

AEROX: A Smart Transforming Rover-Drone for Surveillance and Field Operations

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Abstract: In this paper, we present the designing of AEROX which is the name given to a novel and advanced robot that can work as a transforming rover and drone. The robot is capable of performing tasks related to advanced surveillance as well as field works. It combines both roving and flying properties in a single unit so that efficient performance is ensured regardless of the environment and the type of surface on which it is to perform tasks. It functions in rover mode and drone mode depending on the needs of the task being performed. Sensors, cameras, global positioning satellite, and wireless communication modules are some of the key components of the robot. It can be used for purposes including but not limited to surveillance, agriculture monitoring, disaster management, and security measures. Artificial intelligence is utilized to increase its capabilities.

Keywords: Hybrid Robot, Rover-Drone, AutonomousSystem, Surveillance, Transformation Mechanism

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I. INTRODUCTION

In the recent past, there has been high demand for the use of highly effective surveillance and field operations equipment. The traditional robot and drones have greatly contributed towards the fulfillment of this demand, yet they have some drawbacks. Robots have stability and energy efficiency but are unable to overcome barriers. Drones, on the other hand, are very effective when traversing the skies, but their disadvantage is that they have low battery life and instability during harsh weather conditions.

The use of hybrid robotic systems is therefore becoming popular due to the benefits that they offer. AEROX is among the hybrid robotic systems that take advantage of the features found in both the robot and the drones to ensure their efficient performance. The core aim of this invention is to develop a smart and flexible vehicle that can change mode based on varying situations.

➤ Page Layout

For this paper, the following formatting style will be applied as per the typical research paper requirements. The paper will be presented in standard two columns. All information, texts, figures, and tables, in general, will be contained within a predefined printable page area to allow consistency.

The size of the paper will be based on the standard A4 paper dimensions. Margins for all pages will be set accordingly to ensure that the information is contained within the printable page area. This will involve ensuring that the top margin size is maintained at approximately 2.5 cm, whereas the bottom margin will be slightly bigger to accommodate more spacing. Similarly, the left and right margins will be set accordingly to support the two columns.

Every page in the paper will be presented in two equal columns separated with some white spaces to enhance readability. The alignment of texts will be done using the justified style where texts will be aligned on both sides.

All texts in the paper will use the Times New Roman font. The font size will be 10-pt for the main body of texts. In this case, headings and titles will have bigger fonts compared to the body and will be bold. Texts will be single-spaced to maintain conciseness.

Proper placement of figures and tables in relation to columns will be ensured as well as adequate spacing. Captions for all figures will be presented under the figures whereas captions for tables will appear over the tables. No page number will appear in the text since these are usually added in publication.

➤ Main Title

- AEROX: A Smart Transforming Rover-Drone for Surveillance and Field Operations
- The title should appear at the top of the first page.
- It should be centered on the page.
- The font to use is Times New Roman, 24 pt, bold.
- Only capitalize major word

II. LITERATURE REVIEW

Various scientists have designed hybrid robots that integrate flying and walking abilities. Most of the early models revolved around either equipping drones with wheels or integrating lifting modules into rovers. Unfortunately, most of these hybrid robots were inefficient and could not easily transform from one mode to another.

With recent innovations, more sophisticated hybrid robots are emerging. Most of these robots are equipped with effective control systems and lighter components. While some are equipped with folding wheels on quadcopters, others are fitted with removable drones on tracked vehicles. Despite these advancements, certain limitations such as complicated designs, high costs, and low autonomy levels persist.

The AEROX model improves on these concepts through its innovative approach.

III. METHODOLOGY

➤ System Architecture

There are two primary modes of operations for the AEROX system:

- Rover mode for ground navigation
- Drone mode for aerial reconnaissance

The system design uses light but robust construction materials. The transformation process is seamless and does not require manual switching between the two modes.

➤ Hardware Specifications

The hardware specifications of the AEROX system are outlined below:

- Microcontroller (Arduino/ESP32)
- Brushless DC motors for the drone
- DC motors for the rover
- Propellers and motor drivers
- GPS sensor
- Camera sensor for video recording
- Sensors (ultrasonic, IMU, and temperature sensors)
- Communication Module (Wi-Fi/Rf)

➤ Operating Principle

While operating in rover mode, the device travels using wheels and gathers ground data. If an obstacle is encountered or if an aerial view is needed, it switches to drone mode by engaging the propellers.

The control system is responsible for managing the operation of the motors, stabilizing and coordinating with each other.

➤ Control & Communication

AEROX is remotely controlled through a wireless interface that allows programming of semi-autonomous operation based on sensor information. Video streaming from the camera is available in real time.

IV. RESULTS AND DISCUSSION

AEROX's expected performance exhibits considerable advancements compared to conventional platforms. In rover mode, it guarantees smooth and energy-efficient travel over both plain and moderately rugged surfaces. In drone mode, it facilitates aerial monitoring and obstacle evasion.

The switching capability increases flexibility by ensuring uninterrupted operations without having to switch between various units. The inclusion of sensors increases situational awareness, while wireless transmission supports real-time observation.

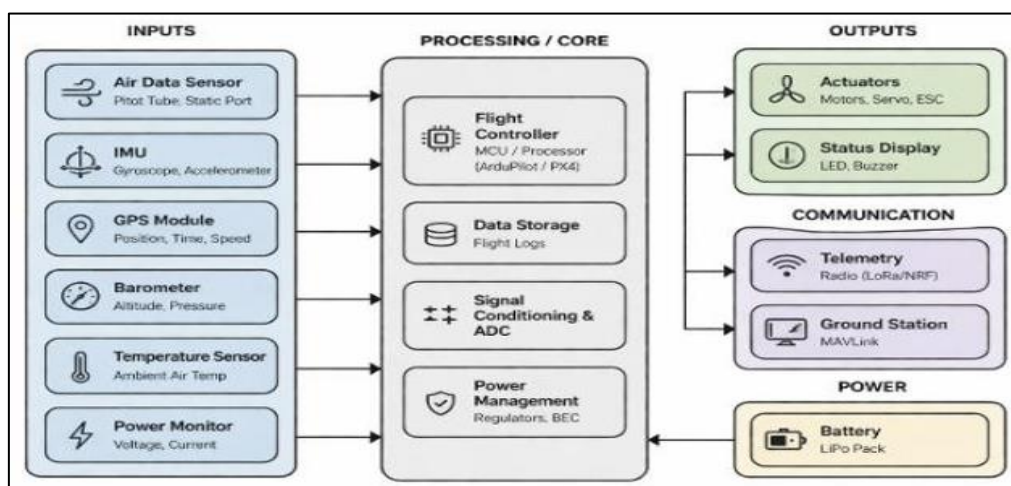


Fig 1 Block Diagram of AEROX

Nevertheless, there are certain limitations that need to be addressed, including energy conservation, weight reduction, and stabilization during switching. Further refinements might involve AI-powered navigation and improved battery capacity.

AEROX System Block Diagram illustrates the structure of the whole AEROX smart transforming rover and drone system based on its key components: inputs, flight controller (processing component), outputs, communication, power system and failsafes.

Inputs include sensors of different kinds, which measure the current parameters of the system – GPS/GNSS, IMU (accelerometer/gyro sensor), barometer, air data sensor, RC receiver. Those inputs deliver the position information, orientation information, altitude information, air speed data, pilot's commands and other relevant data to the flight controller (autopilot). Central Flight Controller (also known as autopilot) is considered a central processor unit, performing important tasks like sensor fusion (for example, Kalman filters) and control algorithms for stability purposes as well as managing the mode (manually-controlled, automatic, RTL), and data log.

Further, those processed data will be passed to the Output Unit including servomotors, actuators and other devices that control movement, orientation, speed. In addition, some payload might be included here as well as the status LED. Communication Unit allows for transmitting data about the drone via telemetry and connecting with the ground station.

Power Unit consists of a LiPo battery and power regulator delivering the required amount of power to all other parts of the system. Finally, some failsafes including geofencing or automatic RTL in case of losing connection have to be mentioned.

Transformation Mechanism Block Diagram illustrates how data flows and turns into physical movement in order to maintain control and stability at every moment of the mechanism operation.

It starts with an Input Signal, which can originate either from a remote controller or an onboard program or a decision-making algorithm basing on the information delivered by sensors. This signal arrives at the Control Unit, which is considered to be the brain of the whole mechanism.

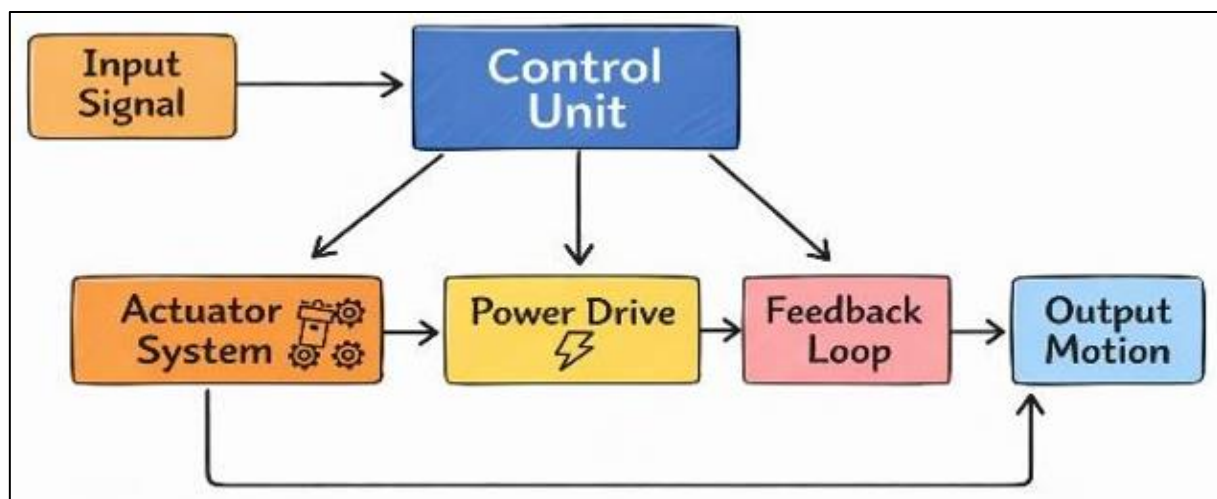


Fig 2 Transformation Mechanism Block Diagram

Commands are then transmitted to three main components, starting with the Actuator System, which consists of motors, servos, or mechanical linkages to perform the transformation, such as switching from a rover mode to a drone mode. Then comes the Power Drive that provides the necessary electric power to make the actuators work efficiently. The last component is the Feedback Loop that constantly tracks the performance of the system by using sensors (position, angle, speed, etc.).

Output Motion becomes the final product of the whole process that is represented by the physical change of the system in question. Feedback is constantly provided back to the control unit for the sake of accuracy, stability, and errors checking. Overall, the diagram shows a closed-loop control system, where input → processing → action → feedback ensures reliable and controlled transformation.

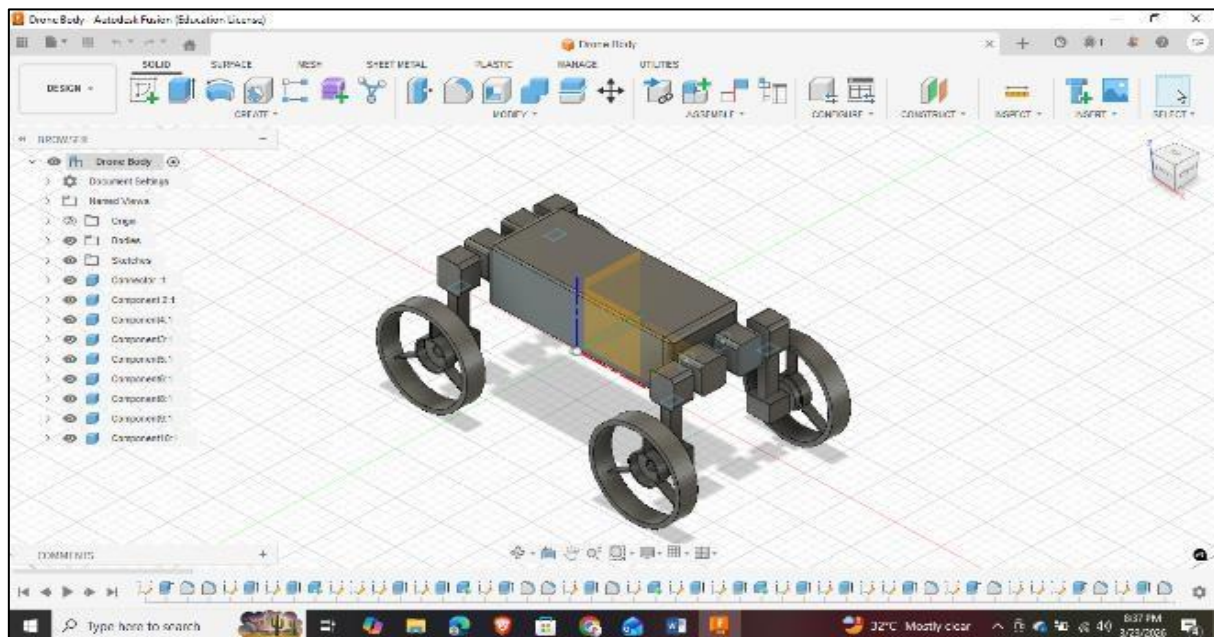


Fig 3 Auto-Cad Design of Project

In summary, the diagram above depicts a closed-loop control system where input → processing → action → feedback guarantee successful and systematic conversion.

The image illustrates a 3D CAD model of the AEROX rover chassis created using Autodesk Fusion 360 (AutoCAD-based platform). This figure indicates the mechanical framework of the rover mode.

The chassis design entails a rectangular body frame. It serves as the core housing unit for the battery, controller, sensors, and transformation device. The body is compact and strong to provide robustness and consistency when performing functions in ground and air modes.

Furthermore, the chassis design incorporates four large wheels on either side joined by axle mountings and brackets. The four large wheels make the rover move efficiently on any uneven terrain. Therefore, the rover can travel smoothly

and maintain good balance while moving on the surface. The mountings are sturdy since they seem to be reinforced.

Additionally, the design involves joint linkages and grouped components (seen on the left panel). Thus, the design comprises several elements such as the chassis, joint linkages, and wheels. The modular design simplifies manufacture and testing processes and allows for subsequent modifications.

The coordinate axes (X, Y, Z) visible on the workspace confirm that the design is correctly oriented within 3D space. This orientation is essential for simulations, motion analysis, and design transformations.

Generally, the 3D CAD model above provides the mechanical structure of the AEROX in rover mode.

➤ Components Used in AEROX

Table 1 Components Used in AEROX

Component	Function
Microcontroller	Controls entire system
DC Motors	Rover movement
BLDC Motors	Drone flight
Sensors (IMU, US)	Navigation & obstacle detection
GPS Module	Location tracking
Camera Module	Live surveillance
Wireless Module	Communication
Motor Driver	Controls motor speed/direction

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