EZRA ROBOTICS

X30 User Manual

Substation patrol and inspection with the Jueying X30, the Skydroid H12 and NETRA

Version 1.0 • 2026-11-21

For the substation's operators and the robot crew. No robotics knowledge needed: everything here is done on the H12 or in NETRA.

About this document

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Installing the robot, the app and NETRA is in the X30 Installation Guide; settings and their tuning in the X30 Tuning Guide. The robot's own hardware (battery, charging pile, power switch, emergency stops, Deep Robotics' handheld) is in Deep Robotics' Jueying X30 Pro User Manual.

The X30 documents

Installation Guide	Getting the stack, the handheld app and NETRA onto a robot and a computer, from nothing to the first patrol.
User Manual	Operating the robot: safety, the Skydroid H12, routes, patrols, inspections, the recorder and NETRA.
Tuning Guide	What every setting does, the models behind them and how to tune a robot for a site; the full parameter reference.
Architecture	How the stack is built: hosts, nodes, topics, frames, the safety pipeline, the protocols to the handheld and to NETRA.
Site Acceptance Test	The handover tests, with pass criteria and sign-off.

All of them, and the same pages as a website with search: `https://darmawanrobotics.github.io/x30_ros/`.

Revisions

Version	Date	Changes
1.0	2026-11-21	First version: patrols with inspection, the recorder, NETRA

Contents

About this document 2

1 Safety first 5
- 1.1 The substation's rules come first 5
- 1.2 Four ways to stop the robot 5
- 1.3 What the robot watches, and what it does not 6

2 The robot and the system 7
- 2.1 What it does 7
- 2.2 Its parts 7
- 2.3 Its start spot 7

3 The H12 and X30Controller 9
- 3.1 Sticks, keys and modes 9
- 3.2 The drive screen 10
- 3.3 STOP and release 10
- 3.4 On a phone or tablet 10

4 A shift 11
- 4.1 Start 11
- 4.2 End 11

5 Teaching a route 12
- 5.1 Where routes go 12
- 5.2 Teach 12
- 5.3 Tags 13

6 Patrols 14
- 6.1 Start a patrol 14
- 6.2 Obstacles 15
- 6.3 Pause, take over, end 15
- 6.4 When the robot does not know where it is 15

7 Inspection 17
- 7.1 Teach the inspection points in NETRA 17

7.2 What happens at a stop . . . 18
7.3 How a finding is judged . . . 18
7.4 Where the results are . . . 19

8 The recorder . . . 20
8.1 When it records . . . 20
8.2 What you see . . . 20
8.3 The disk . . . 20

9 NETRA . . . 21
9.1 What is where . . . 21
9.2 Alerts . . . 21
9.3 Commands to the robot . . . 21

10 Checks . . . 22
10.1 Every shift . . . 22
10.2 Every week . . . 22

11 When something is wrong . . . 23

A Words used here . . . 24

CHAPTER 1

Safety first

The X30 walks among energized high-voltage equipment. Read this chapter before you use the robot for the first time, and follow it on every shift.

1.1 The substation's rules come first

- The robot works under the substation's safety rules and permits. Only people trained on this manual and authorized by the substation operate it; one of them is responsible for the robot during every patrol, scheduled ones included.
- **Safe distances.** The robot and everything on it stay outside the minimum approach distance of every energized part. Teach routes only along walkways and roads people may use while the equipment is energized: the robot does not know where live parts are, the route is what keeps it away from them.
- **Switching and maintenance.** No patrol through a bay under switching or maintenance. Stop the schedule in NETRA and keep the robot on its dock while work goes on.
- **Weather.** No patrols in rain, lightning or standing water, nor on ground the robot was not taught on.

1.2 Four ways to stop the robot

Stop	What happens
Hard emergency stop (tail)	cuts the joints at once: the robot drops. Only when it must stop whatever it costs
H12: key B or STOP	software e-stop: the robot stands, the patrol pauses; release by holding STOP for a second
NETRA: E-stop	the same e-stop from the dashboard
Deep Robotics' handheld	takes over the robot (manual mode), past the whole stack

The software stops are not certified The e-stop of the H12 and of NETRA, and the robot's protective field, are software. They are a second line, never the only one: keep the hard emergency stop and Deep Robotics' handheld within reach of someone responsible whenever people are near the robot.

1.3 What the robot watches, and what it does not

- **It watches** the space around its body with four LiDARs: it slows down and stops before obstacles in its way (the protective field), and stops when it cannot see.
- **It does not see** holes, steps down or the edge of a platform; objects lower than about 10 cm close to its legs; thin wires. Keep routes on even, solid ground.
- **It does not know** where the live parts are. The route keeps it away from them.
- **It stops itself** when it loses its position, when its sensors fail, or when its battery runs low, and says why on the H12 and in NETRA.

CHAPTER 2

The robot and the system

2.1 What it does

The X30 walks routes taught by an operator and inspects the equipment at their stop points:

- **Teach once, repeat**: an operator walks the robot along the route with the H12 and marks where it stops. The robot repeats the route as often as asked, on its own or on a schedule. There is no map: the route is the robot's memory of the walk.
- **Inspect at every stop**: the thermal camera looks at each piece of equipment taught there and measures its temperatures; the acoustic camera listens for partial discharge. Every finding has a severity, from normal to critical.
- **Record**: during every patrol the cameras' video, their raw thermal frames and the acoustic data are recorded on the robot.
- **Report**: NETRA, the command center, shows the robot live, keeps every patrol, every inspection with its images, and the trend of every piece of equipment.

2.2 Its parts

Part	What it is for
Jueying X30 Pro	the four-legged robot, Deep Robotics
HIKMICRO PTZ camera	thermal and visible camera that pans, tilts and zooms
Hertzino HZ-FA-371	acoustic camera for partial discharge
Four LiDARs	see around the body: obstacles, the robot's own position
Skydroid H12	the handheld with the X30Controller app
NETRA	the command center on a laptop or server

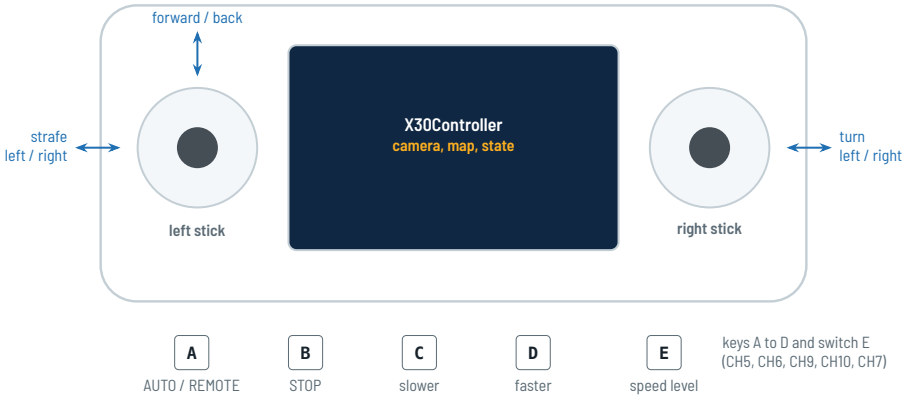
2.3 Its start spot

The robot knows where it is relative to the spot it was started on, usually its dock. Start it there every time, facing the same way: every route was taught from that spot, and the robot

repeats it from there. Markers on the walls (tags), where the site has them, correct the small drift that grows with every metre walked.

CHAPTER 3

The H12 and X30Controller



3.1 Sticks, keys and modes

Control	What it does
Left stick	forward and back; left and right: step sideways
Right stick	turn left and right
A	AUTO or REMOTE
B	STOP: the software e-stop
C / D	slower / faster (three speed levels)
Switch E	the speed level directly

- **REMOTE**: the sticks drive the robot. Nothing else does.
- **AUTO**: the robot follows its route; the sticks do nothing. The screen says **AUTO mode: switch to REMOTE to drive** when you try.

The robot listens to one handheld at a time. When the H12 falls silent (out of range, app closed), the robot stops its stick motion within a fraction of a second.

3.2 The drive screen

- **Top bar**: battery, signal, mode, localization (**Start pose**, **Tag**, **No loc**), the protective field (**Path clear**, **Slowed**, **Blocked**, **No scan**), health (**Needs attention**) and the trip.
- **Large view**: the inspection camera, visible or thermal (the camera button switches); swap it with the map, which shows the route, its stop points and the robot.
- **STOP**: the red button, same as B.
- **Actions**: **Record**, **Point**, **Finish**, **Tags**, **Localize**, **Routes**, **Start**, **Pause**, **Resume**, **End**, **Inspect**, the recorder, and the robot's postures (stand up, sit down).

3.3 STOP and release

STOP (key B or the red button) holds the robot still: **E-stop on: the robot is held still**. A patrol pauses. To release, **hold** STOP for a second (**Hold to release**). After a release the robot moves only once the sticks were let go: a stick held during the release never moves it.

3.4 On a phone or tablet

The same app (version 1.1 or later) runs on any Android phone or tablet. Without the H12 it shows touch sticks on the screen: the left one drives and steps sideways, the right one turns; let go and the robot stops. **Settings › Sticks** chooses who drives:

Choice	Drives
Auto	the H12's sticks, else a gamepad, else the touch sticks
H12	only the H12's sticks
Gamepad	only a gamepad (Bluetooth or USB)
Touch	only the touch sticks

CHAPTER 4

A shift

4.1 Start

1. The robot sits on its start spot (the dock), facing the usual way. Turn it on.
2. Wait about two minutes: the robot's computers start the stack by themselves.
3. Turn on the H12, open X30Controller and pick the robot.
4. Check the top bar: battery, **Start pose** (or **Tag**), **Path clear**, no **Needs attention**.
5. Stand the robot up (the posture action).
6. On the Mac: `scripts/local.sh start`, then the robot shows online in NETRA.

> **Not on the start spot?** If the robot was started anywhere else, its routes are shifted by that much. Sit it down, put it on the start spot and restart it, or ask the technician to localize it on a tag.

4.2 End

1. Stop the patrol (**End**) and stop the schedules in NETRA if no one will watch.
2. Walk the robot back to its dock in REMOTE, sit it down.
3. Charge it (Deep Robotics' manual), then turn it off if it stays off.

CHAPTER 5

Teaching a route

A route is a walk the robot repeats. You teach it once, by walking the robot along it, and mark the stop points where it will stand still and inspect.

5.1 Where routes go

- Along walkways and roads people may use while the equipment is energized, outside every minimum approach distance.
- On even, solid ground the robot can see: no steps down, no holes, no loose gravel slopes.
- With room: at least 1 m wider than the robot (0.47 m) where it passes things, so it can step around an obstacle.
- Starting at the dock, so every patrol begins where the robot was started.

5.2 Teach

1. REMOTE (key A). The robot stands on the dock, **Start pose** in the top bar.
2. **Record**: **Recording a route**.
3. Walk the route slowly and smoothly, as you want it repeated. The robot remembers its path every few centimetres.
4. At each place to inspect, stop the robot where the cameras see the equipment and press **Point**: **Stop point, inspect 10 s**. The robot will stand there on every patrol.
5. At the end, **Finish**: **Route saved**. Its name is the date and the time.

The route is saved on the robot and sent to NETRA by itself (**Routes**), now or as soon as NETRA is reachable.

> **Stop points** Stop where the robot sees the equipment straight and close enough, without leaning into any approach distance. The inspection points are then taught for that stop (Chapter 7); a stop with none simply waits its time.

5.3 Tags

Where the site has markers (tags) on walls or posts, put the robot in view of one near the start and press **Tags**: the robot records where it is. On later patrols, each time it sees that tag it corrects the small drift of its position. Ask the technician where tags help.

CHAPTER 6

Patrols

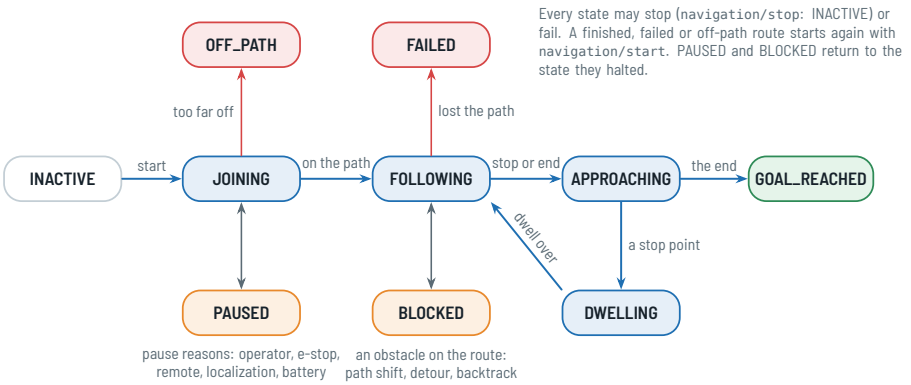
6.1 Start a patrol

From the H12 **Routes**, pick the route, AUTO (key A), **Start**.

From NETRA **Patrols › Start a patrol now** with the robot and the route, or a schedule in **Schedules** (days and time). The robot downloads the route and its inspection points itself.

The robot walks onto the route, follows it, stops and inspects at every stop point, and ends at the route's end. During the patrol the H12 and NETRA show its state:

State on the H12	Meaning
Walking onto the route	on its way to the route
Patrolling	following the route
Approaching a stop	slowing down to a stop point or the end
Inspecting	standing at a stop: the cameras at work
Paused	someone paused it, or the e-stop, REMOTE, localization or the battery
Blocked	something is in its way (below)
Off the route	too far from the route to follow it
Route finished	done



6.2 Obstacles

The robot slows down near an obstacle and stops before it. Then, on its own:

1. it steps to the side and passes the obstacle if there is room (path shift);
2. if not, it tries a short detour around it;
3. if the way stays blocked, it backs up a little and tries again, and finally reports **Blocked** on the H12 and as an alert in NETRA.

Clear the way and it goes on by itself; or take it over in REMOTE.

6.3 Pause, take over, end

- **Pause** / **Resume**: the robot stands and waits.
- REMOTE (key A) during a patrol pauses it: drive the robot, then AUTO and **Resume**. Bring it back near its route first.
- **End**: the patrol stops; the robot stands where it is.
- STOP (key B): the e-stop; after the release the patrol stays paused until **Resume**.

6.4 When the robot does not know where it is

The top bar shows **No loc** and the patrol pauses (Paused: localization). This happens after the robot's odometry restarted. Walk the robot back to its start spot, facing the usual way:

- with a recorded tag in view, press **Localize**: the robot finds its place from the tag;
- without a tag, sit the robot down on the start spot and restart it (or ask the technician to restart its service): the start spot becomes its origin again.

Then start the patrol again.

CHAPTER 7

Inspection

At every stop point of a patrol the robot inspects the **inspection points** taught for that stop: it points the thermal camera at each piece of equipment, measures it and judges it, and listens with the acoustic camera where partial discharge is checked.

7.1 Teach the inspection points in NETRA

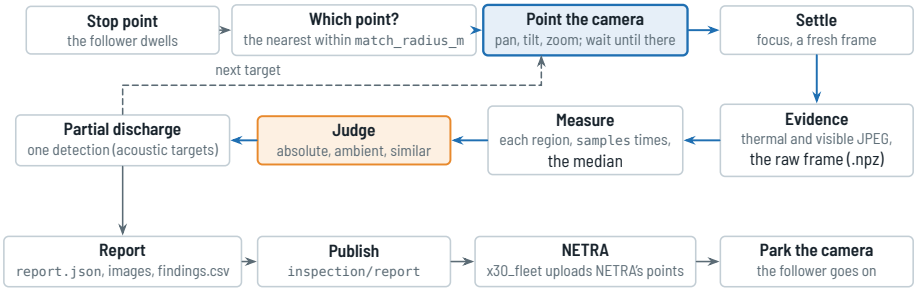
Substation › Inspection points › New point:

1. Pick the route and its **Stop**, and the type: **Thermal** or **Partial discharge**.
2. Set the camera's pose: **Pan °**, tilt and zoom, as the camera saw the equipment at that stop.
3. For a thermal point, add a **Target** for each component (phase R, S, T, a clamp) and draw its region on the image; give **Max °C**, its rated temperature: a reading at or above it is critical (P1).
4. **Create point**.

The robot takes the plan with every patrol started from NETRA. A point **Not on a route** is **Taken on request**: NETRA asks the robot to inspect it where it stands (not during a patrol).

> **Note** The technician can also teach targets on the robot itself, from the camera's current view (Tuning Guide, "Inspection"). Both work side by side; NETRA's points are uploaded to NETRA.

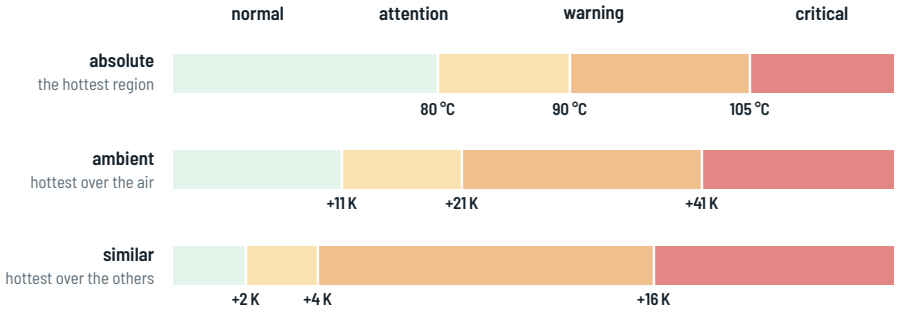
7.2 What happens at a stop



A stop with no inspection point just waits its time. A camera that does not answer is reported, never a reason to end the patrol.

7.3 How a finding is judged

Every thermal target is judged three ways; the finding takes the highest severity of the three:



A finding takes the highest severity of its criteria; a target's own `max_temp_c` replaces 105 °C as its critical limit. Scales are not to scale between the rows.

Criterion	Compares
absolute	the hottest region with fixed limits, or the target's rated temperature
ambient	the hottest region with the air temperature of the day
similar	the hottest region with the others of the same target (the three phases)

Set the air temperature The ambient criterion needs the day's air temperature. The robot uses 30 °C until the technician sets it; on a hot day, loaded equipment otherwise reads high.

Partial discharge is classified by the acoustic camera:

Type	Severity	Meaning
noise	normal	no discharge
corona	attention	common outdoors on high-voltage parts: watch the trend
surface	warning	tracking on insulators or terminations
floating	critical	a loose, floating part

7.4 Where the results are

- **NETRA**: **Substation › Overview** (every piece of equipment and its last capture), **Findings** (what needs action), each point with its trend of readings and its images (thermal, visible, sound map).
- **The H12**: the last point and its severity after **Inspect** or a stop.
- **The robot**: every report with its images and raw thermal frames, by day (`~/x30/reports`); the oldest days go when the disk runs short.

Inspect on the H12 inspects the point where the robot stands, now: useful to check a newly taught point. It takes a few minutes for a point with several targets.

CHAPTER 8

The recorder

The robot records its cameras on its own disk: the visible and thermal video, every raw thermal frame (temperatures per pixel, for analysis later) with the robot's position, and the acoustic camera's data. Nothing goes over the network while it records, so a weak link loses nothing.

8.1 When it records

- **Every patrol**, by itself: from the moment the robot walks onto the route until 30 s after it finished.
- **On request**: start and stop it from the H12 (the recorder action) or in NETRA (**Live control › Recorder**, the switch). A manual recording that runs into a patrol goes on as one session.

8.2 What you see

- **H12**: **REC 4:12 · 250 frames · patrol**, or **Recorder ready**; **Recorder not answering** when the perception host does not answer.
- **NETRA**: a red **REC** badge on the robot's card; in **Live control** the duration, who started it, the thermal frames, the videos, the free disk, and a warning when frames are dropped because the disk is too slow.

8.3 The disk

Before each session and every 30 s while it runs, the oldest recordings are removed until 10 GB is free; below 3 GB nothing is recorded and the recorder says why. Copy recordings you want to keep off the robot (the technician: `~/x30/recordings` on the perception host).

CHAPTER 9

NETRA

NETRA is the command center: open it in a browser on the laptop that runs it (`http://localhost`) or on any device on the same network, and log in.

9.1 What is where

Page	For
Dashboard	every robot at a glance; what needs attention (e-stop, alarms, battery, lost); **E-stop** and its release
Operations map	where the robots are; a robot's card: battery, mode, health, REC, and **Live control** (the recorder, the robot's computer)
Patrols	every patrol with its recap and timeline; **Start a patrol now**
Schedules	patrols by day and time
Routes	the routes the robot taught
Substation	overview, findings, equipment, inspection points
Reports	PDF and Excel exports

9.2 Alerts

The robot reports when it is blocked, off its route or failed, and when its e-stop engages. NETRA shows them on the dashboard and, where configured, sends them to Telegram. Every finding of warning or critical severity appears under **Substation › Findings**.

9.3 Commands to the robot

From the robot's card: pause, resume, stop the patrol, localize, the e-stop and its release, and the recorder. The robot answers each one; a refused command shows the robot's reason.

CHAPTER 10

Checks

10.1 Every shift

	Check
☐	hard emergency stop and H12 STOP stop the robot (test one of them)
☐	battery charged; the H12 charged
☐	camera windows and LiDAR covers clean, nothing loose on the robot
☐	routes clear: no new obstacles, no work in a bay the routes cross
☐	top bar: localized, path clear, no **Needs attention**
☐	NETRA: the robot online, the recorder ready
☐	the day's air temperature set for the ambient criterion

10.2 Every week

	Check
☐	a short patrol watched from start to end: stops reached, inspections complete
☐	findings reviewed in NETRA; trends of the critical equipment
☐	free disk on the robot (NETRA's Live control)
☐	reports and recordings copied off the robot where they must be kept
☐	the feet, the legs and the cameras' mounts

CHAPTER 11

When something is wrong

You see	Do
The H12: **The robot does not answer**	the H12 on the robot's Wi-Fi; the robot on and started (two minutes after power-up)
Another handheld is driving this robot	close the app on the other device
The robot rejected the token	the technician gives you the right token
The sticks do nothing	REMOTE (key A); the e-stop released (hold STOP); the robot standing
No loc	Chapter 6, "When the robot does not know where it is"
No scan or **Blocked** with nothing in the way	a covered LiDAR (dust, a bag on the robot): clean it; otherwise call the technician
Needs attention	the technician; NETRA's dashboard names the issue
Patrol **Off the route**	bring the robot back next to its route in REMOTE, AUTO, start again
No inspection results in NETRA	the inspection points belong to the stops of the route patrolled; NETRA's license must include the substation module
Recorder not answering	the robot's perception computer: the technician

APPENDIX A

Words used here

AUTO, REMOTE who drives: the route (AUTO) or the operator's sticks (REMOTE).

Dock, start spot where the robot starts; the origin of its routes.

E-stop the software emergency stop; the robot is held still until released.

Inspection point a place, at a stop, where the camera looks at equipment.

NETRA the command center.

Partial discharge (PD) small electrical discharges in insulation, heard by the acoustic camera.

Protective field the space around the robot it keeps free: it slows and stops for obstacles.

Route a walk taught once and repeated.

Site a substation's routes, tags and inspection points.

Stop point a place on a route where the robot stands and inspects.

Tag a printed marker that corrects the robot's position.