Autonomous payload handling and positioning system

1	**Problem Statement**	A secure, modular, intelligent payload handling and autonomous placing mechanism for releasing payload at precise locations.
2	**Technology Area**	Autonomous Drone systems, image processing, Robotics and Mechatronics, Computer Vision, UAV Payload Management Systems, Sensor Fusion
3	**Project Introduction**	Unmanned Aerial Vehicles (UAVs) are increasingly used to carry and deploy payloads in hard-to-reach or high-risk areas. However, most current drone systems either drop payloads blindly or require human intervention. For critical missions, like placing communication nodes for rescue teams or deploying medical kits, precision placement and secure payload handling are essential. A modular, autonomous payload holding and positioning system allows drones to: • Securely carry mission-critical payloads. • Navigate and evaluate the best placement spot using onboard sensors. • Align precisely. • Safely and intelligently release the payload at the optimal location. Traditional drones lack: • Secure payload interface: Manual or fixed locking systems can't adapt to different payloads. • Environmental awareness: They can’t identify optimal placement zones in real time. • Adaptive release control: They either drop payloads at fixed GPS points or under manual control.

4	**Description**	The system should provide modular, intelligent, and automated payload deployment, significantly enhancing operational efficiency and safety in critical scenarios.
		A. Mechanical Subsystem (Payload Holding)
		• Attachable and Detachable Mechanism
		  ○ Servo-controlled latch, electromagnetic hook, or mechanical clamp
		• Modular Payload Mount
		  ○ Universal attachment points with guided locking rails or pins
		• Lightweight, Rugged Design
		  ○ Carbon fiber or reinforced polymer frame
		
		B. Autonomous Positioning Subsystem
		• High-Precision Navigation
		  ○ RTK-GNSS + IMU Fusion for centimetre-level accuracy
		• Terrain/Zone Analysis
		  ○ Downward-facing camera, LIDAR, or IR sensor to detect suitable surfaces
		• Decision-Making Algorithm

		○ AI model selects best drop point C. Control & Release Subsystem • Microcontroller-Based Controller ○ Interfaces with flight controller (via MAVLink, UART, or I²C) • Release Trigger ○ Based on GPS, visual cue, terrain match, or remote command • Feedback Loop ○ Confirms payload lock/unlock status, logs telemetry
5	**Roles & Responsibilities of C-DOT**	C-DOT will provide technical development assistance, and financial support to the project partner(s) selected through a process of evaluation and due diligence conducted by a committee of subject experts. Wherever deemed necessary and depending upon the project type (i.e. co-development or fully outsourced), C-DOT may arrange resources, equipment, training, testing infrastructure, mandatory clearances, statutory permissions, and provide gap funding to the partner(s) in realizing the respective target deliverables. Development costs of the module, whether developed from scratch or derived from existing background technology of partner(s), shall be borne by C-DOT. C-DOT shall use the final solution for integration with production grade software. C-DOT reserves the right to modify and enhance the solution and provide it to C-DOT customers or another Partner(s). C-DOT shall engage with Partner(s) on a non-exclusive basis and shall retain its right to develop similar projects/products through other developmental programs.
6	**Roles & Responsibilities of Partner(s)**	The Partner(s) may build the required module afresh or by modifying pre-existing background technologies available with them. As per the project demand or project type, the Partner(s) may utilize the available test and infrastructure facilities offered by C-DOT with no/some financial implication for its usage. Specialised equipment required for system specific testing and demonstration of solution capabilities, will have to be arranged by the partner(s). All commercial proposals shall include necessary cloud infrastructure cost as per requirements, manpower and cost breakup (Capital, Consumables, Travel, DA, Training, Contingency, Overhead, GST etc.). The proposal should include minimum of one year support for

		enhancements and capacity building for future enhancements in the product. Participation in the project shall be on a non-exclusive basis. All partner(s) shall be required to demonstrate commitment to the project by entering into a formal agreement with C-DOT as per the CCRP policy.
7	**Expected Deliverables**	1. Fully Integrated Drone Payload Handling System A functional drone system that: • Securely holds, transports, and releases a payload. • Autonomously navigates and aligns over optimal placement locations. • Reliably performs precision placement of payloads based on environmental analysis. 2. Modular Payload Mount with Smart Locking Mechanism which is interoperable with industry standard drones. • Mechanical or electromechanical attach/detach mechanism (e.g., servo latch, magnetic clamp, or winch). • Feedback sensors to confirm lock and release states. • Modular design supporting various payload shapes and sizes. • Soft landing of the payload • Reusable payload handling system 3. Autonomous Positioning and Site Selection Capability • Onboard sensors (camera, LiDAR, RTK-GPS, IMU) for environment perception. • AI or rule-based logic for terrain analysis and optimal location selection. • Ability to avoid obstacles and adjust in real time based on local features (e.g., flatness, line-of-sight, proximity to target). 4. Real-Time Control and Feedback Loop • Payload controller that: o Interfaces with flight controller and sensors. o Executes release commands. o Sends real-time feedback (locked/unlocked, success/failure). • Telemetry/logging of payload deployment (timestamp, GPS, altitude, placement status). 5. Mission Automation and Repeatability • Drone can autonomously: o Identify target zone. o Execute drop. o Log status and return for the next payload.

		• Supports multi-drone coordination or swarm-based deployment scenarios.
		
		6. Demonstration Scenario / Prototype Test
		• Live field test or simulation showcasing:
		  ○ Autonomous flight to a GPS-defined zone.
		  ○ Visual or terrain-based landing site selection.
		  ○ Payload release onto a predefined surface (e.g., rooftop or marked area).
		  ○ Confirmation of successful drop with onboard camera or sensor.
		
		7. Documentation and Performance Metrics
		• System block diagrams, control flow, and mechanical design documentation.
		• Evaluation of performance under:
		  ○ Varying terrain and weather.
		  ○ Different payload weights.
		  ○ GPS-available vs GPS-denied environments.
		• Key metrics:
		  ○ Payload placement accuracy (cm-level)
		  ○ Release success rate (%)
		  ○ System latency (ms)
		  ○ Mission success/failure cases
		
		8. Scalable and interoperable Framework for Other Applications
		The developed system can be extended to:
		• Sensor deployment in remote monitoring (e.g., forest, volcano, radiation zone).
		• Temporary installation of telecom relays or surveillance equipment.
		• Tactical deployment in defense or border patrol operations.
		
		9. A minimum of 2 Prototype units for testing and demos; readiness for producing pilot quantities.

8	**Ownership of Background & Foreground IP**	All technologies created during the project shall be owned by the C-DOT. Any agreement required for collective ownership shall be subsequently settled directly with the concerned partners, but the ownership/IPR of the final solution shall rest with C-DOT only with all the deliverables including complete source code etc.
9	**Timeline for Project**	6-8 months from date of approval

10	**Eligibility Criteria of Partner(s)**	Desirable Vendor Requirements for ensuring expertise in Drone Technology, 1. Proven expertise in development of Drone Technologies, Computer vision 2. Industry Recognition 3. Experience in Mechatronics/Robotics