1. **Title:** Autonomous Ocean Debris Cleanup System
2. **Published Patents and Patent Applications:**
3. **US 20210214055 A1: "Ocean Cleanup Autonomous System (OCAS)"**
    - This patent describes an automated system for ocean cleanup that includes a central autonomous vehicle for debris collection, sorting mechanisms, and storage containers. It emphasizes cost reduction and efficiency through autonomous operation and real-time sorting of collected debris at ocean patches.
    - **Distinguishing Aspect**: Our system integrates advanced AI algorithms and multiple detection sensors for real-time decision-making, which are not emphasized in the OCAS system.
4. **2. US 20200091347 A1: "Autonomous Marine Debris Collection System"**
    - This patent outlines a system using autonomous vessels for debris collection. It lacks integration of advanced AI algorithms for real-time decision-making and multiple detection sensors found in our system.
    - **Distinguishing Aspect**: Our system's AI and multi-sensor approach for detecting and classifying debris make it more advanced and comprehensive.
5. **Non-Patent Literature:**
6. **The Ocean Cleanup Project**
    - Boyan Slat's Ocean Cleanup Project uses a passive system of floating barriers to funnel debris for collection. This project focuses on using natural ocean currents to collect plastic waste.

- **Distinguishing Aspect**: Our system's active AI-based detection and robotic capture mechanisms are more advanced than the passive approach used by The Ocean Cleanup Project.

7. **WasteShark by RanMarine**
    - WasteShark is an autonomous drone system designed for urban waterways. It uses AI for navigation and collects debris using a storage bin.
    - **Distinguishing Aspect**: WasteShark is limited to smaller urban water environments and lacks the comprehensive sensor and robotic capabilities of our system, which is designed for broader oceanic environments.
8. **Public Use or Sale:**
9. **The Ocean Cleanup Interceptor**
    - An autonomous system for river plastic collection preventing waste from reaching the ocean. While effective for river cleanup, it does not address the broader oceanic environment nor does it employ advanced AI and robotic mechanisms for deep-water operations.
    - **Distinguishing Aspect**: Our system is designed for oceanic environments and integrates advanced AI and robotic mechanisms for comprehensive debris detection and collection.
10. **Prior Public Disclosure:**
11. **TED Talk by Boyan Slat (2017)**
    - Discusses the concepts behind large-scale ocean cleanup but does not detail autonomous operations or advanced AI integration.

- **Distinguishing Aspect**: Our system's detailed integration of AI and robotics for autonomous operations sets it apart from the general concepts discussed in the TED Talk.

12. Distinguishing Aspects of the New Patent

- **Unique Combination of Technologies**: Our system integrates advanced AI algorithms, multiple detection sensors, and robotic mechanisms in a single solution. This combination distinguishes it from existing technologies that generally employ one or two of these components but not all three in combination.
- **Enhanced Autonomous Operation**: Unlike passive systems, our system operates autonomously over extended periods using AI for real-time decision-making and debris classification with minimal human intervention.
- **Comprehensive Detection and Capture Capabilities**: Our system uses a combination of sonar, lidar, optical cameras, and IR sensors for detecting and capturing debris of various sizes and types, both on the surface and underwater. This multi-sensor approach ensures a more comprehensive detection capability compared to existing systems.
- **Efficient Energy Management**: Our system employs solar panels and energy storage to ensure continuous operation and sustainability. This energy management approach enhances the system's efficiency and effectiveness, making it more suitable for extended missions in remote areas.
- **Environmental Compliance and Safety**: Our system is designed to comply with international marine regulations and environmental guidelines, ensuring safe and

responsible debris removal operations. This compliance is a crucial differentiator from other systems, emphasizing our commitment to environmental protection.

13. **Technical Field**
14. This invention relates to marine environmental technologies, specifically to an autonomous system designed for the detection, capture, and removal of ocean debris.
15. **Background of the Invention**
16. Ocean debris, including plastic waste, abandoned fishing gear, and other pollutants, poses a significant threat to marine life, ecosystems, and human health. Current methods for cleaning up ocean debris are labor-intensive, costly, and often ineffective over large areas. There is a need for an autonomous, efficient, and cost-effective system to address the growing problem of ocean debris.
17. **Summary of the Invention**
18. The present invention is an autonomous ocean debris cleanup system designed to detect, capture, and remove ocean debris. The system employs advanced sensors, AI for debris detection and tracking, and robotic mechanisms for debris capture and disposal. This innovation aims to enhance the health of marine environments by effectively managing ocean debris.
19. **Brief Description of the Drawings**
20. **Fig. 1 Overall Architecture of the Autonomous Ocean Debris Cleanup System**
21. This figure illustrates the overall architecture of the autonomous ocean debris cleanup system, highlighting the central control unit, detection sensors, AI algorithms, robotic capture mechanisms, debris sorting and disposal system, energy management system, and autonomous navigation system.

22. **Explanation of Each Element and Connections**:

- **Central Control Unit (CCU) (101)**:
  - The CCU is the main processing hub of the system, coordinating all internal functions and ensuring smooth operation. It integrates various subsystems, including sensors, AI algorithms, and robotic mechanisms.
  - **Solid Line with Bi-directional Arrow**: Indicates a direct two-way data exchange with the Energy Management System, signifying continuous feedback and real-time adaptability.
- **Detection Sensors (102)**:
  - The detection sensors include sonar, lidar, optical cameras, and infrared sensors for comprehensive debris detection and tracking.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Detection Sensors to the CCU, showing the transfer of detected debris data for processing.
- **AI Algorithms (103)**:
  - The AI algorithms analyze sensor data to identify and classify ocean debris based on size, composition, and location, enabling real-time decision-making.
  - **Solid Line with Bi-directional Arrow**: Indicates a direct two-way data exchange with the CCU, showing continuous feedback and adaptability based on real-time data.
- **Robotic Capture Mechanisms (104)**:

  - The robotic capture mechanisms include robotic arms, nets, and conveyor belts for capturing and collecting debris.
  - **Solid Line with Arrow**: Indicates a direct data flow from the CCU to the Robotic Capture Mechanisms, showing the transfer of commands for debris capture.
- **Debris Sorting and Disposal System (105)**:
  - The system sorts captured debris on board, separating recyclable materials from non-recyclable waste for efficient disposal.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Robotic Capture Mechanisms to the Debris Sorting and Disposal System, showing the transfer of captured debris for sorting and disposal.
- **Energy Management System (106)**:
  - The energy management system includes solar panels and energy storage to power the operations continuously, ensuring sustainability.
  - **Solid Line with Bi-directional Arrow**: Indicates a direct two-way data exchange with the CCU, showing continuous feedback and real-time adaptability in energy management.
- **Autonomous Navigation System (107)**:
  - The autonomous navigation system ensures the vessel can maneuver safely in various marine environments, avoiding obstacles and marine life.
  - **Solid Line with Arrow**: Indicates a direct data flow from the CCU to the Autonomous Navigation System, showing the transfer of navigation commands.

23. **Fig. 2 Detection Sensors**

24. This figure illustrates the detection sensors integrated into the autonomous ocean debris cleanup system, showing the various types of sensors used for comprehensive debris detection and tracking.

25. **Explanation of Each Element and Connections**:

- **Detection Sensors (201)**:
  - The Detection Sensors block represents the integrated system of sensors used for detecting and tracking ocean debris. It collects data from various types of sensors to provide comprehensive detection capabilities.
- **Sonar Sensor (202)**:
  - The Sonar Sensor uses sound waves to detect underwater debris, providing information about the size, shape, and location of objects.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Sonar Sensor to the Detection Sensors block, showing the transfer of sonar data for processing.
- **Lidar Sensor (203)**:
  - The Lidar Sensor uses laser light to measure distances and detect debris on the surface of the water. It provides high-resolution data for identifying and tracking debris.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Lidar Sensor to the Detection Sensors block, showing the transfer of lidar data for processing.
- **Optical Camera (204)**:

    - The Optical Camera captures visual images of debris on the water's surface, aiding in the identification and classification of different types of debris.
    - **Solid Line with Arrow**: Indicates a direct data flow from the Optical Camera to the Detection Sensors block, showing the transfer of visual data for processing.
- **Infrared (IR) Sensor (205)**:
    - The Infrared (IR) Sensor detects heat signatures from debris, allowing for the identification of objects based on their thermal properties.
    - **Solid Line with Arrow**: Indicates a direct data flow from the Infrared (IR) Sensor to the Detection Sensors block, showing the transfer of infrared data for processing.

26. **Fig. 3 AI Algorithms**
27. This figure illustrates the AI algorithms integrated into the autonomous ocean debris cleanup system, showing the various modules used for debris detection, tracking, classification, and continuous learning through machine learning models.
28. **Explanation of Each Element and Connections**:

- **AI Algorithms (301)**:
    - The AI Algorithms block represents the core artificial intelligence system that processes sensor data to detect, track, and classify ocean debris. It integrates various modules to perform these tasks efficiently.
- **Debris Detection Module (302)**:

  - The Debris Detection Module analyzes sensor data to identify the presence of ocean debris. It uses advanced image and signal processing techniques to detect debris.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Debris Detection Module to the AI Algorithms block, showing the transfer of detection data for further processing.
- **Debris Tracking Module (303)**:
  - The Debris Tracking Module monitors the movement of detected debris, providing real-time updates on their location and trajectory.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Debris Tracking Module to the AI Algorithms block, showing the transfer of tracking data for further analysis.
- **Debris Classification Module (304)**:
  - The Debris Classification Module categorizes detected debris based on size, composition, and type, aiding in the determination of appropriate capture and disposal methods.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Debris Classification Module to the AI Algorithms block, showing the transfer of classification data for decision-making.
- **Machine Learning Model (305)**:
  - The Machine Learning Model continuously improves the accuracy of debris detection, tracking, and classification by learning from past encounters and adapting to new debris characteristics.

  - **Solid Line with Arrow**: Indicates a direct data flow from the Machine Learning Model to the AI Algorithms block, showing the integration of learned data for enhancing AI performance.

29. **Fig. 4 Robotic Capture Mechanisms**
30. This figure illustrates the robotic capture mechanisms integrated into the autonomous ocean debris cleanup system, showing the various tools and systems used for capturing and collecting debris.
31. **Explanation of Each Element and Connections**:

- **Robotic Capture Mechanisms (401)**:
  - The Robotic Capture Mechanisms block represents the integrated system of robotic tools used for capturing and collecting ocean debris. It includes robotic arms, capture nets, and conveyor belts.
- **Robotic Arms (402)**:
  - The Robotic Arms are versatile tools designed to grab and manipulate debris of various sizes and shapes. They can extend, retract, and rotate to ensure secure capture.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Robotic Arms to the Robotic Capture Mechanisms block, showing the transfer of captured debris for processing.
- **Capture Nets (403)**:
  - The Capture Nets are designed to scoop and hold floating debris, preventing it from escaping back into the water. They are particularly effective for collecting large volumes of small debris.

    - **Solid Line with Arrow**: Indicates a direct data flow from the Capture Nets to the Robotic Capture Mechanisms block, showing the transfer of captured debris for processing.

- **Conveyor Belts (404)**:
    - The Conveyor Belts transport captured debris from the capture tools to the storage compartment. They ensure continuous and efficient movement of debris within the system.
    - **Solid Line with Arrow**: Indicates a direct data flow from the Conveyor Belts to the Robotic Capture Mechanisms block, showing the transfer of captured debris for processing.
- **Debris Storage Compartment (405)**:
    - The Debris Storage Compartment stores captured debris temporarily before it is sorted and disposed of. It is designed to handle debris of different sizes and types.
    - **Solid Line with Arrow**: Indicates a direct data flow from the Robotic Capture Mechanisms block to the Debris Storage Compartment, showing the transfer of captured debris for storage.

32. **Fig. 5 Debris Sorting and Disposal System**
33. This figure illustrates the debris sorting and disposal system integrated into the autonomous ocean debris cleanup system, showing the mechanisms used for sorting and disposing of collected debris.
34. **Explanation of Each Element and Connections**:
    - **Debris Sorting and Disposal System (501)**:

  - The Debris Sorting and Disposal System block represents the integrated system used for sorting and disposing of captured debris. It ensures that recyclable materials are separated from non-recyclable waste.
- **Sorting Mechanism (502)**:
  - The Sorting Mechanism separates captured debris based on its composition, sorting recyclable materials from non-recyclable waste for efficient disposal.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Sorting Mechanism to the Debris Sorting and Disposal System block, showing the transfer of sorted debris for further processing.
- **Recyclable Material Storage (503)**:
  - The Recyclable Material Storage stores sorted recyclable materials separately for later processing and recycling.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Debris Sorting and Disposal System block to the Recyclable Material Storage, showing the transfer of sorted recyclable materials for storage.
- **Non-Recyclable Waste Compactor (504)**:
  - The Non-Recyclable Waste Compactor compacts non-recyclable waste to reduce its volume, making it easier to store and transport for final disposal.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Debris Sorting and Disposal System block to the Non-Recyclable Waste Compactor, showing the transfer of non-recyclable waste for compaction.
- **Final Disposal Unit (505)**:

  - The Final Disposal Unit is the final destination for compacted non-recyclable waste, ensuring it is disposed of in an environmentally responsible manner.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Non-Recyclable Waste Compactor to the Final Disposal Unit, showing the transfer of compacted waste for final disposal.

35. **Fig. 6 Autonomous Navigation System**
36. This figure illustrates the autonomous navigation system integrated into the autonomous ocean debris cleanup system, showing the modules used for navigation, obstacle detection, route planning, and communication.
37. **Explanation of Each Element and Connections**:

- **Autonomous Navigation System (601)**:
  - The Autonomous Navigation System block represents the integrated system that enables the vessel to navigate autonomously in various marine environments. It includes modules for GPS, obstacle detection, route planning, and communication.
- **GPS Module (602)**:
  - The GPS Module provides real-time location data to the navigation system, ensuring accurate positioning and navigation of the vessel.
  - **Solid Line with Arrow**: Indicates a direct data flow from the GPS Module to the Autonomous Navigation System block, showing the transfer of location data for navigation.
- **Obstacle Detection Module (603)**:

  - The Obstacle Detection Module uses sensors to detect obstacles in the vessel's path, ensuring safe navigation and avoidance of collisions with marine life and other objects.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Obstacle Detection Module to the Autonomous Navigation System block, showing the transfer of obstacle data for processing.
- **Route Planning Module (604)**:
  - The Route Planning Module generates optimal routes for the vessel to follow, considering factors such as debris locations, obstacles, and environmental conditions.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Route Planning Module to the Autonomous Navigation System block, showing the transfer of route data for execution.
- **Communication Module (605)**:
  - The Communication Module enables the vessel to communicate with ground control and other vessels, ensuring coordination and safety during operations.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Communication Module to the Autonomous Navigation System block, showing the transfer of communication data for processing.

38. **Fig. 7 User Interface**

39. This figure illustrates the user interface integrated into the autonomous ocean debris cleanup system, showing the various displays and panels used for monitoring, control, and real-time updates.

40. **Explanation of Each Element and Connections**:

- **User Interface (701)**:
  - The User Interface block represents the interface through which ground control monitors the system status, views debris tracking data, and overrides autonomous operations if necessary.
- **System Status Display (702)**:
  - The System Status Display provides real-time information about the overall status of the system, including operational status, energy levels, and system health.
  - **Solid Line with Arrow**: Indicates a direct data flow from the System Status Display to the User Interface block, showing the transfer of status data for monitoring.
- **Debris Tracking Data Display (703)**:
  - The Debris Tracking Data Display shows real-time tracking information about detected and captured debris, including location, type, and quantity of debris.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Debris Tracking Data Display to the User Interface block, showing the transfer of tracking data for monitoring.
- **Control Override Panel (704)**:

  - The Control Override Panel allows ground control to manually override autonomous operations, providing direct control over the system when necessary.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Control Override Panel to the User Interface block, showing the transfer of control commands for execution.
- **Real-Time Updates Display (705)**:
  - The Real-Time Updates Display provides continuous updates on debris removal progress, system performance, and any alerts or notifications.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Real-Time Updates Display to the User Interface block, showing the transfer of update data for monitoring.

41. **Fig. 8 Energy Management System**
42. This figure illustrates the energy management system integrated into the autonomous ocean debris cleanup system, showing the components used for energy generation, storage, distribution, and monitoring.
43. **Explanation of Each Element and Connections**:

- **Energy Management System (801)**:
  - The Energy Management System block represents the integrated system that manages energy generation, storage, distribution, and monitoring to ensure continuous operation of the debris cleanup system.
- **Solar Panels (802)**:

    - The Solar Panels generate renewable energy from sunlight, providing a sustainable power source for the system.
    - **Solid Line with Arrow**: Indicates a direct energy flow from the Solar Panels to the Energy Management System block, showing the transfer of generated energy for management and storage.
- **Energy Storage (803)**:
    - The Energy Storage stores excess energy generated by the solar panels, ensuring a stable power supply during periods without sunlight.
    - **Solid Line with Bi-directional Arrow**: Indicates a two-way energy flow between the Energy Storage and the Energy Management System block, showing the storage of excess energy and retrieval of stored energy when needed.
- **Energy Distribution Module (804)**:
    - The Energy Distribution Module allocates energy to various components of the system, ensuring efficient and balanced energy usage.
    - **Solid Line with Arrow**: Indicates a direct energy flow from the Energy Management System block to the Energy Distribution Module, showing the transfer of managed energy for distribution.
- **Energy Monitoring System (805)**:
    - The Energy Monitoring System tracks energy generation, storage levels, and consumption, providing real-time data for optimizing energy usage and ensuring efficient operation.

  - **Solid Line with Arrow**: Indicates a direct data flow from the Energy Monitoring System to the Energy Management System block, showing the transfer of monitoring data for energy management.

44. **Fig. 9 Safety and Compliance Protocols**
45. This figure illustrates the safety and compliance protocols integrated into the autonomous ocean debris cleanup system, showing the components used for collision avoidance, marine life detection, regulatory compliance, and adherence to environmental guidelines.
46. **Explanation of Each Element and Connections**:

- **Safety and Compliance Protocols (901)**:
  - The Safety and Compliance Protocols block represents the integrated system that ensures safe and compliant operation of the debris cleanup system, adhering to safety standards and environmental regulations.
- **Collision Avoidance System (902)**:
  - The Collision Avoidance System uses sensors and algorithms to detect and avoid collisions with marine life, other vessels, and obstacles, ensuring safe navigation.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Collision Avoidance System to the Safety and Compliance Protocols block, showing the transfer of collision data for processing.
- **Marine Life Detection Module (903)**:
  - The Marine Life Detection Module uses specialized sensors to identify and track marine life, preventing harm to sea creatures during debris cleanup operations.

- **Solid Line with Arrow**: Indicates a direct data flow from the Marine Life Detection Module to the Safety and Compliance Protocols block, showing the transfer of detection data for processing.

- **Regulatory Compliance Module (904)**:
  - The Regulatory Compliance Module ensures the system operates in accordance with international marine regulations and standards, maintaining legal compliance.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Regulatory Compliance Module to the Safety and Compliance Protocols block, showing the transfer of compliance data for monitoring and adjustment.
- **Environmental Guidelines Module (905)**:
  - The Environmental Guidelines Module ensures the system adheres to environmental protection guidelines, minimizing ecological impact and promoting sustainability.
  - **Solid Line with Arrow**: Indicates a direct data flow from the Environmental Guidelines Module to the Safety and Compliance Protocols block, showing the transfer of guideline data for adherence.

47. **Detailed Description of the Invention**
48. **Autonomous Ocean Debris Cleanup System**
49. The present invention relates to an autonomous ocean debris cleanup system designed to detect, capture, and remove ocean debris. The system employs advanced sensors, AI for debris detection and tracking, and robotic mechanisms for debris capture and disposal.

This innovation aims to enhance the health of marine environments by effectively managing ocean debris.

50. System Architecture

51. The ocean debris cleanup system comprises a central control unit, multiple detection sensors, AI algorithms, and robotic capture mechanisms. The system is designed for deployment on an autonomous vessel equipped with solar panels and energy storage for extended operations.

52. Detection Sensors

53. The system includes sonar, lidar, optical cameras, and infrared (IR) sensors for comprehensive debris detection and tracking. These sensors are capable of detecting debris of various sizes and compositions both on the surface and underwater.

- **Sonar Sensor**:
  - Utilizes sound waves to detect underwater debris. The sonar sensor provides information about the size, shape, and location of objects beneath the surface.
  - Example: A sonar sensor can detect a piece of plastic debris at a depth of 10 meters, identifying its dimensions and exact location for targeted retrieval.
- **Lidar Sensor**:
  - Uses laser light to measure distances and detect surface debris. The lidar sensor provides high-resolution data for identifying and tracking debris.

- Example: A lidar sensor can identify a floating plastic bottle from a distance of 50 meters, providing precise location data for the robotic capture mechanisms.

- **Optical Camera**:
  - Captures visual images of debris on the water's surface, aiding in the identification and classification of different types of debris.
  - Example: An optical camera can capture real-time images of an oil spill, enabling the system to differentiate between oil and solid debris.
- **Infrared (IR) Sensor**:
  - Detects heat signatures from debris, allowing for the identification of objects based on their thermal properties.
  - Example: An IR sensor can detect the heat signature of a piece of marine debris in cooler water, making it easier to identify and track at night.

54. Artificial Intelligence

55. AI algorithms analyze sensor data to identify and classify ocean debris based on size, composition, and location. Machine learning models continuously improve detection accuracy by learning from past encounters and adapting to new debris characteristics.

- **Debris Detection Module**:
  - Analyzes sensor data to identify the presence of ocean debris. It uses advanced image and signal processing techniques.
  - Example: The detection module can identify microplastics floating on the ocean surface using data from optical cameras and IR sensors.
- **Debris Tracking Module**:

  - Monitors the movement of detected debris, providing real-time updates on their location and trajectory.
  - Example: The tracking module can follow the movement of a drifting fishing net, predicting its future location for interception.
- **Debris Classification Module**:
  - Categorizes detected debris based on size, composition, and type, aiding in the determination of appropriate capture and disposal methods.
  - Example: The classification module can distinguish between biodegradable and non-biodegradable debris, optimizing the sorting and disposal process.
- **Machine Learning Model**:
  - Continuously improves the accuracy of debris detection, tracking, and classification by learning from past encounters and adapting to new debris characteristics.
  - Example: The machine learning model can update its algorithms based on the types of debris encountered, improving future detection and classification accuracy.

56. Robotic Capture Mechanisms

57. The system employs robotic arms, nets, and conveyor belts for capturing and collecting debris. Capture mechanisms are designed to handle debris of different sizes and types, ensuring secure capture and removal.

- **Robotic Arms**:

    - Versatile tools designed to grab and manipulate debris of various sizes and shapes. They can extend, retract, and rotate to ensure secure capture.
    - Example: Robotic arms can pick up a large piece of driftwood and place it on a conveyor belt for sorting.

- **Capture Nets**:
    - Designed to scoop and hold floating debris, preventing it from escaping back into the water. They are particularly effective for collecting large volumes of small debris.
    - Example: Capture nets can gather a cluster of small plastic fragments, holding them securely until they are processed.
- **Conveyor Belts**:
    - Transport captured debris from the capture tools to the storage compartment. They ensure continuous and efficient movement of debris within the system.
    - Example: Conveyor belts can move captured debris from the robotic arms to the sorting mechanism for further processing.

58. Debris Sorting and Disposal

59. Captured debris is sorted on board the vessel, separating recyclable materials from non-recyclable waste. Recyclable materials are stored in designated containers for later processing, while non-recyclable waste is compacted and stored for safe disposal.

- **Sorting Mechanism**:
    - Separates captured debris based on its composition, sorting recyclable materials from non-recyclable waste for efficient disposal.

  - Example: The sorting mechanism can separate plastic bottles from organic matter, directing each type to the appropriate storage container.

- **Recyclable Material Storage**:
  - Stores sorted recyclable materials separately for later processing and recycling.
  - Example: A designated storage bin for plastic bottles ensures they are kept separate from other types of debris for efficient recycling.
- **Non-Recyclable Waste Compactor**:
  - Compacts non-recyclable waste to reduce its volume, making it easier to store and transport for final disposal.
  - Example: The compactor can crush non-recyclable plastics into compact blocks, optimizing storage space on the vessel.
- **Final Disposal Unit**:
  - The final destination for compacted non-recyclable waste, ensuring it is disposed of in an environmentally responsible manner.
  - Example: Compacted waste can be transferred to a land-based facility for safe disposal, ensuring minimal environmental impact.

60. Autonomous Operation

61. The system operates autonomously using AI to make real-time decisions on debris capture and disposal. Autonomous navigation ensures the vessel can maneuver safely in various marine environments, avoiding obstacles and marine life.

- **GPS Module**:

- Provides real-time location data to the navigation system, ensuring accurate positioning and navigation of the vessel.
- Example: The GPS module can guide the vessel to a known debris hotspot, optimizing the cleanup route.

- **Obstacle Detection Module**:
  - Uses sensors to detect obstacles in the vessel's path, ensuring safe navigation and avoidance of collisions with marine life and other objects.
  - Example: The obstacle detection module can identify and navigate around a school of fish, ensuring safe passage.
- **Route Planning Module**:
  - Generates optimal routes for the vessel to follow, considering factors such as debris locations, obstacles, and environmental conditions.
  - Example: The route planning module can plot a course that maximizes debris collection efficiency while avoiding rough seas.
- **Communication Module**:
  - Enables the vessel to communicate with ground control and other vessels, ensuring coordination and safety during operations.
  - Example: The communication module can send real-time updates to ground control, allowing for remote monitoring and intervention if necessary.

62. Energy Management

63. The system includes solar panels and energy storage to power its operations. Efficient energy management ensures continuous operation during extended missions, even in remote areas.

- **Solar Panels**:
  - Generate renewable energy from sunlight, providing a sustainable power source for the system.
  - Example: Solar panels can supply power to the entire system during daylight hours, reducing the reliance on stored energy.
- **Energy Storage**:
  - Stores excess energy generated by the solar panels, ensuring a stable power supply during periods without sunlight.
  - Example: Energy storage can provide power during nighttime operations, ensuring continuous cleanup efforts.
- **Energy Distribution Module**:
  - Allocates energy to various components of the system, ensuring efficient and balanced energy usage.
  - Example: The energy distribution module can prioritize power to essential systems, optimizing energy use during extended missions.
- **Energy Monitoring System**:
  - Tracks energy generation, storage levels, and consumption, providing real-time data for optimizing energy usage and ensuring efficient operation.

   - Example: The energy monitoring system can alert the system to adjust energy usage during low sunlight conditions, ensuring sustained operations.

64. Safety and Compliance

65. The system includes safety protocols to avoid collisions with marine life and other vessels. Compliance with international marine regulations and environmental guidelines ensures safe and responsible debris removal operations.

- **Collision Avoidance System**:
   - Uses sensors and algorithms to detect and avoid collisions with marine life, other vessels, and obstacles, ensuring safe navigation.
   - Example: The collision avoidance system can steer the vessel away from a whale, preventing harm to marine life.
- **Marine Life Detection Module**:
   - Uses specialized sensors to identify and track marine life, preventing harm to sea creatures during debris cleanup operations.
   - Example: The marine life detection module can recognize a turtle and adjust the vessel's course to avoid it.
- **Regulatory Compliance Module**:
   - Ensures the system operates in accordance with international marine regulations and standards, maintaining legal compliance.
   - Example: The regulatory compliance module can ensure the vessel's operations meet environmental protection standards set by international bodies.

- **Environmental Guidelines Module**:
    - Ensures the system adheres to environmental protection guidelines, minimizing ecological impact and promoting sustainability.
    - Example: The environmental guidelines module can enforce procedures to prevent oil spills or other environmental hazards during operations.

66. This detailed description provides a comprehensive and robust understanding of the autonomous ocean debris cleanup system, enabling someone skilled in the relevant field to replicate and utilize the invention effectively. Specific examples have been included to illustrate the practical application of each component and operation, ensuring clarity and precision in the disclosure.

Claims

1. An autonomous ocean debris cleanup system for detecting, capturing, and removing ocean debris comprising:

    A central control unit with integrated AI algorithms for debris detection, tracking, and classification;

    Multiple detection sensors including sonar, lidar, optical cameras, and infrared sensors for comprehensive debris detection;

    Robotic capture mechanisms including robotic arms, nets, and conveyor belts for capturing and collecting debris;

    A debris sorting and disposal system for separating recyclable materials from non-recyclable waste;

    An autonomous navigation system for maneuvering the vessel safely in various marine environments.

2. The ocean debris cleanup system of claim 1, wherein the AI algorithms analyze sensor data to identify and classify debris based on size, composition, and location.
3. The ocean debris cleanup system of claim 1, wherein the robotic capture mechanisms are designed to handle debris of different sizes and types.
4. The ocean debris cleanup system of claim 1, wherein the system operates autonomously using AI to make real-time decisions on debris capture and disposal.
5. The ocean debris cleanup system of claim 1, wherein the user interface allows ground control to monitor system status, view debris tracking data, and override autonomous operations if necessary.

6. The ocean debris cleanup system of claim 1, wherein the energy management system includes solar panels and energy storage for continuous operation.
7. The ocean debris cleanup system of claim 1, wherein the safety protocols ensure the system avoids collisions with marine life and other vessels.
8. The ocean debris cleanup system of claim 1, wherein compliance with international marine regulations and environmental guidelines ensures safe and responsible debris removal operations.

Inventor: Robert V. Salinas
Title: Autonomous Ocean Debris Cleanup System

Abstract

1. An autonomous ocean debris cleanup system designed to detect, capture, and remove ocean debris. The system employs advanced sensors, AI for debris detection and tracking, and robotic mechanisms for debris capture and disposal. Features include autonomous operation, efficient energy management, and compliance with international marine regulations. This innovative solution aims to enhance the health of marine environments by effectively managing ocean debris.