

## UxV/35 Sturnus

### Manual Operation Manual

This document outlines the basic knowledge needed to fly the Sturnus drone.

**Note:** Refer to the pre-flight checklist in order to prepare a Sturnus for flight.

#### Section One: Radio Controller

The labels found on every Radio Controller serve only as a helpful reminder as to the function of all switches and analog sticks. The functions of every input on the Radio Controller are found below.



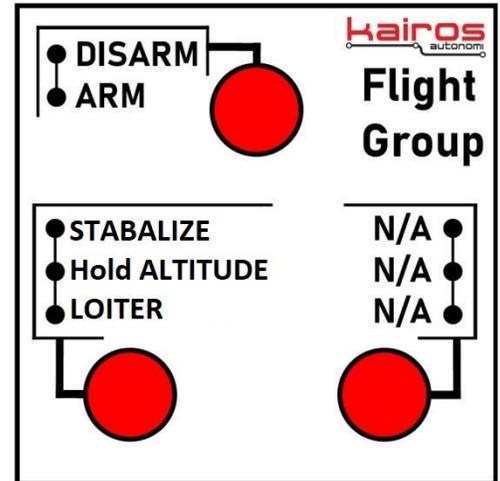
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## Flight Group:

Located in the top left of the Radio Controller, the flight group contains every switch you will need in order to safely takeoff, fly and land the Sturnus drone.

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**Arm/Disarm:** This switch, located furthest back left in the flight group, powers on and powers off the motors of the Sturnus drone. “Arming” a Sturnus drone refers to flipping this switch towards the operator by lifting the switch vertically and pulling it towards oneself. **The Sturnus is able to be “Disarmed” at any time** by flipping this switch away from the operator. Practice flipping this switch. The ability to reliably kill the motors of a large drone is important to the safety of people working around the drone.



**Flight Mode Switch:** The switch located closest to the operator on the left is the switch that determines the “mode” of the drone. For a Sturnus, there are three selectable modes detailed below.

**Loiter:** When the Flight mode switch is in the position closest to the operator the drone is in the “Loiter” flight mode. In this mode, with an adequate GPS signal, the drone will hold its position in 3D space. There is little to no reason to ever leave this flight mode.

**Altitude Hold:** When the flight mode switch is in the middle the drone is in the “altitude hold” flight mode. In this mode, the throttle stick will either tell the drone to lose descend and lose altitude below fifty percent throttle, stay and its current altitude at fifty percent throttle, and increase in altitude above fifty percent throttle. Although altitude is assisted in this mode yaw, pitch, and roll will still need to be controlled by the operator.

**Stabilize:** When the Flight mode switch is in the position farthest to the operator, the drone enters Stabilize mode. **In the Stabilize mode the drone will NOT hold its position in 3D space.** Often the drone will drift as a result of wind and other factors. This Flight mode is only ever used to recover a drone that is flying erratically or becoming a fly-away (Fly-away defined below).

**Not Assigned:** The third switch, located closest to the operator on the right, is not used for any input. The switch has no effect on the drone or the Radio Controller.

For most flights, Loiter mode is the only flight mode that should ever be used in order to fly the Sturnus drone. For this reason, the “Loiter” position should be selected before ever arming the Sturnus drone. Take care to not accidentally change the flight mode of the Sturnus during operation.

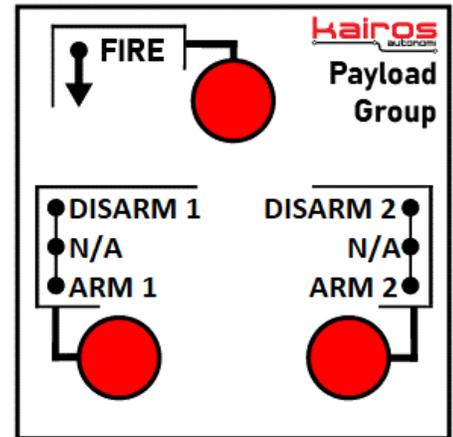
## Payload Group:

This grouping contains the two switches that enable the Sturnus drone to arm and fire any payload mounted to the drone. The two switches used to arm and fire this payload are detailed below

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**Arm/Disarm Switch 1 & 2:** Not to be confused with the arm/disarm switch of the Flight group, this switch enables a payload to be armed before firing. The switches located closest to the operator on the left within the Payload group serves this function. When in the position furthest from the operator or in the middle position, the payload of the Sturnus will be “disarmed” and unable to fire. When in the position closest to the operator the payload will be “armed”.

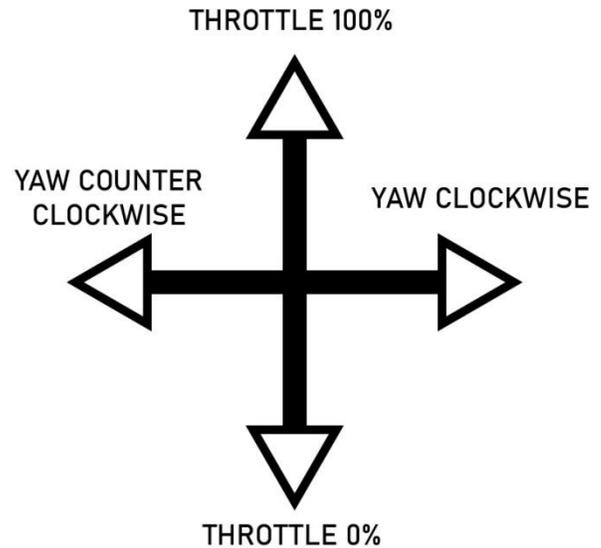
**Fire Switch:** The “firing” switch is located furthest from the operator in the payload group of switches. The Fire Switch must be moved into the position nearest the operator before the payloads can be dropped.



## Left Analog Stick:

Controlling the **Throttle** and **Yaw** of the Sturnus, the left analog stick will be primarily used to increase and decrease the altitude of the drone. Both inputs are detailed below.

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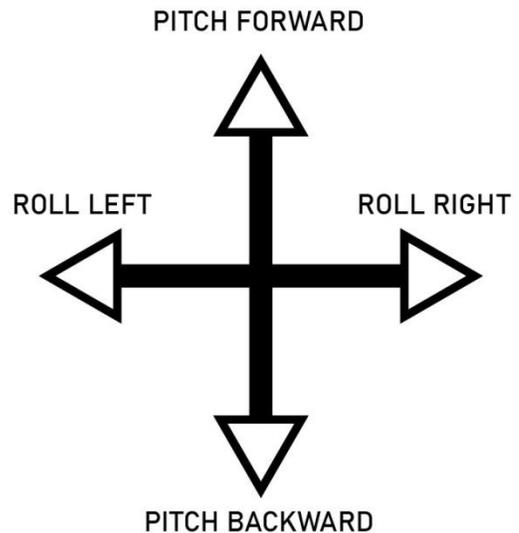
**Throttle input:** The throttle input of the Sturnus is manipulated by moving the Left analog stick vertically up and down. If in Loiter mode, the throttle of the Radio controller naturally sits at 50% with no input from the operator, meaning the drone will not attempt to gain or lose any altitude. Moving the Left analog stick vertically up will make the drone increase in altitude. Moving the Left analog stick vertically down will make the drone lose altitude.

**Yaw input:** Yawing refers to changing the direction in which the nose of the Sturnus drone is facing. Think of manipulating yaw as rotating a compass to point at a different heading. If you were looking at the Sturnus from above, moving the left analog stick horizontally left will rotate the drone counter clock wise, while moving the stick to the right will rotate the drone clock wise.

For pilots with limited experience flying drones, it is Important to **use Yaw to keep the nose of the drone facing away from the operator.** The skill required to pilot a drone that is facing in any other direction develops over dozens of hours of flight. New pilots will quickly lose control of a Sturnus whose nose is not facing away from the operator.

**Right Analog Stick:** Controlling the **Roll** and **Pitch** of the Sturnus, the right analog stick is used to maneuver the drone in the horizontal plane. The manipulation of Roll and Pitch on the right analog stick is outlined below.

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**Roll:** The “Roll” of the Sturnus is controlled by moving the right analog stick horizontally left and right. With the nose of the drone (the side of the drone containing the camera) furthest from the operator, moving the right analog stick horizontally left will lean the Sturnus to the left. Moving the right analog stick horizontally right will lean the Sturnus to the right.

**Pitch:** The “Pitch” of the Sturnus is controlled by moving the right analog stick vertically up and down. Again with the nose of the drone (the side of the drone containing the camera) furthest from the operator, moving the right analog stick vertically upwards will make the Sturnus lean forwards. Moving the right analog stick vertically downwards will make the Sturnus lean backwards.

The practical application of the Right analog stick is to move the Sturnus drone in any direction through the horizontal plane. By exclusively manipulating the right analog stick, (while in loiter mode) the drone will maneuver horizontally through space without changing altitude.

## Section Two: Takeoff

This section outlines the steps of arming and lifting the Sturnus off of the ground. It is assumed the drone, radio controller and video receiving system have all been appropriately prepared and powered. Refer to the preflight checklist for details.

### 1. Loiter Flight Mode

Ensure Sturnus is set to Loiter Mode. Expanded upon above, the Loiter flight mode is by far the easiest flight mode to takeoff in and should be used exclusively for most flights.

### 2. Wait for GPS positional fix

Once powered and after a delay of less than three minutes, the number of satellites displayed in the top left of the video should be greater than 9, allowing the drone to arm.

### 3. Arm the Sturnus drone

Arm the drone using the arm switch in the back left of the flight group. Motors will begin to spin. Allow the drone to sit with motors spinning for at least 3 seconds.

**Note: If the drone does not arm**, it is likely that the drone does not yet have a GPS fix on its position, as required to fly in the Loiter flight mode. Switch the Arm/Disarm switch back into the disarmed position and wait for the number of satellites in the top left of the video to rise. Then attempt to arm the drone again.

### 4. Observe the Sturnus drone spins up propellers

If props begin to spin, the drone is ready for takeoff. For new pilots it is helpful to quickly rise off the ground, as the drone handles better when 5+ feet off of the ground. For these pilots the goal is to quickly rise to this altitude.

### 5. Raise throttle to 75%

By vertically moving the left analog stick upwards, raise the throttle to approximately 75% (or  $\frac{3}{4}$  of the way upwards on the left analog stick). Do not interact with any other analog stick during takeoff. Ensure that you are not moving the left analog stick horizontally while increasing throttle, as this will cause the drone to yaw while it gains altitude.

### 6. Put both left and right analog sticks to their Center Point

Once the drone has risen to 10+ feet above the ground the operator can cease any input to both of the analog sticks. In loiter mode the drone will hold its position in 3D space and no input is required to keep the Sturnus airborne and stationary.

## Section Three: Basics of Flight

This section outlines safely navigating the Sturnus through space to a destination once the drone is airborne.

- For all new pilots, the Sturnus should **ALWAYS** be flown with the nose of the drone facing away from the operator. This keeps the controls of the drone relatively straightforward and intuitive. To check that this is the case, briefly move the right analog stick to the left or right, ensuring this results in the expected change in position of the drone as expanded upon in section one.
- Navigating to a new position in 3D space is best done in two steps.
  1. Use throttle to change the altitude of the Sturnus to the desired final altitude. Beginners are advised against making changes in both altitude and position simultaneously.
  2. While leaving the left analog stick completely untouched, manipulate the right analog stick to move the Sturnus horizontally through space. With the nose of the drone facing away from the operator changes in the position of the right analog stick should be mimicked closely by the Sturnus.
- If the operator ever loses confidence in the controls while piloting the Sturnus it is best to simply center the position of both sticks (make sure not to drop the controller!). This means allowing both sticks to reset to their center position. While in Loiter mode this will make the drone hold its position and allow the Operator to regain their orientation and confidence in the drone.
- **The Sturnus drone is not equipped with obstacle avoidance.** It is the responsibility of the operator to maneuver the Sturnus around obstacles. If the operator is ever uncertain, it is best to make extremely small inputs one at a time until confidence is regained.
- **Maintain Focus on the Sturnus drone**

While the Loiter flight mode is proven to be reliable, it is still essential that the operator maintains focus on the drone **and its surroundings**. For this reason, the operator should **never divert their attention from the aircraft/controls while the drone is airborne.**

## Section Four: Landing

This section outlines landing a Sturnus drone while in loiter mode. In the Loiter flight mode this is achieved easily as detailed below.

The procedure for landing the Sturnus drone is simple and can be broken down into five stages.

### 1. Navigate above Landing Zone

First, use the right analog stick to navigate the drone above the desired landing location. Once there release input from the both analog sticks allowing the Sturnus to hold its position.

### 2. Perform a slow descent to the ground

Cautiously vertically lower the left analog stick until the Sturnus begins to descend. The target rate of descent for a Sturnus drone nearing the ground is approximately 1ft/s. Ensure the drone descends at this rate as it approaches the ground

### 3. Acclimate the drone to the ground

Once the drone has touched the ground, push the left analog stick vertically all the way to the bottom of its range of motion, where throttle is 0%. Hold the throttle to this position for greater than two seconds. This will ensure the drone sticks to the ground and acclimates to the air pressure of the ground.

### 4. Release analog stick input

While the drone is sitting on the ground release all input from both analog sticks. Visually ensure that the drone is stationary when all analog sticks have reset to their central position.

### 5. Disarm the Sturnus drone

Finally, use the Arm/Disarm switch within the Flight Group of the Radio Controller to stop the spinning of the propellers.

## Unexpected Behavior/Fly-Away Drone

While the Sturnus drone is proven to be reliable, the operator of any large aircraft must be equipped to deal with failures. The skill to recover a drone that is behaving unexpectedly is essential to any operators of a Sturnus drone.

### Battery Running out: Land Immediately

The most likely cause of the Sturnus failing to hold its position in 3D space is the battery running out. In this situation the drone gradually begins to lose altitude. While there is little an operator can do to counter this loss of altitude, it is possible to use the right analog stick to guide the drone in a direction. **The drone should be landed immediately in the safest nearby location possible.**

### Fly-Away: Switch to Stabilize flight Mode - Land immediately

There is a small chance that a drone's sensors mislead it into believing it is losing altitude. While in the Loiter flight mode, this will result in a fly-away where the drone increases throttle and gains altitude completely on its own. An operator can recognize this behavior by observing the drone aggressively gaining altitude while the left analog stick is at 50% throttle. **The solution to a fly-away is to switch the Sturnus into the Stabilize flight mode.** This will cause the sensors that are acting unpredictably to be ignored by the drone, allowing the operator to land the drone safely. The drone cannot perform optimally outside of the Loiter flight mode and should be landed as soon as possible. Be aware that allowing the left analog stick to reset to the central position may cause the drone to gain altitude in stabilized mode. Landing will require the throttle to be held to 0% while disarming.

## Version History

Name	Date	Version	Description
Nicholas Ronnie	7/1/2024	V1.0.0	Document Created