SISTEM INTEGRAT AUTONOM DE RETELE DE DRONE INTERCONECTATE PENTRU SECURIZAREA FRONTIEREI MARITIME SI FLUVIALE

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Inventia se refera la un sistem integrat autonom de retele de drone interconectate pentru securizarea frontierei maritime si fluviale, destinat operatiunilor de recunoastere, supraveghere si control 24/7 ziua si noaptea cu camere cu termoviziune si infrarosu, transmitand imaginile 4k in timp real prin streaming, cu microfoane, senzori, sonare active si pasive, cu sistem de navigatie Global Navigation Satellite System GNSS, prelucrand datele cu inteligenta artificiala AI, pentru a detecta miscarea navelor, aeronavelor, dronelor, vehiculelor si oamenilor, pentru a alerta personalul de securitate din Centrul de Comanda, precum si la interceptarea si distrugerea dronelor maritime, aeriene si subacvatice inamice. Centrele de Comanda zonale sunt dotate cu transmitatoare pentru comanda la distanta a dronelor, receptoare pentru primirea semnalelor audio-video si a datelor colectate de drone, care sunt prelucrate cu AI si stocate pe servere si calculatoare. Toate actiunile sunt transmise pe monitoare video care primesc imagini 4k in timp real de la nivelul apei, aerian si subacvatic. Datele si informatiile sunt transmise Centrului de Comanda principal, care asigura managementul strategic al misiunilor. Are aplicatii in misiuni militare, de securitate si control pentru Politia de Frontiera si Garda de Coasta, precum si in misiuni de cautare si salvare marina, aeriana si subacvatica.

Se utilizeaza drone maritime fotovoltaice modulare purtatoare de drone aeriene, rachete antidrona si drone subacvatice, care pot functiona independente 24/7 si au capacitatea de a-si pastra pozitia nemiscata pe anumite coordinate GPS, prin functionarea independenta a motoarelor.

Sistemul este alcatuit din sute de drone maritime interconectate prin satelit, care functioneaza ca niste balize plutitoare, pozitionate la o distanta de 500 metri una de alta, care transmit imagini de la suprafata apei, aeriene si subacvatice, precum si sunet captat prin microfoane si sonare, pozitiile lor pe harta si coordonatele GPS cat si ale dronelor inamice, catre Centrele de Comanda zonale, dispuse pe malurile apei. Informatiile sunt prelucrate prin inteligenta artificiala AI, care in momentul detectarii unei drone inamice, poate da comanda celei mai apropiate drone maritime sa se apropie de tinta si sa atace prin lansarea dronelor aeriene, a dronelor subacvatice torpile sau a rachetelor antidrona, pana la distrugerea totala a tintei. In anumite zone de interes deosebit, se pot integra in retea si drone velier modulare purtatoare de drone subacvatice si minidrone USV, dotate deasemenea cu senzori, camere video, microfoane, sonare active si pasive, sisteme de navigatie GNSS, care sunt ultrasilentioase si pot detecta dronele maritime si subacvatice inamice. Centrul de Comanda principal centralizeaza toate informatiile, supervizeaza si prioritizeaza toate actiunile, in cazul unui atac masiv.

Sistemul se refera la trei retele de drone interconectate, la nivelul apei, aerian si subacvatic, care colaboreaza pentru a indeplini misiunile specifice, utilizand tehnologii de comunicatie avansate pentru a partaja date si coordona miscarile, oferind o eficienta sporita fata de o singura drona. Dronele comunica intre ele si cu Centrul de Comanda prin retele wireless. Un software centralizat asistat de inteligenta artificiala AI, coordoneaza activitatile dronelor, planifica misiunile, monitorizeaza performanta si analizeaza datele colectate. Aceasta permite operatorilor din Centrul de Comanda sa monitorizeze misiunile in timp real, sa intervina daca este necesar si sa preia controlul asupra dronelor.

Sistemul functioneaza astfel:

- Planificarea misiunii: operatorul defineste obiectivele misiunii cum ar fi supravegherea unei zone extinse, iar sistemul creeaza un plan de navigatie si de zbor pentru reteaua de drone;
- Executia misiunii: dronele maritime pleaca de la baza si, in functie de sarcina, se pozitioneaza ca niste balize plutitoare in locuri bine stabilite pentru a acoperi o zona cat mai mare, iar in cazul unui atac cu drone inamice sa poata raspunde foarte rapid prin interceptarea acestora de la nivelul apei, aerian si subacvatic, precum sa le si distruga;
- Colectarea si partajarea datelor: senzorii de pe drone colecteaza date, care sunt procesate si partajate intre drone si transmise catre Centrul de Comanda;
- Luarea deciziilor si adaptarea: dronele isi pot adapta rutele si strategiile in timp real, bazandu-se pe informatiile primite de la alte drone sau de la Centrul de Comanda;
- Finalizarea misiunii: dronele revin la Centrul de Comanda zonal, sunt reincarcate cu dronele aeriene si dronele subacvatice de tip kamikaze, iar datele sunt analizate si folosite pentru a crea rapoarte catre Centrul de Comanda principal.

Avantajele unui sistem de drone sunt:

- Eficienta sporita - misiuni mai complexe pot fi finalizate mai rapid datorita distribuirii sarcinilor;
- Acoperire extinsa - o retea de drone poate monitoriza zone mult mai mari decat ar putea o singura drona;
- Flexibilitate si redundanta – daca o drona intampina probleme, alte drone pot prelua sarcina, asigurand continuitatea misiunii;
- Colectarea inteligenta a datelor – prin colaborare pot crea modele 3D detaliate ale mediului si ale tintelor.

Sistemul GNSS utilizeaza sateliti pentru a transmite semnale catre receptoarele amplasate pe drone, care le utilizeaza pentru a determina cu precizie locatia, viteza si ora exacta a acestora. Receptorul foloseste semnalele de la cel putin patru sateliti pentru a calcula diferentele de timp si a determina cu precizie pozitia, navigarea si sincronizarea.

Principalele sisteme GNSS sunt GPS (SUA), GLONASS (Rusia), Galileo (Europa), BeiDou (China), QZSS (Japonia) si NavIC (India).

Dronele aeriene decoleaza de pe pistele dronelor maritime doar in cazul in care este necesara transmiterea de imagini de sus din aer, iar cele subacvatice la fel daca este necesara identificarea dronelor inamice sub apa, apoi se intorc la drona maritima si asteapta urmatoarea misiune, timp in care isi incarca acumulatorii prin panoul solar.

Deasemenea dronele aeriene care decoleaza de pe puntile dronelor maritime pot identifica navele inamice sau tintele de pe malul inamic si sa transmita la Centrul de Comanda imaginile aeriene in timp real, precum si a pozitiei pe harta si a coordonatelor GPS ale tintelor, astfel prin marcarea acestora se pot efectua lovituri de precizie cu rachete de la mare distanta de pe sol, aer, apa, fara a pune in pericol personalul uman.

Intreg sistemul se poate deplasa automat la trecerea navelor civile sau militare, precum si sa asigure escortarea acestora la intrarea si iesirea din porturi, unde navele se deplaseaza cu viteza mica, fiind cel mai vulnerabil punct.

In caz de razboi, sistemul de drone poate raspunde foarte rapid la o debarcare de pe mare sau o incercare de traversare a raurilor si fluviilor a trupelor inamice, transmitand catre Centrul de Comanda toate informatiile necesare apararii.

Inteligenta artificiala AI, detecteaza vizual si acustic dronele inamice analizand forma si sunetul produs de acestea, comparandu-l cu o baza de date proprie, deoarece dronele iraniene Shahed-136 sau varianta lor ruseasca Geran-2, zboara la mica altitudine si produc zgomot mare.

In Centrele de Comanda zonale nu este necesar un numar mare de personal, deoarece toata analiza de sistem se face cu un software AI, factorul uman aparand doar pentru asigurarea mentenantei sistemului, in cazul aparitiei defectiunilor electronice sau pentru incarcarea, reparatia sau inlocuirea dronelor.

In varianta fara armament si incarcatura exploziva, intregul sistem poate fi utilizat de Politia de Frontiera si Garda de Coasta, in vederea combaterii trecerii ilegale de frontiera, traficului de droguri si persoane. Se poate inspecta perimetrul navelor la nivelul apei, aerian si subacvatic si cablurile submarine; poate marca anumite locuri periculoase in care sunt detectate mine marine, emitand semnale acustice si luminoase; poate identifica, transporta si neutraliza minele marine.

Sistemul este foarte util si in cazul operatiunilor de cautare si salvare (marina, aeriana si subacvatica): identificarea navelor esuate sau scufundate si a naufragiatilor; identificarea persoanelor aflate in pericol in cazurile de inundatii; echipata cu microfon si difuzor pentru transmiterea audio la distanta, in vedera contactarii supravietuitorilor si transmiterea catre Centrul de Comanda a imaginilor audio-video in timp real, a pozitiei pe harta si a coordonatelor GPS a navei in pericol si a naufragiatilor; transmiterea de mesaje, semnale luminoase si acustice in zone greu accesibile, in cazuri de cataclisme, razboi, furtuni.Totodata ajuta la inspectia infrastructurii porturilor, digurilor, podurilor si detectarea si identificarea deseurilor care pot bloca caile navigabile, sau pentru mediu, dronele pot fi echipate si cu senzori pentru masurarea calitatii apei in cazul scurgerilor de titei.

De exemplu, se poate utiliza pe fluviul Rio Grande care este frontiera dintre Mexic si statul Texas din U.S.A., in vederea combaterii trecerii ilegale de frontiera, precum si in Stramtoarea Ormuz pentru escortarea navelor civile si pentru identificarea - neutralizarea minelor marine, sistemul de drone prezentat fiind o solutie ieftina si eficienta.

Frontiera estica a Romaniei cu Ucraina, in lungime de 343,9 km fluvial si 31,7 km maritim, in momentul de fata nu este acoperita complet, datorita patrularii unui numar foarte mic de nave militare sau ale Politiei de Frontiera. Este practic imposibil sa ai informatii in timp real, de pe toata lungimea frontierei, mai ales in zona Deltei Dunarii, utilizand doar nave cu personal uman si care nu au dotarea necesara sa distruga dronele maritime, aeriene sau subacvatice. Dronele aeriene iraniene Shahed-136 sau varianta lor ruseasca Geran-2, zboara la mica altitudine, au amprente radar si termica mica, ceea ce le face foarte greu de detectat cu radarul. Dronele maritime inamice au dimensiuni mici, sunt fara suprastructura ceea ce la distanta le face practic invizibile atat vizual cat si cu radarul, iar dronele subacvatice sunt complet invizibile din aer sau de la suprafata apei, putand fi detectate doar cu sonarul, ceea ce e complicat, avand deasemenea dimensiuni mici si motoare silentioase. Singura solutie actuala este prin ridicarea de la sol a avioanelor F-16 si distrugerea dronelor aeriene cu rachete de

500.000 de euro, ceea ce implica un cost foarte mare pentru dronele inamice care costa 20.000 de euro, precum si utilizarea unui numar mare de personal uman si de aeronave de 100 milioane de euro.

Drona maritima este mica, silentioasa, rapida, manevrabila, poate functiona in conditii extreme fiind rezistenta la vant, valuri, ploaie, frig si este realizata din materiale compozite, fibra de sticla, fibra de carbon, ceea ce confera acesteia o rezistenta foarte mare la o greutate mica, cu costuri de fabricatie scazute.

Problemele tehnice pe care le rezolva inventia sunt urmatoarele:

- Se securizeaza frontiera maritima si fluviala cu costuri foarte mici si cu utilizarea unui numar mic de personal uman, fiind complet autonom energetic;
- Prin utilizarea dronelor maritime fotovoltaice modulare purtatoare de drone aeriene, rachete antidrona si drone subacvatice, intregul arsenal pentru distrugerea dronelor inamice este la locul misiunii, avand posibilitatea unui raspuns rapid, fara sa mai pierdem timp cu transportul acestora pentru indeplinirea misiunilor si fara a pune in pericol personalul uman.

Prin aplicarea inventiei se obtin urmatoarele avantaje:

- Se pot identifica, intercepta si distruge dronele maritime, aeriene si subacvatice inamice, pe linia de frontiera, exact la momentul intrarii pe teritoriul tarii, actiune prin care se evita pierderile de vieti omenesti si distrugerea obiectivelor civile si militare;
- Nu mai este necesara utilizarea fortelor aeriene si navale, cu implicarea avioanelor de lupta F-16, a fregatelor militare si a militarilor din sistemul de aparare.

INTEGRATED AUTONOMOUS SYSTEM OF INTERCONNECTED DRONE NETWORKS FOR MARITIME AND RIVERINE BORDER SECURITY

Invention registered with OSIM under patent application no. A/00424 dated September 29, 2025, and published in the Official Industrial Property Bulletin – Inventions Section No. 3 on March 30, 2026.

The invention relates to an integrated autonomous system of interconnected drone networks designed to secure maritime and riverine borders. It is intended for 24/7 reconnaissance, surveillance, and control operations—day and night—utilizing thermal imaging and infrared cameras to stream 4K video in real-time, alongside microphones, sensors, active and passive sonars, and GNSS (Global Navigation Satellite System) navigation. The system employs artificial intelligence (AI) to process data, detect the movement of vessels, aircraft, drones, vehicles, and personnel, and alert security staff at the Command Center, as well as to intercept and destroy hostile maritime, aerial, and underwater drones. Zonal Command Centers are equipped with transmitters for remote drone control and receivers for audio-video signals and data collected by the drones; this data is processed via AI and stored on servers and computers. All activities are displayed on monitors receiving real-time 4K imagery from surface, aerial, and underwater vantage points. Data and information are transmitted to the main Command Center, which oversees strategic mission management. The system has applications in military, security, and control missions for the Border Police and Coast Guard, as well as in maritime, aerial, and underwater search and rescue operations.

The system employs modular, solar-powered maritime drones that carry aerial drones, anti-drone missiles, and underwater drones; these units operate autonomously 24/7 and can maintain a stationary position at specific GPS coordinates through independent motor operation. The system consists of hundreds of satellite-linked maritime drones acting as floating beacons—spaced 500 meters apart—that transmit surface, aerial, and underwater imagery, as well as audio captured via microphones and sonar, along with their own map positions and GPS coordinates (as well as those of enemy drones) to regional command centers located onshore. Data is processed using artificial intelligence (AI); upon detecting an enemy drone, the AI can command the nearest maritime drone to approach the target and attack—launching aerial drones, underwater drones, torpedoes, or anti-drone missiles—until the target is completely destroyed. In areas of particular strategic importance, the network can also integrate modular sailing drones that carry underwater drones and USV mini-drones; these are ultra-silent and equipped with sensors, video cameras, microphones, active and passive sonar, and GNSS navigation systems, enabling them to detect enemy maritime and underwater drones. A main command center centralizes all information, overseeing and prioritizing actions in the event of a massive attack.

The system comprises three interconnected drone networks—operating at the surface, in the air, and underwater—that collaborate to execute specific missions; by utilizing advanced communication technologies to share data and coordinate movements, the system achieves greater efficiency than a single drone could. The drones communicate with one another and with the Command Center via wireless networks. Centralized, AI-assisted software coordinates drone activities, plans missions, monitors performance, and analyzes collected data. This enables operators at the Command Center to monitor missions in real time, intervene if necessary, and take control of the drones.

The system operates as follows:

- Mission planning: the operator defines mission objectives—such as surveying a vast area—and the system generates a navigation and flight plan for the drone network;
- Mission execution: maritime drones depart from the base and, depending on the task, position themselves like floating beacons at designated locations to maximize coverage; in the event of an enemy drone attack, they can respond rapidly by intercepting threats—whether surface, aerial, or underwater—and destroying them;
- Data collection and sharing: sensors on the drones collect data, which is processed, shared among the drones, and transmitted to the Command Center;
- Decision-making and adaptation: drones can adjust their routes and strategies in real-time based on information received from other drones or the Command Center;
- Mission completion: drones return to the regional Command Center to be reloaded with aerial and underwater kamikaze drones, while the collected data is analyzed and used to generate reports for the main Command Center.

The advantages of a drone system include:

- Increased efficiency – more complex missions can be completed faster through task distribution;
- Extended coverage – a drone network can monitor much larger areas than a single drone could;
- Flexibility and redundancy – if one drone encounters issues, others can take over the task, ensuring mission continuity;
- Intelligent data collection – through collaboration, they can create detailed 3D models of the environment and targets.

The GNSS system uses satellites to transmit signals to receivers mounted on drones, which utilize them to precisely determine their location, speed, and exact time. The receiver uses signals from at least four satellites to calculate time differences and accurately determine position, navigation, and timing. The main GNSS systems are GPS (USA), GLONASS (Russia), Galileo (Europe), BeiDou (China), QZSS (Japan), and NavIC (India).

Aerial drones launch from maritime drone platforms only when overhead imagery is required, while underwater drones deploy similarly if the identification of enemy underwater drones is necessary; they then return to the maritime drone platform to await the next mission, recharging their batteries via solar panels in the interim.

Additionally, aerial drones launching from maritime drone platforms can identify enemy vessels or targets on enemy shores and transmit real-time aerial imagery—along with map positions and GPS coordinates—to the Command Center; by marking these targets, precision long-range missile strikes can be executed from land, air, or sea without endangering human personnel.

The entire system can automatically maneuver to make way for civilian or military vessels and provide escort services as they enter or exit ports—areas where vessels move at low speeds and are most vulnerable.

In the event of war, the drone system can respond rapidly to enemy amphibious landings or attempts to cross rivers, transmitting all information necessary for defense to the Command Center.
Artificial Intelligence (AI) visually and acoustically detects enemy drones by analyzing their shape and the sound they produce—comparing this data against an internal database—since Iranian Shahed-136 drones (or their Russian Geran-2 variants) fly at low altitudes and generate significant noise.
Zonal Command Centers do not require large staffing levels, as all system analysis is performed by AI software; human personnel are needed only for system maintenance—addressing electronic malfunctions—or for loading, repairing, and replacing drones.
In a configuration without weaponry or explosive payloads, the system can be utilized by Border Police and the Coast Guard to combat illegal border crossings, as well as drug and human trafficking. It allows for the inspection of vessel perimeters (at the waterline, in the air, and underwater) and submarine cables; it can mark hazardous areas where naval mines are detected by emitting acoustic and visual signals; and it can identify, transport, and neutralize naval mines.
The system is also highly valuable for search and rescue operations (maritime, aerial, and underwater), including locating grounded or sunken vessels and shipwreck survivors, as well as identifying individuals in danger during floods. It is equipped with a microphone and speaker for remote audio communication to contact survivors, and transmits real-time audio-video footage, map location, and GPS coordinates of the distressed vessel and shipwreck victims to the Command Center; it can also transmit messages, as well as visual and acoustic signals, into hard-to-reach areas during natural disasters, wartime, or storms. Furthermore, it assists in inspecting infrastructure—such as ports, breakwaters, and bridges—and detecting debris that could block waterways; for environmental purposes, the drones can also be fitted with sensors to measure water quality in the event of oil spills.

For instance, the drone system presented—a cost-effective and efficient solution—could be deployed along the Rio Grande (the border between Mexico and the U.S. state of Texas) to combat illegal crossings, as well as in the Strait of Hormuz to escort civilian vessels and identify or neutralize naval mines.
Romania’s eastern border with Ukraine—spanning 343.9 km of river and 31.7 km of coastline—is currently not fully covered, as patrols are conducted by a very limited number of military or Border Police vessels. It is virtually impossible to obtain real-time information across the entire length of the border—particularly in the Danube Delta area—using only manned vessels that lack the necessary equipment to destroy maritime, aerial, or underwater drones. Iranian Shahed-136 aerial drones (and their Russian variant, the Geran-2) fly at low altitudes and possess small radar and thermal signatures, making them extremely difficult to detect via radar. Enemy maritime drones are small and lack superstructures, rendering them practically invisible—both visually and to radar—at a distance; meanwhile, underwater drones are completely invisible from the air or the water's surface, detectable only by sonar—a complex task given their small size and silent engines. The only current solution involves scrambling F-16 fighter jets to destroy aerial drones using missiles costing €500,000 each; this entails exorbitant costs to neutralize enemy drones worth only €20,000, while also requiring significant personnel and aircraft valued at €100 million. The maritime drone is small, silent, fast, and maneuverable; it can operate in extreme conditions—withstanding wind, waves, rain, and cold—and is

constructed from composite materials such as fiberglass and carbon fiber, which provide high strength and low weight at a low manufacturing cost.

The technical problems addressed by the invention are as follows:

- Maritime and river borders are secured at very low cost and with minimal human staffing, as the system is completely energy-autonomous;
- By using modular, photovoltaic-powered maritime drones that carry aerial drones, anti-drone missiles, and underwater drones, the entire arsenal required to destroy enemy drones is already on-site; this enables a rapid response without wasting time transporting assets to the mission area or endangering human personnel.

Implementing the invention yields the following advantages:

- Enemy maritime, aerial, and underwater drones can be identified, intercepted, and destroyed at the border—precisely as they enter the country's territory—thereby preventing loss of life and the destruction of civilian and military targets;
- There is no longer a need to deploy air and naval forces—such as F-16 fighter jets, military frigates, and defense personnel—for this purpose.