Aircrew Operator's and Maintenance Manual: 3D Robotics SOLO

1. Introduction

The **3D Robotics (3DR) SOLO** is a commercial hobby type UAS commonly used for photography and recreational use, and provides a stable platform for aerial photography. This document describes operating and maintenance procedures developed with the help of the University of Nevada AirCTEMPs instrument center. This document is intended for AirCTEMPs aircrew familiar with the operations and maintenance of the 3DR SOLO. The following 3DR documents provide supplemental and more detailed information: SOLO Quick Start Guide and the SOLO User's Manual; which contains a section on safety procedures. New AirCTEMPs aircrew are encouraged to familiarize themselves with the above DJI documents before operation or maintenance, and during training.

1.1 3DR SOLO Performance Specifications

Aircraft	
Weight (including battery)	1500g
Weight (including battery, gimbal, GoPro)	1800g
Max Payload	420g
Max ascent	10m/s *stabilize* mode, 5m/s *fly* mode
Max descent	10m/s *stabilize* mode, 5m/s *fly* mode
Max flight speed	15m/s *fly* mode
Max flight altitude	6000m
Max flight altitude A.G.L.	122m (FAA regulation, Geofenced)
Flight time	20 – 25 minutes (approximate)
Motors	880kV
Radio Control	
Frequency	2.4GHz
Control signal range	800m (factory standard) (~0.5 miles)
Communication	3DR Link secure WiFi network
Drone Smart Battery	
Type	Lithium Polymer
Weight	0.50 kg (~1.1 lb)
mAh	5200
Vdc	14.8 (4 cell)
Charging Time	~1.5 hours
Controller Battery	
Type	Lithium Ion
mAh	2600
Vdc	7.2 (rechargeable)

2. Operation Checklists

2.1 3DR SOLO Pre-Mission Checklist

___ Flight Log, Registration, Manual, Check lists, Com Radios

___ Firmware up to date, log book check

___ Airframe: no cracks or separations.

___ Motors free and no roughness; only slight detent

___ Motor Airframe and Accessory screws tight

___ Propellers and spares in good condition, tightened

___ Gimbal guards in place (when applicable)

___ Batteries half charge for transport, or full charge if mission imminent

___ Battery chargers (Smart battery, controller battery, tablet battery)

___ Control switches, sticks, tablet mount functioning

___ Primary and backup tablet check and map(s) Pre-fetched

___ Primary and spare USB cable

___ SD card(s) cleared

___ Firmware up to date

2.2 Preflight Checklist

Registration, Manual, Log, Com Radios (if applicable)

Craft

Airframe and Hardware	Check
Gimbal	Locks removed and gimbal free
Propellers	No nicks, cracks Check to make sure props are on correct motors (black to black, silver to silver)
Motors	Free
Flight Battery	5 Lights, Voltage recorded
Camera SD Card	Installed

Controls

Battery	at least 50% charge
Sticks	Full and smooth
Controller Display	Check
Tablet	Attached, screen clean
Antenna	45 degrees

2.3 Power-Up Checklist

Control	On
Tablet/laptop	On
Flight Battery	8 LED's lit in sequence, then all lit
Connection Established	Check
GPS lock	Check
Data Channel	WiFi Connection established
Compass	*Calibrate if new location
Home Point	Established when SOLO starts up. Check
Take off Area	Clear for 5m
Camera	Connected, transmitting (if applicable)

2.4 Takeoff and Hover

Taking off Home Point	Check (auto created by Mission Planner)
Controls	Check digital display (battery, GPS, WiFi…)
Telemetry Data Collection	Check
Video Link	Check
Camera Gimbal	Check
Camera	Start

2.5 Landing and Shut Down

Camera	Stop
Landing Area	Clear for 5m
Motors	Stopped
Battery Voltage and Flight Time	Recorded
Flight Battery	Power Off

2.6 Post Flight

Flight Battery	Off (too hot?)
Control	Off
Motors	Check and remove propellers
Gimbal	Install locks
Airframe and Hardware	Check
Camera SD card	Removed and mission labeled.

2.7 3DR SOLO Common LED Codes

LED lights are under each arm, at the base of the leg attachments

Light Sequences

Solid White (front and back)	Ready to fly: standard flight configuration
Pulsing white and red	Under Auto Pilot Control
Flashing red, alt. front and back	Controller Signal Lost
Flashing Rainbow	Update in Progress
Solid Green: then turning off one by one	Startup Successful
Sold green without turning off automatically	Startup Unsuccessful, restart SOLO

3. Lost Link Procedures

3.1 Emergency Procedure Features with SOLO

Pause

Allows you to stop SOLO in its current position in the air. Stays until further commands given.

Use to: -prevent hitting an object
-reorient
-only works with GPS lock

Regaining Manual Control

Always have controller in hand. If, for any reason during otherwise automated flight, manual (standard) control is needed. Use the fly  button.

Return Home

Use this to automatically force SOLO to return home, so long as GPS is locked.

Use when: -low battery indicated on controller shows
-quick, unexpected end to flight needed
-DOES NOT AVOID OBSTACLES WHEN THIS FEATURE USED. Need standard flight and manual control to do this.

Land

Press and hold  to land SOLO directly under its current position.
Can work without GPS lock, but drift can occur.

Emergency Motor Shut-off

Simultaneously hold down the A, B and Pause Buttons. LAST RESORT.

3.2 Controller Signal Loss

An automatic failsafe procedure is programmed into the SOLO, so that in the event of controller signal loss, the “Return Home” feature is automatically enabled. If controller signal is regained, PIC has the option to regain control by pressing the  button.

3.3 Home Point Establishment

The PIC shall access the flight course to determine if terrain or obstacles are within the course area. If there are any terrain or obstacles ensure that the return to home altitude is set to clear these obstacles. The PIC shall establish home point at the takeoff location, which, if using Mission Planner software, is done automatically; the home point is designated at the location of quad start up.

If flying without GPS lock, DO NOT use return to home feature, even if, during the flight, the drone re-acquires a GPS lock. If in this case, the drone acquires a GPS lock, it will make its first lock location the return-to-home location, which can be potentially dangerous.

3.4 Fly-Away

The 3DR flight controller failsafe mode is to land immediately or return to home. Because of this, fly-away is unlikely to occur providing that proper start up procedures are followed and the craft is not launched before GPS satellite acquisition has occurred and home point has been established.

In the event of a suspected fly-away the craft should be monitored, after above-mentioned attempts to correct the errant flight have been attempted, and if it appears the craft is not responding to controls, or does not appear to be following fail safe mode of land immediately or return. ATC shall be notified of the last position and altitude and heading of the craft, and of the approximate flight time remaining.

3.5 GPS Signal Loss

SOLO will automatically switch to manual flight mode if a GPS signal is lost. NOTE: because a GPS signal is lost, SOLO will not maintain a position when the right joystick is released.

If GPS is lost, attempt to immediately land and wait for GPS signal to reconnect.

If a secondary error occurs (low voltage, signal loss) the drone will initiate an immediate landing procedure at current location.

3.6 Battery Alerts

Controller display will give a battery warning at 25% and 10%. At 5%, SOLO will immediately initiate the “Return to Home” program.

DO NOT let battery reach 0%, as this will ruin the battery.

Plan mission in order to land with a minimum 25% charge.

Controller Battery charge will also display when low; at 10%, 5% and 0%. If controller battery goes below 5%, “return to home” program will be initiated by the drone automatically.

Plan mission in order to before controller battery reaches 10%.

3.7 Recovery

All reasonable efforts shall be made by the flight crew to recover lost aircraft, with crew safety being a priority.

3.8 Imminent Crash

If all attempt to regain control fail and a crash is Imminent. PIC is to first: attempt to, if at all possible, steer the UAS away from bystanders and other field workers. Second: audibly communicate to any nearby workers or bystanders of the imminent crash, forcing all nearby personnel and bystanders to keep their eyes on the UAS if possible.

4. Maintenance

4.1 Introduction

Because the 3DR SOLO is powered by electric motors and lithium polymer smart batteries, and the manufacture 3DR does not have a specified TBO or specified periodic maintenance, AirCTEMPs conducts physical inspection of craft pre- and post-flight and post-mission for any mechanical defects or indication of ware or aging of the airframe and components. Since flights are of a duration of approximately 20 minutes, because of battery capacity, problems with propulsion motors such as indications of bearing ware should be evident on inspection and initial power up. Also because of the short duration of flight, motors have a low likelihood to fail catastrophically during flight. Because this is a multi-rotor VTOL craft and does not have control surfaces, there are no moving parts or actuators other than the flight motors that require inspection or for ware or function. The lithium polymer battery life expectancy is dependent on charge and discharge rates and storage practices, and have an unpredictable life expectancy. To predict battery replacement interval, the voltage of each battery shall be recorded in a battery log along with the flight time and the percent battery remaining as indicated on the tablet/laptop display.

4.2 Inspection and Maintenance Procedures

UNR AirCTEMPs SOLO is to be inspected by the PIC pre- and post-flight and pre- and post-mission by the AirCTEMPs Technician.

Pre- and Post-mission Inspection

_____ **Static Start Up**

Remove gimbal locks. Remove propellers or secure aircraft landing gear to test bench. Start aircraft and ensure indicator lights and annunciators are functioning. Arm motors and listen for uniform idle operation.

_____ **Control**

Test control sticks for correct motor response. Test function of controller switches, and sticks (see Appendix for web link)

_____ **Firmware**

Check last firmware update in log book and confirm firmware is current version. Update as needed.

_____ **Airframe**

Ensure airframe has no cracks or separations. Replace airframe shell or other components if cracks are detected. Shell separation may be due to miss-alignment and may snap into place with slight pressure. Confirm that shell separation is not due to missing or loose screws or hardware, and replace any damaged components.

_____ **Motors**

Motors free and no roughness. Inspect motors visually for any debris between rotor and stator. Place propeller on motor and spin with finger to confirm motors turn freely with slight detent due to motor magnets. Any grinding, ticking or squeaking sound may indicate debris in the motor or worn bearing. Clean or replace motor as necessary.

_____ **Propellers**

Inspect primary propellers and spares for cracks chips or nicks. Replace cracked or chipped propellers. Small nicks may be sanded or burnished, however it is advisable to replace rotors with even slight defects.

_____ **Gimbal**

Inspect gimbal for free movement and put guards in place.

_____ **Batteries**

Confirm batteries are at half charge for long term storage or full charge if mission is imminent.

_____ **Tablet/Laptop**

Check tablet/laptop for current flight app. version.

_____ **Accessories**

Check flight, controller and tablet/laptop battery chargers cables and connectors.

_____ **Test Flight**

Schedule test flight if control systems, propulsion motors or airframe components have been replaced, or if firmware has been upgraded.