The DC motor is rotated at an intended angular speed so that a control valve to which the DC motor is mounted is controlled, thereby enabling precise control of a flow rate.

Conceptual view of operation principle



Graph of flow rate control performance

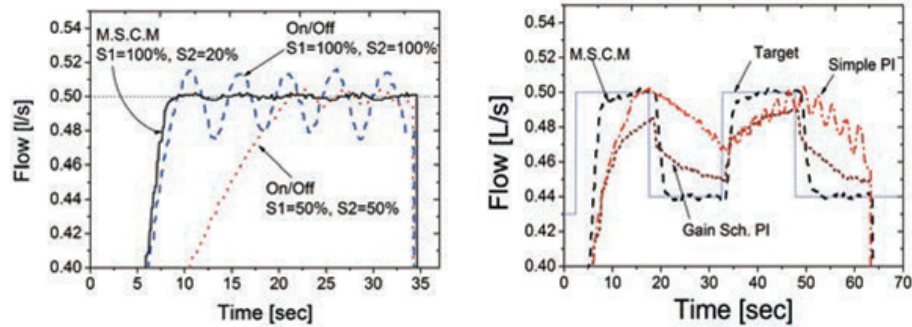


Technical features and advantages

Distinctiveness

- The DC motor can be rotated at a desired angular speed, and therefore precise control of a flow rate is possible.

Comparison of results of flow rate control by multistage control technique



Rapidly reaching a target value without overshoot or undershoot



Properly controlling a flow rate of a device whose thrust must be changed to a low thrust level



Additional tuning for controlling speed not necessary



Setting an appropriate target value based on information about the angular speed of the DC motor and by calculating the reduction ratio of gears



Simple driving mechanism and freely changeable design using electrical adjustment such as adjustment of a voltage



Technical effects

Speed control of DC motor

- Setting suitable limit values depending on stages according to angular speed components of a DC motor depending on a drive voltage that is applied during angular speed control over the DC motor, and executing speed control over the DC motor within a corresponding limit range -> A target value can be rapidly reached without overshoot or undershoot

DC motor rotatable at a desired angular speed

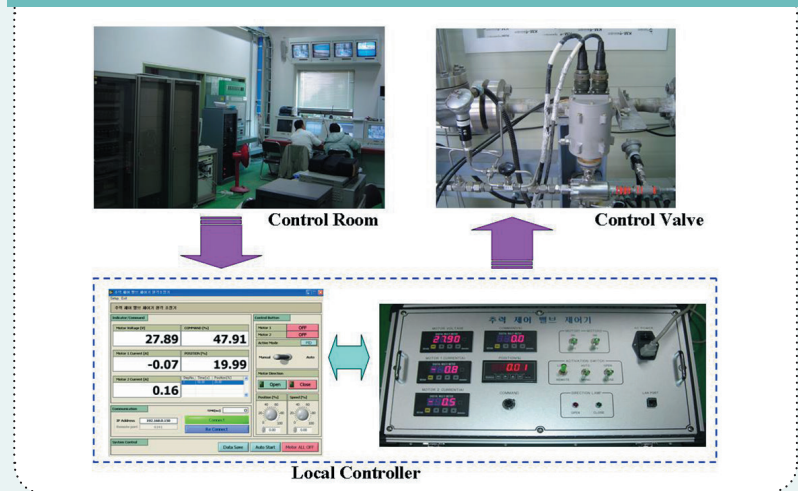
- DC motor rotatable at an intended angular speed, leading to precise flow rate control

Multistage control method of flow control valve using DC motor

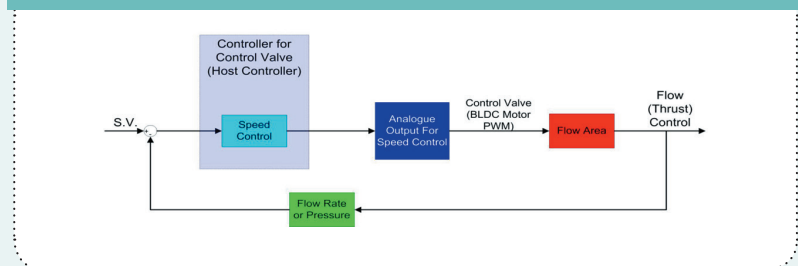
Technical detail

- For a proportional integral derivative (PID) controller which is widely used in the industry, while the result of dynamic characteristic is nonlinear during control, the result of the multistage control method is linear.
- In the multistage control method, there is no tuning procedure of trial and error which is a disadvantage of a PID controller.
- When controlling feedback, precise control is possible without overshoot or undershoot.

Controller for controlling a flow rate control valve



Flow rate control using multistage control method



Dividing angular speed limit areas of a DC motor depending on stages based on a plurality of limit values (SP1, SP2, SP3, SP4, ...) according to a driving voltage that is applied to the DC motor

Controlling the DC motor to rotate at a determined angular speed value depending on a corresponding angular speed instruction (Sn) to the DC motor within one angular speed limit area

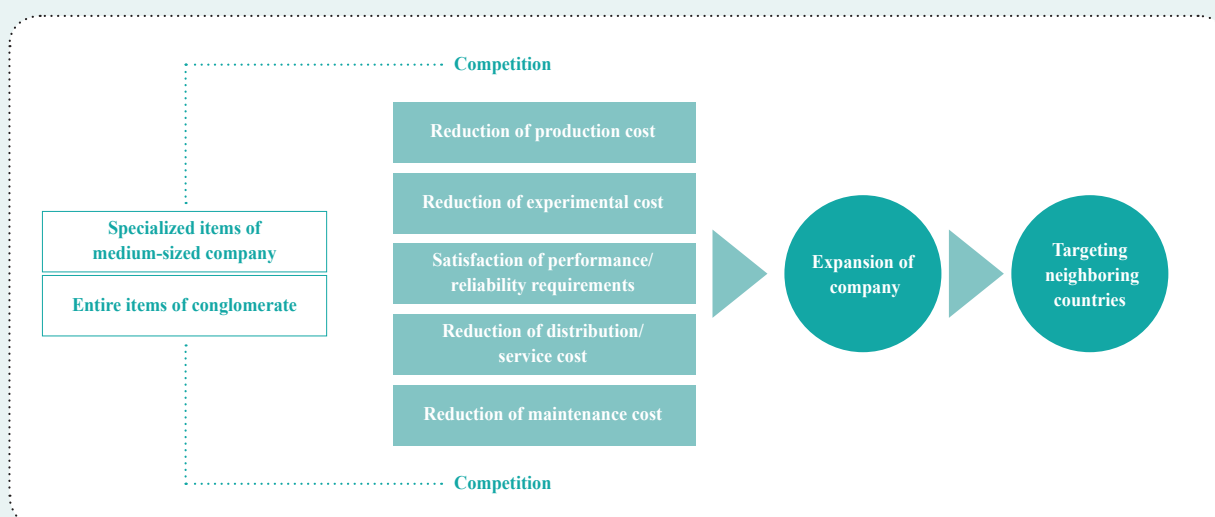
When the angular speed value of the DC motor is outside the range of a limit value (SPn) of the angular speed limit area, the DC motor is controlled to rotate at a determined angular speed value within an angular speed limit area of a next stage.

Market and future prospect

- The global control valve market will likely rise at a CAGR of 6.4% during the period between 2017 and 2025. At this rate, the market which was worth \$6.01 billion in 2016 will likely become worth \$10.46 billion by 2024. In terms of volume, the global control valves market is expected to reach 13,734.6 thousand units in 2025.



- Market characteristics of control valve technique



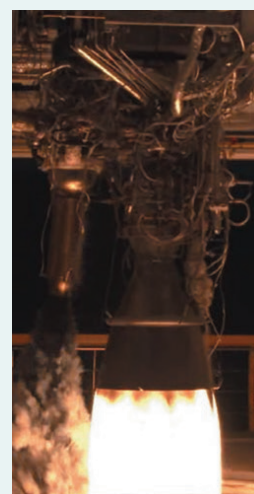
Applications

Fields of precise flow rate control

Diversely applicable to the fields of aerospace, automobiles, watercraft, petrochemistry, development, construction, plant industry, etc. as an essential and core component

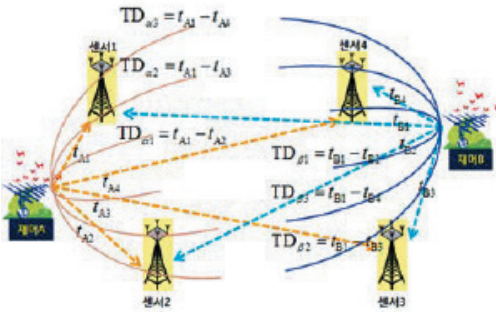
Fields of motor control

Robot, electric vehicle, etc.



05

Localization method of multiple jammers



Inventor

Senior researcher, Deok-won Lim

Team

Satellite Navigation Team

Status of right

- US : 8587478
- US : 14/763465

Title

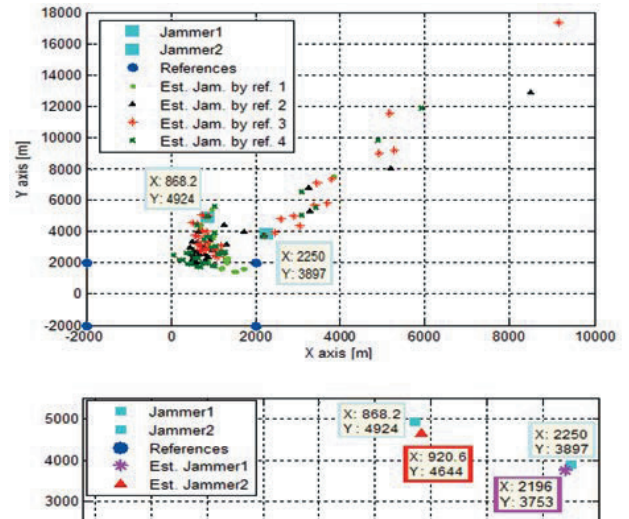
- LOCALIZATION METHOD OF MULTIPLE JAMMERS BASED ON TDOA METHOD
- DISTURBANCE SIGNAL DETECTION APPARATUS AND METHOD

TLO of the KARI

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Outline of Technology

A device and method capable of localizing multiple jammers using a time difference of signal arrival (TDOA)



Technical features and advantages

Distinctiveness

- A procedure of localizing jammers is reduced by only searching a quadrant having an actual jammer among coordinates where location solutions are shown and excluding other quadrants from the searching range.

Technical features and advantages

Technical effects

- Accurate detection of locations of multiple jammers, and secure operation of a system are possible.

Prior art

All the combinations of true TDOA measured values and false TDOA measured values for estimating locations of multiple jammers → Localization is not possible because the estimated values of locations of jammers do not converge at one location, but are spread broadly.

Subject technology

An average value of true estimated values converges near multiple actual jammers

Flowchart of localization algorithm of multiple jammers

Technical detail

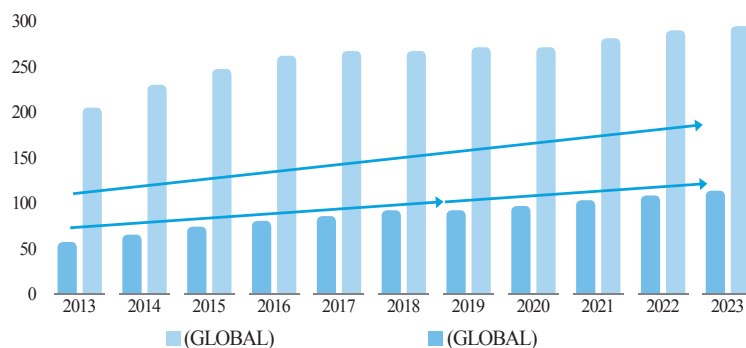
Flowchart of localization algorithm of multiple jammers

1. Multiple sensors for receiving GPS signal are arranged, and TDOA measurements are obtained while a reference sensor is changed in order among the multiple sensors.
2. Location solutions of multiple jammers are estimated using the obtained TDOA measurements.
3. The estimated location solutions of multiple jammers are shown in the coordinates set in reference to each sensor.
4. A searching interval and a searching range with respect to a quadrant having the highest density of the location solutions shown in the coordinates are decided, and a cell including all true location solutions corresponding to the number of sensors is searched while shifting by searching intervals.
5. Each average value of distances between the true location solutions in the searching cells having the true location solutions are calculated to define the number of jammers, and location solutions of the jammers are calculated.

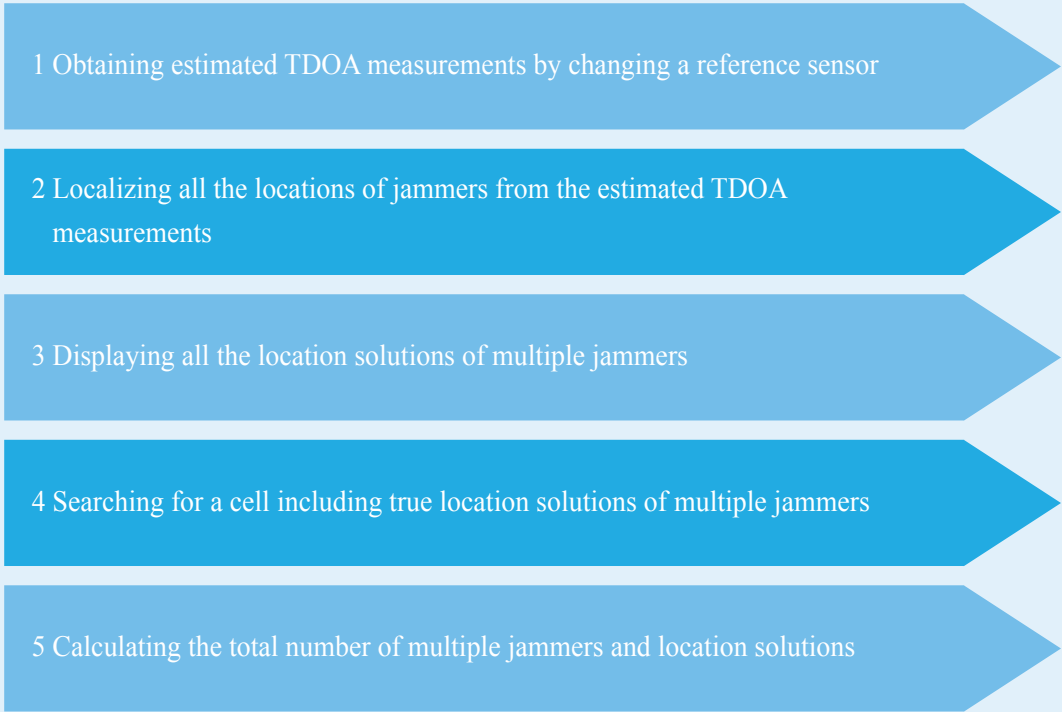
Localization method of multiple jammers

Market and future prospects

- A satellite navigation system is an infrastructure used in transportation, time, national defense, etc. the related market is continuously increasing, and independent satellite navigation systems have been established by the United States and Russia as well, as by Europe, China, India, and Japan.
- The GNSS market is expected to increase 8.3% every year until 2019, and 4.6% until 2023. In 2023, the net sales of GNSS chipset are anticipated to break through 100 billion euros and the sales including smart devices will reach about 300 billion euros.



Source : European GNSS Agency, “GNSS Market Report”, Issue 4, Mar. 2015.



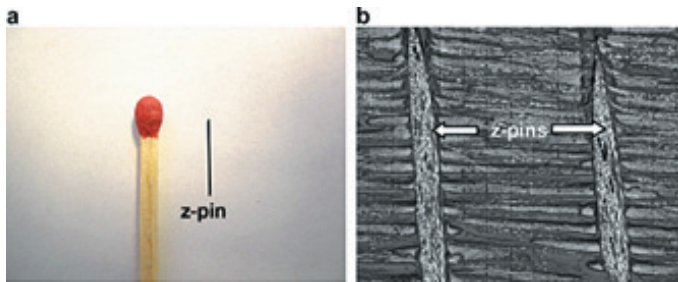
Applications

- Applicable to various fields of mobile communication base stations, national defense equipment, etc.
- A technique of localizing multiple jammers can be utilized in diverse fields using GPS signals such as mobile communication, measurement, emergency rescue, agriculture, traffic safety including aviation/maritime/railroad/highway, infrastructure, and national defense related equipment including military planes.

Demand for technology	Application parts
Defense industry company	Mobile communication field
	Traffic safety field (aviation/maritime/railways, etc.)
Network equipment manufacturer, etc.	National defense field including military planes, tanks, warships, etc.

06

Composite material Z-pinning



Inventor

Principal Researcher Choi, Ik-Hyeon

Team

Material Structure Research Team

Status of right

- US : 9434110
- US /JP/CN : 8205654 / 2010-522655 / 101668633

Title

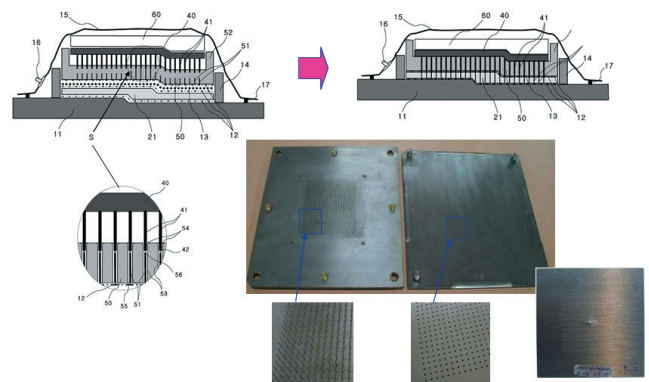
- METHOD OF MANUFACTURING UNEVENNESS SHAPED Z-PIN AND Z-PIN MANUFACTURED USING THE SAME AND COMPOSITE STRUCTURE INCLUDING THE Z-PIN
- COMPOSITE LAMINATED STRUCTURE REINFORCED BY INSERTING PINS, A METHOD AND A APPARATUS FOR MAKING THE SAME AND A METHOD FOR MAKING THE APPARATUS

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Outline of Technology

Technology of inserting pins in a thickness direction of a composite material laminated structure to prevent interlayer separation or strengthening a connection part by driving pins into a joint part when a plurality of composite material members are formed integrally.



Technical features and advantages

Distinctiveness

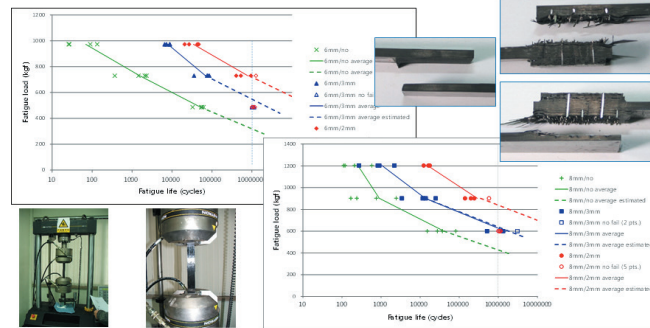
- It does not cause any waste of materials, and a pre- and post-process of removing compressed foam before and after molding, and projecting pins is not necessary.

Technical features and advantages

Technical effects

- Since little influence is given to a process of manufacturing current composite materials, immediately applicable in industrial fields.
- Upon comparison with drilling work and use of metal fasteners, insertion of an automated Z-pin can achieve a 70% reduction on manufacturing costs.

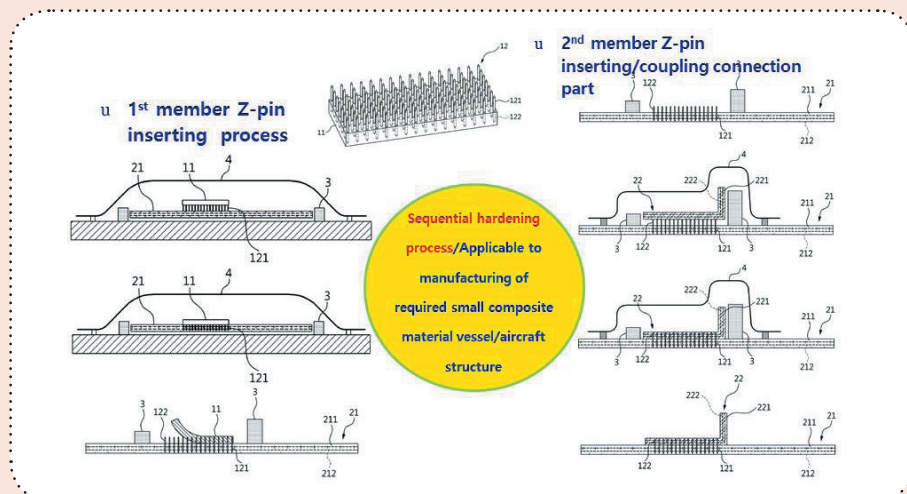
Tension Fatigue Test Results for Joint Part



Technical detail

This technology is in a state in which a sample product has been manufactured, and has been applied to manufacturing of small vessels in Korea.

- Static tensile test results for unevenness shaped pin single-lap shear joint
 - Pin having a diameter of 0.5 mm, made of stainless steel, and having a pin density of 2.2% (an interval of 3 mm) and 4.9% (an interval of 2 mm).
 - According to the joint part having a thickness of 6 to 8 mm, static strength is increased by 54 to 69%.
- Tensile test results for unevenness shaped pin single-lap shear joint part
 - Pin having a diameter of 0.5 mm, made of stainless steel, and having a pin density of 2.2% (an interval of 3 mm) and 4.9% (an interval of 2 mm).
 - Fatigue strength is improved by about 100%, and fatigue life is improved by 100 times.



Composite material Z-pinning

Market and future prospects

- AZTEX applied this technology to connect the engine bay door to the air inlet duct of a rear fuselage for F/A-18 E/F Super Hornet instead of a titanium fastener, so that the cost was reduced by \$83,000 per aircraft and the weight was reduced by 17 kg per aircraft.
- Applied to the cargo door of C17 Globemaster and Boeing-Sikorsky RAH-66 Comanche. X-CorTM that has the sandwich structure to which the Z-pinning technology is applied is applied to the tail cone in UH60M Black Hawk, so that a weight is reduced by 21 kg per helicopter.
- Examples of use for roll over bar of Formula 1 Racing Car



Applications

- Carbon fiber/glass fiber composite materials are broadly used for light weight products that require higher specific stiffness/specific strength than metal such as aerospace/wind turbine blade/boat/yacht/high speed train/automobile/sporting goods.
- For the purpose of use of metal pins such as stainless steel in Korea and broad use in various fields of manufacturing composite materials, research into Z-pinning patch/elastic pad concept has been conducted to be applied to the various fields of manufacturing composite materials.



07

Power supply system having an emergency power supply cutoff function

Power Supply Route of Launch Support Test Set

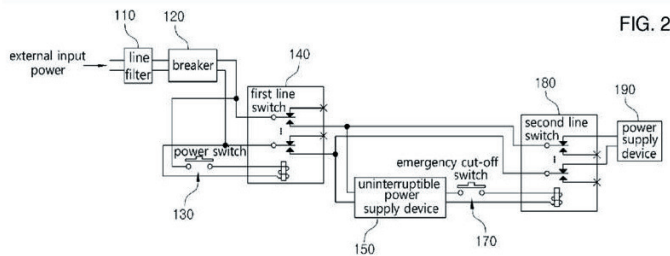


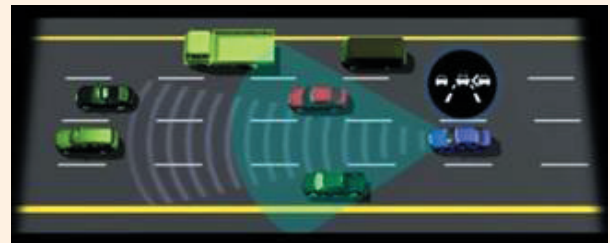
FIG. 2

Outline of Technology

It is directed to a satellite power supply system capable of cutting off the power supply using the uninterruptible power supply device even when the remote controller is out of order in the emergency.

■ Problems with conventional technology

- When a remote controller inside the LSTS is out of order, it is impossible to cut off the power supply of the power supply device.
- When an emergency occurs during the launch process, it is necessary to cut off the satellite power supply or to abort the battery charging process.
- When the power is still supplied to the satellite and the satellite battery in the emergency, it can cause a serious damage.
- ▶ If the remote controller is broken down, a machine with power supply working at far area could not be switch off and still would be working on.



Inventor

Principal Researcher Kwon, Jae-Wook

Team

Spacecraft Control System Department

Status of right

• US : 9537349

Title

• POWER SUPPLY SYSTEM HAVING AN EMERGENCY POWER SUPPLY CUTOFF FUNCTION

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R&D Performance Diffusion Division

Technical features and advantages

Distinctiveness

- Cutting off the power supply of the power supply device using the uninterruptible power supply device even when the remote controller is out of order in the emergency.

Technical effects

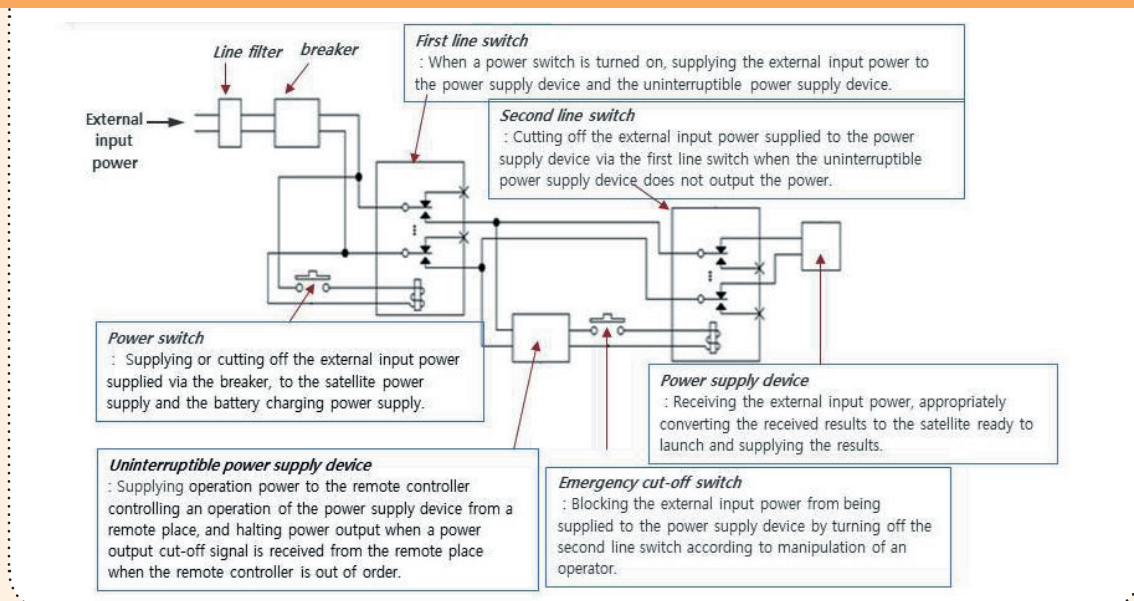
- Capable of autonomously halting the power output when a power output cut-off signal is received from the remote place.

Economic effects

- Capable of reducing satellite maintenance fees by preventing accidents that may be caused when power supply is maintained in the emergency.
 - Manufacturing a satellite costs about 200 billion KRW, and launching the same costs about 5 million to 40 million KRW or more.
- In addition to stable power supply, stable cut-off can be implemented.
 - Applicable to various industries that make much of power supply and cut-off such as nuclear power plants and equipment for controlling hazardous substances.

Technical detail

Constitution of Power Supply Having Emergency Power Supply Cutoff Function

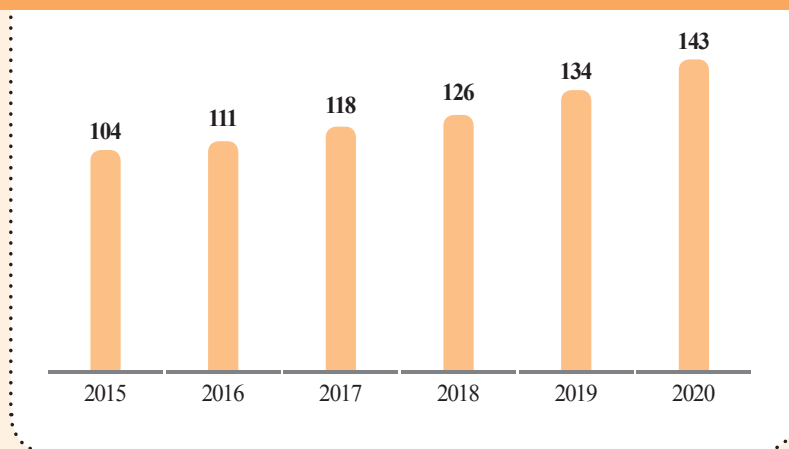


Power supply system having an emergency power supply cutoff function

Market and future prospects

- As the high-tech manufacturing markets such as data centers and semiconductor in addition to satellites expand, there is a growing interest of global companies in the UPS market.
- The global UPS market size grew to about USD 11.1 billion USD as of 2016, and is expected to grow to 14.3 billion USD by 2020. Also, it is expected to grow at an average annual growth rate (CAGR) of 9.16% from 2017 to 2021.

Global UPS Market Size



Applications

Demand for Technique	Applications
Development of power supply device/manufacturer	Field of launch vehicle power supply device
	Field of equipment for controlling hazardous substances such as nuclear power plant, etc.
	Data center
	Field of semiconductor



08

Apparatus and Method for Playing Video in Real Time

Ground Control System



Inventor

Chief Researcher Kim, Jong-Uk

Team

Flight Test Team

Status of right

• US : 9547992

Title

• APPARATUS AND METHOD FOR PLAYING VIDEO BASED ON REAL-TIME DATA

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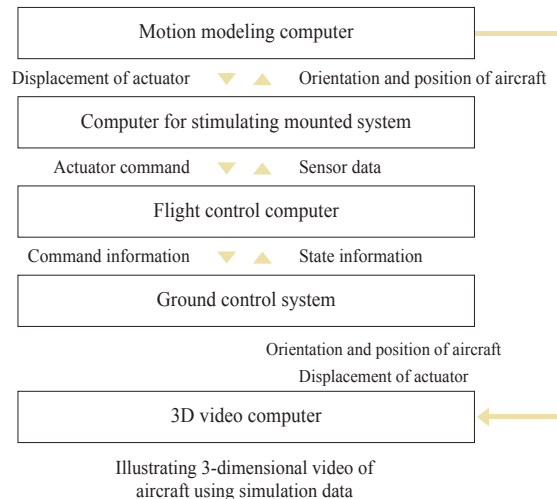
Outline of Technology

Technology related to apparatus for playing 3-dimensional video of aircraft using aircraft information transmitted via communication link in flight tests of unmanned aerial vehicle.

■ Problems of conventional art

- A conventional video playing apparatus is being widely used for post-processing of flight data or in simulation systems, and simulation environment includes a ground control system, a flight control computer, a computer to simulate a mounted system, a motion modeling computer, a 3D video computer and a screen.
- While these conventional video playing apparatuses transmit an orientation and position of the aircraft, and actuator information to the 3D video computer to display configuration and position information of aircraft, the data used for displaying is limited to simulation data, and is mainly used during pilot training in virtual environment, and thus a range of the use is limited.

Conventional simulation environment



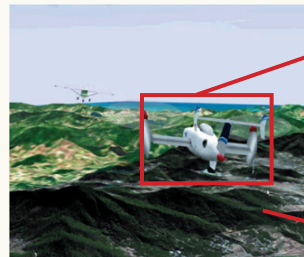
Technical features and advantages

Distinctiveness

- Flight data is received in real time to display a 3-dimensional video of information of an aircraft such as a position, speed and attitude, so that operational stability using geographic information and 3D aircraft information, and a situation recognition rate can be increased to be applicable to precision relative navigation using 3D information extended from 2D information.

Technical effects

- The attitude and position of the aircraft can be visually identified using real-time data transmitted through a communication system during actual flight.



Aircraft information

Receiving orientation and position information of aircraft from RTC of ground control system to display received results in real time.

Geographic information

Receiving position information of aircraft to display received results in real time

Technical detail

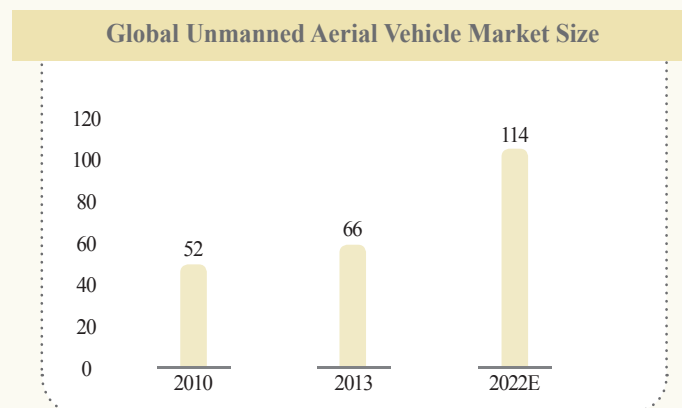
The "smart unmanned device" development project has been promoted, and hardware and software necessary for ground control that controls a smart unmanned device have been developed since 2002. There has been an example of technical transfer of a ground control system for an unmanned aerial vehicle based on the obtained technology.

- Conventionally, an internal pilot can know an attitude and position of the aircraft only as numbered information, however, the pilot can visually identify the attitude and the position of the aircraft using the apparatus for playing a video based on real-time data, and thus it is helpful for the pilot when operating the aircraft.
- When the apparatus for playing a video based on real-time data is used in flight tests, flight information analysts can identify the attitude and the position of the aircraft at a glance, and thus, can determine a reaction of the aircraft with respect to an operational command at a glance and in a very short time.

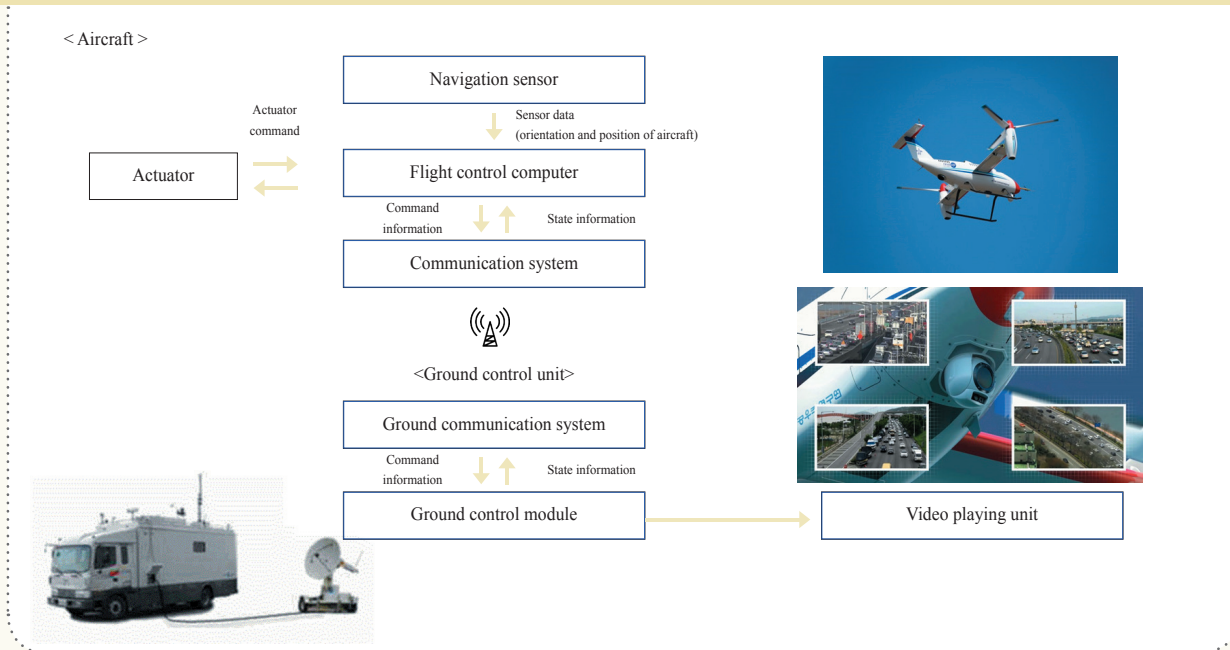
Apparatus and Method for Playing Video in Real Time

Market and future prospects

- The ground control system is an essential element for operating an unmanned aerial vehicle, and about 5 and 6% of the expenditures for development of the unmanned aerial vehicle out of the development of the smart unmanned aerial vehicle is injected into the ground control system.
- The unmanned aerial vehicle market is expected to grow at an average annual rate of 8% by 2020 to be developed to the market size reaching 11.4 billion USD. European countries, and Asian countries such as China and Singapore have actively participated in development of the unmanned aerial vehicle, and in particular, China has proceeded with its own development of the high altitude long endurance unmanned aerial vehicle and unmanned combat air vehicle.
- The unmanned aerial vehicle market is expected to grow at an average annual rate of 8% by 2020 to be developed to the market size reaching 11.4 billion USD. European countries, and Asian countries such as China and Singapore have actively participated in development of the unmanned aerial vehicle, and in particular, China has proceeded with its own development of the high altitude long endurance unmanned aerial vehicle and unmanned combat air vehicle.



Apparatus for playing video in real time



Applications

- Companies that manufacture system/aerial vehicle design, aerial vehicle manufacturing, ground control system, ATC, supervisory equipment, radar, flight support system are the main market.
- As the intelligence and autonomy of the unmanned aerial vehicle are getting higher, one pilot can operate a plurality of unmanned aerial vehicles. In addition, for this purpose, research into development of Man-Machine Interface has been actively progressing.

< One System >



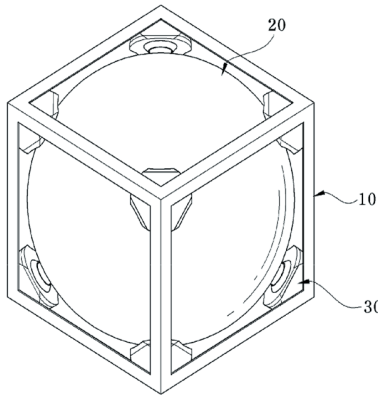
< Universal Control System >



09

Three Dimensional Rigid Ball driving System

Rigid ball driving system for controlling attitude of satellite



Inventor

Senior Researcher Kim, Dae-Kwan

Team

Satellite Control Team

Status of right

- US : 9751644
- JP : 6023326

Title

- THREE-DIMENSIONAL RIGID BALL DRIVING SYSTEM
- THREE-DIMENSIONAL RIGID BALL DRIVING SYSTEM

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Outline of Technology

A three dimensional rigid ball actuation system is a new concept of next generation actuator that can be replaced with the conventional general actuator used for attitude control and momentum storage, and is capable of accurately controlling the orientation in a three-axis direction by rotating a spherical fly wheel in a desired direction.

■ Problems of conventional art

- A conventional actuator operates in a manner of generating a single axis control torque, and requires at least three actuators to control an attitude of a satellite in a three-axis (X, Y and Z) direction.
- Since a plurality of actuators are used for the purpose of three-axis attitude control, there are problems with an increase in costs, volume and weight, and ensuring technical/economic competitiveness of a satellite shall be taken into account.

Technical features and advantages

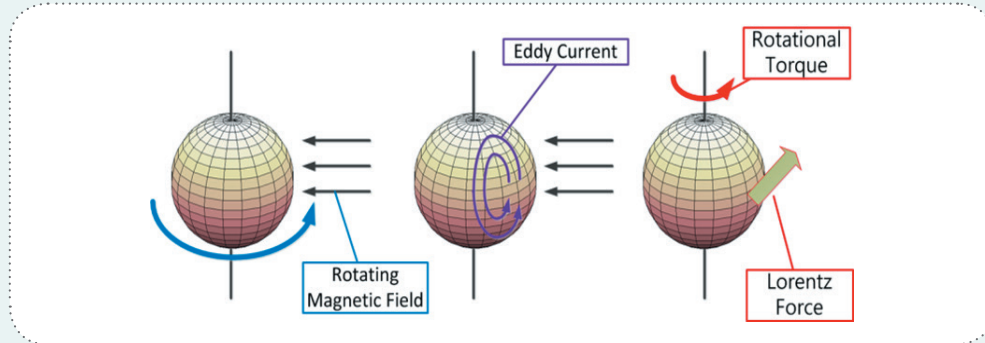
Distinctiveness

- A single actuator enables three-axis control of a satellite, and thus lightweight, small in size and a reduction in cost can be implemented.

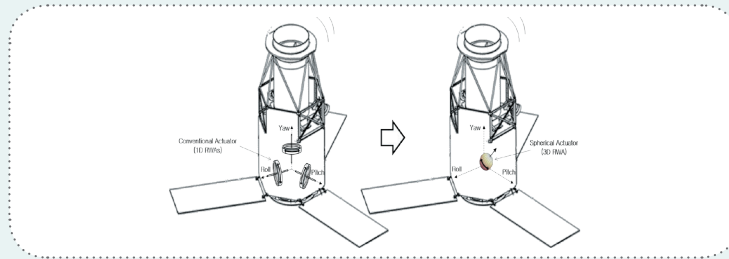
Technical features and advantages

Technical effects

- A torque generated by Lorentz's force between a rotating magnetic field and an induced current is used for a spherical (3D) fly wheel.

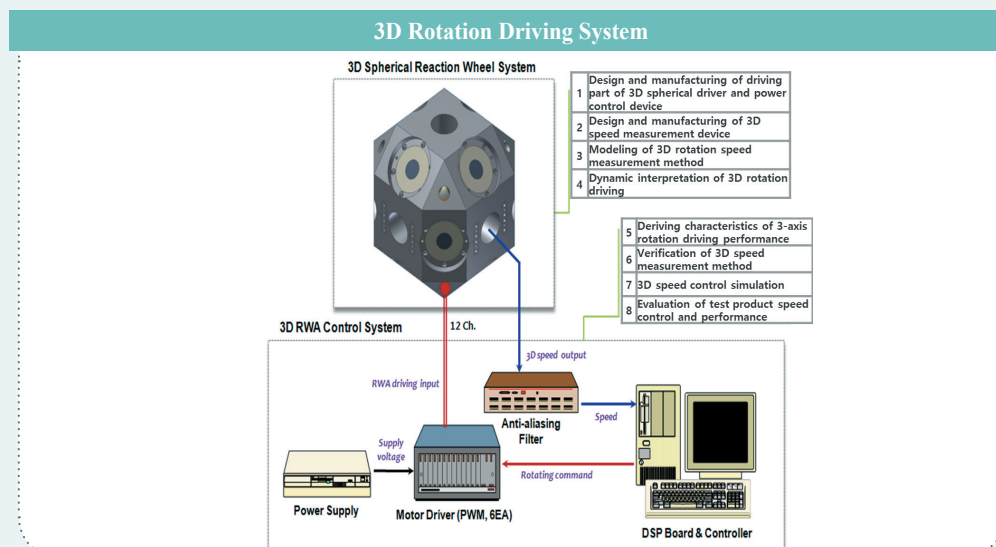


- The spherical fly wheel can rotate in a three dimensional direction, and a torque in a three-axis direction is generated.



Technical detail

- Analysis of driving characteristics through design and manufacturing of a one-dimensional spherical actuator model and performance test

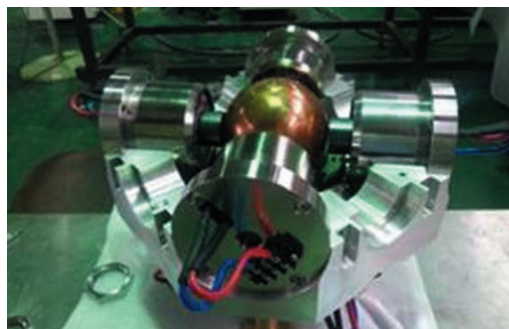
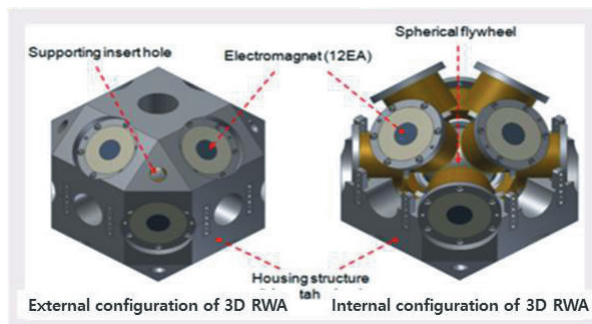


Three Dimensional Rigid Ball driving System

Technical detail

- Design of 3D spherical actuator and interpretation of speed control (S/W), and development of 3D spherical actuator test products (H/W)

Internal/External Configuration



Application example

Segway (conceptual diagram)



Market and future prospect

For the next 10 years from 2013 to 2022, the U.S., Russia, Europe (France and Italy), Japan, China, India, and Israel are capable of operating low earth orbit and geostationary orbit launch vehicle, and launch vehicles that have been operated and under development by the countries are 46. The launch vehicle market size is estimated to produce 739 vehicles, and to reach a sales of fifty-eight billion, four hundred million, nine hundred twenty thousand USD for the next 10 years.

Identification	2003~2012	2013~2022	Increase/decrease
Number of launching satellite	809 satellites	1,151 satellites	+42%
Total weight of launched satellites	1,824 tons	2,397 tons	+31%
Satellite market	142 billion UDS	1,81 billion UDS	+27%
Launching service market	45 billion USD	55 billion UDS	+23%
Sum of satellite + launching service markets	187 billion USD	2,36 billion UDS	+26%

Estimate of demand for launching a satellite for the next 10 years

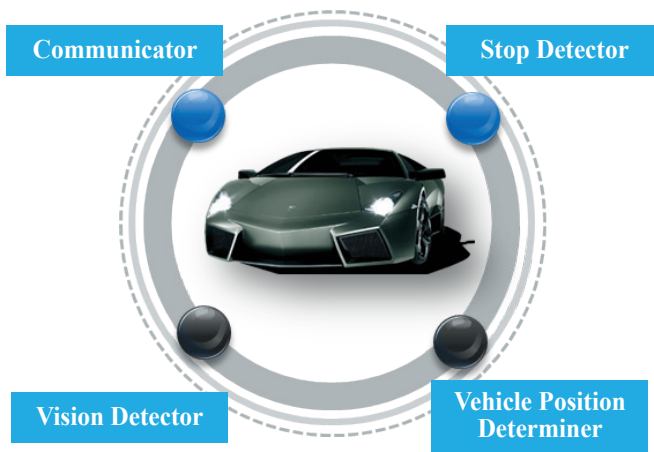
Applications

- CNG is employed to substitute the conventional actuator for controlling an attitude of a satellite.
- This technology has been drawing an increasing amount of attention as the next generation attitude control actuator covering the field of space and underwater robotics, vessels, flight, precision motors as well as small satellites.



10

Method of determining road lane



Inventor

Senior Researcher Woo Yong KANG

Team

Satellite Navigation Team

Status of right

• US : 9562777

Title

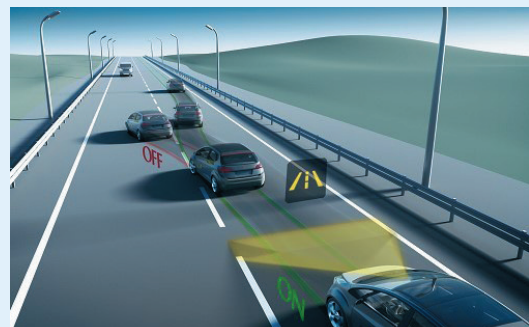
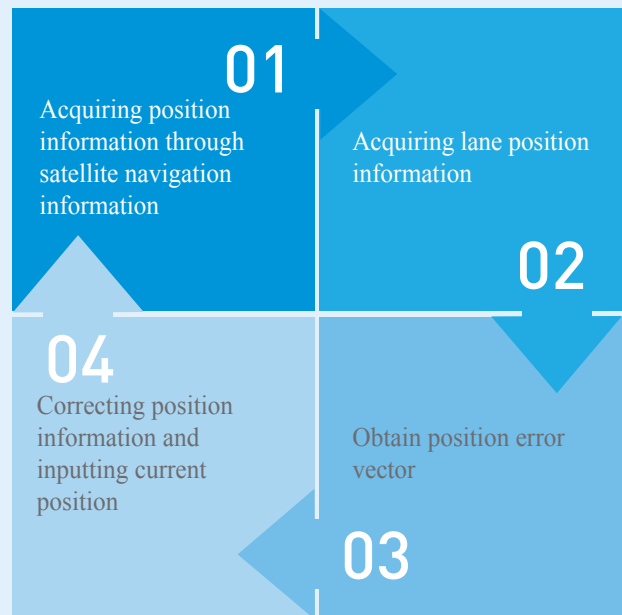
• AUTONOMOUS VEHICLE ASSISTANCE DEVICE

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Outline of Technology

This technology uses carrier-based differential GPS information having accuracy of recognizing a road lane and a precise electronic map in which road lanes can be identified. Also, a steering model of a vehicle is used to further exactly determine a road lane on which a current vehicle is being driven.



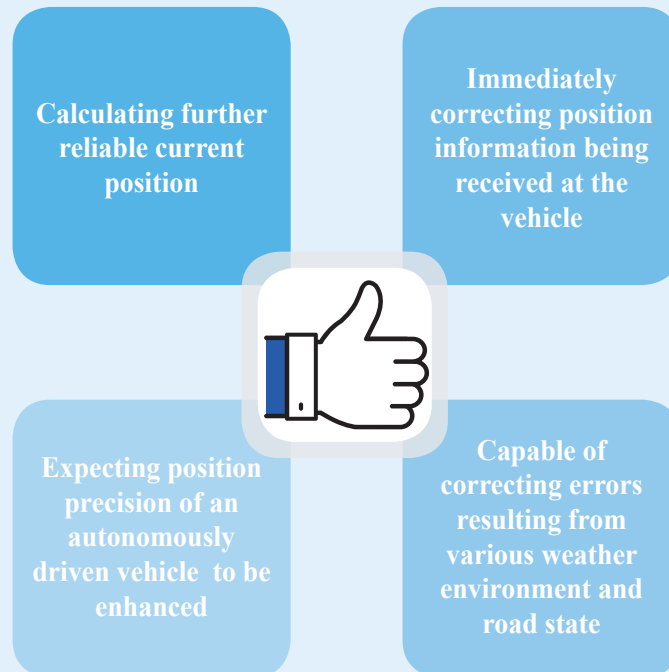
Technical features and advantages

Distinctiveness

- Vector error information in a heading direction of a vehicle on a lane and that in a direction perpendicular to the heading direction of the vehicle are received to be used for correction of a position.
- Position information of the vehicle being currently driven is analyzed to determine a current position, and position error information is reflected.

Technical effects

- Due to an external environment such as a satellite state or weather, an error may be present in vehicle position information based on the satellite navigation information. It is possible to further precisely verify a current position of the vehicle by correcting position information being received at the vehicle based on position error information measured at the fixed body.



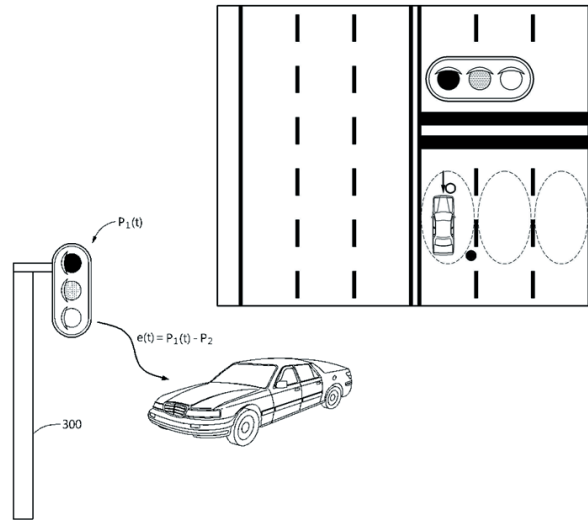
Technical detail

- This technology has great significance in view that in the field to which this technology pertains, limitations of vehicle position recognition using a general GPS satellite navigation code are overcome, and further enhanced position precision can be accomplished.

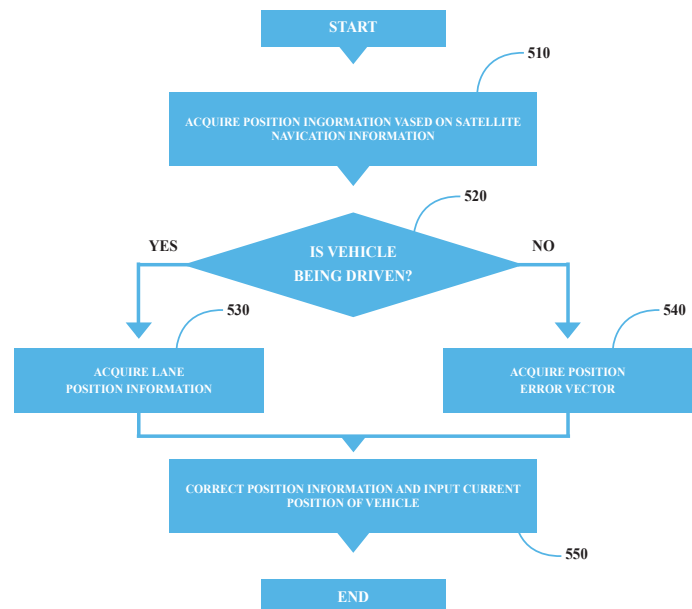
Method of determining road lane

Technical detail

Process of generating/transmitting position error vector and interaction



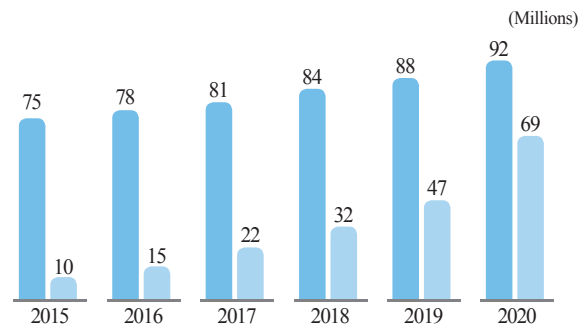
Flowchart illustrating flow of autonomous vehicle assistance method



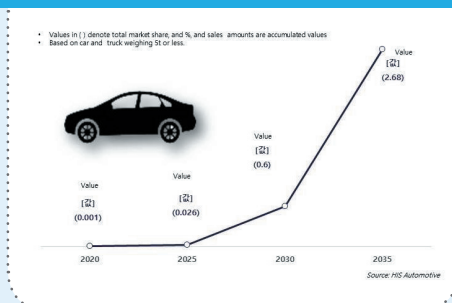
Market and future prospect

- From a long-term point of view, the connected car market is in an intermediate step between development of driverless driving and current vehicle industries. Also, the connected car market that exhibited 7 millions of cars in size globally as of 2014 is expected to reach 69 million cars in 2020 and to rapidly grow.

Average annual growth rate of 45%

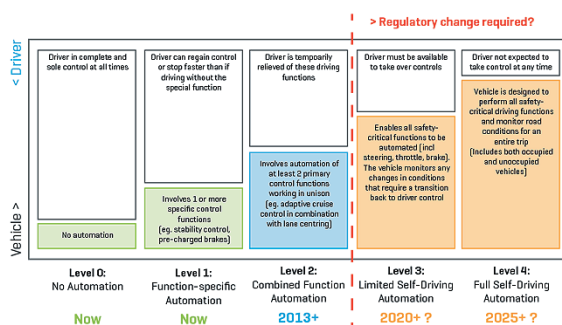


Estimated trends in sales of global autonomous vehicle



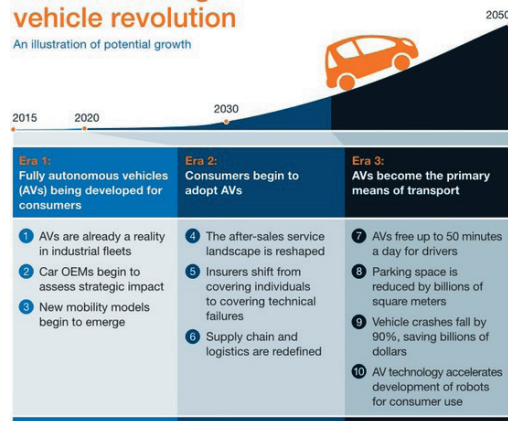
- Most of the connected cars in North America are purchased in the U.S., and about 20 million cars (95%) out of new 21 million cars to be produced in 2020 are expected to be mounted with the automatic Internet connection option.

Levels of driving automation (NHTSA)



The self-driving vehicle revolution

An illustration of potential growth



McKinsey&Company

Applications

Vehicle-to-vehicle (V2V) : Multi-home communication technology

- Warning such as emergency brake, front collision warning, supporting intersection safety, and blind spot and lane change warning
- Warning for passing, and warning for out of control

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