DEPLIFE™
DETECT PRESENCE OF LIFE

USER MANUAL

MaXentric
Technologies LLC
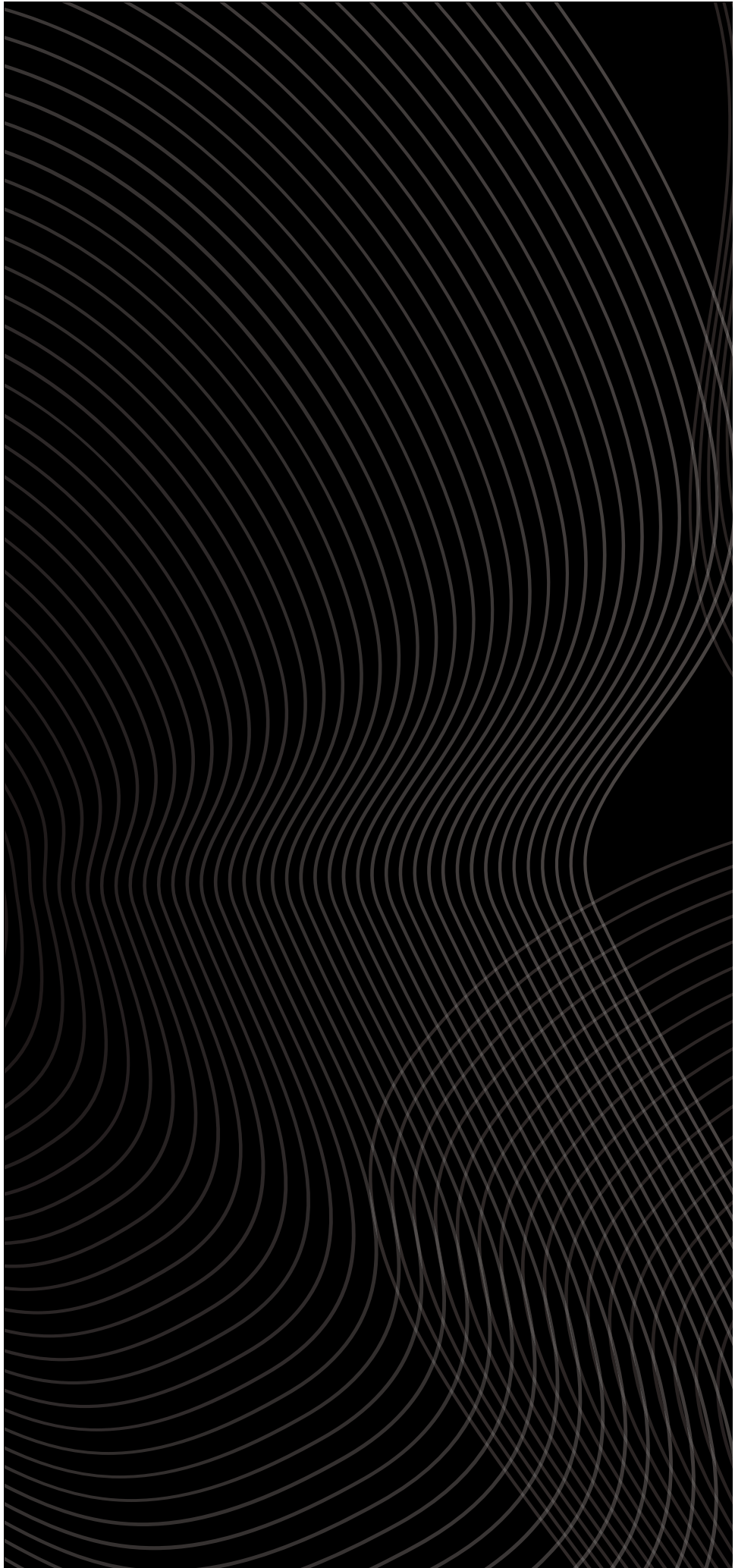
Safety Instructions

Please review the DepLife Radar System information before using the device. Indications, contraindications, warnings, precautions, cautions, and other user information can be found in the product user manual booklet that is included or accompanies the Radar System, and the digital version in the app settings.

> **This equipment is intended for use by law enforcement, emergency rescue, and firefighter personnel for the detection of the presence of life through walls made of non-metallic building materials.**

- This Through-wall Radar Imaging Device shall be operated only by law emforcement agencies or emergency rescue or firefighting organizations that are under a local, provincial or federal authority. This equpitment is to be operated only in providing services and for necessary training operation. (RSS-220 6.3)
- For your safety, this device should only be charged with its original USB-C cable and provided wall adapter.
- Only use the supplied accessories to avoid risk of damaging the DepLife device.
- Lifting and carry the unit by either of the adjustable handles.
- Transport within the provided pelican case and avoid storing in extreme temperatures to prevent battery deterioration over time.
- To prevent electric shock do not attempt to service the device yourself, if you remove the label from the case, you will lose your warranty.
- Technical assistance can be obtained by contacting MaXentric Technologies at 7590 Fay Ave., Suite 301, La Jolla, CA 92037.

This device complies with Part 15 of the FCC Rules.
Operation is subject to the following two conditions:
(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation.

User Information according to FCC 15.21:
Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Statement according to RSS GEN Issue 5:
This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
(1) This device may not cause interference
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil contient des émetteurs / récepteurs exemptés de licence conformes aux RSS (RSS) d'Innovation, Sciences et Développement économique Canada. Le fonctionnement est soumis aux deux conditions suivantes:
(1) Cet appareil ne doit pas causer d'interférences
(2) Cet appareil doit accepter toutes les interférences, y compris celles susceptibles de provoquer un fonctionnement indésirable de l'appareil.

Statement according to RSS-220 6.3
This Through-wall Radar Imaging Device shall be operated only by law emforcement agencies or emergency rescue or firefighting organizations that are under a local, provincial or federal authority. This equpitment is to be operated only in providing services and for necessary training operation.

Ce dispositif d'imagerie radar à travers les murs ne doit être utilisé que par des organismes d'application de la loi, d'intervention d'urgence ou de lutte contre les incendies qui sont autorisés au niveau local, provincial ou fédéral. Le matériel doit être uniquement destiné à la fourniture de services et à la formation nécessaire.

RF Exposure Statements
IMPORTANT NOTE: This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

NOTE: Do not use equipment while charging.

Table of Contents

1. Welcome

Harnessing the latest in Ultra-wideband radar technology, DepLife provides a safe, efficient, accurate, hands-free, and easy-to-assemble sensor system that can be deployed rapidly in any environment.

DepLife is comprised of four main components: an encased radar system, mounting tripod, portable case with accessories included, and a pre-loaded mobile device which connects to the radar via Wi-Fi to stream results wirelessly from 50ft-300ft of clearance.
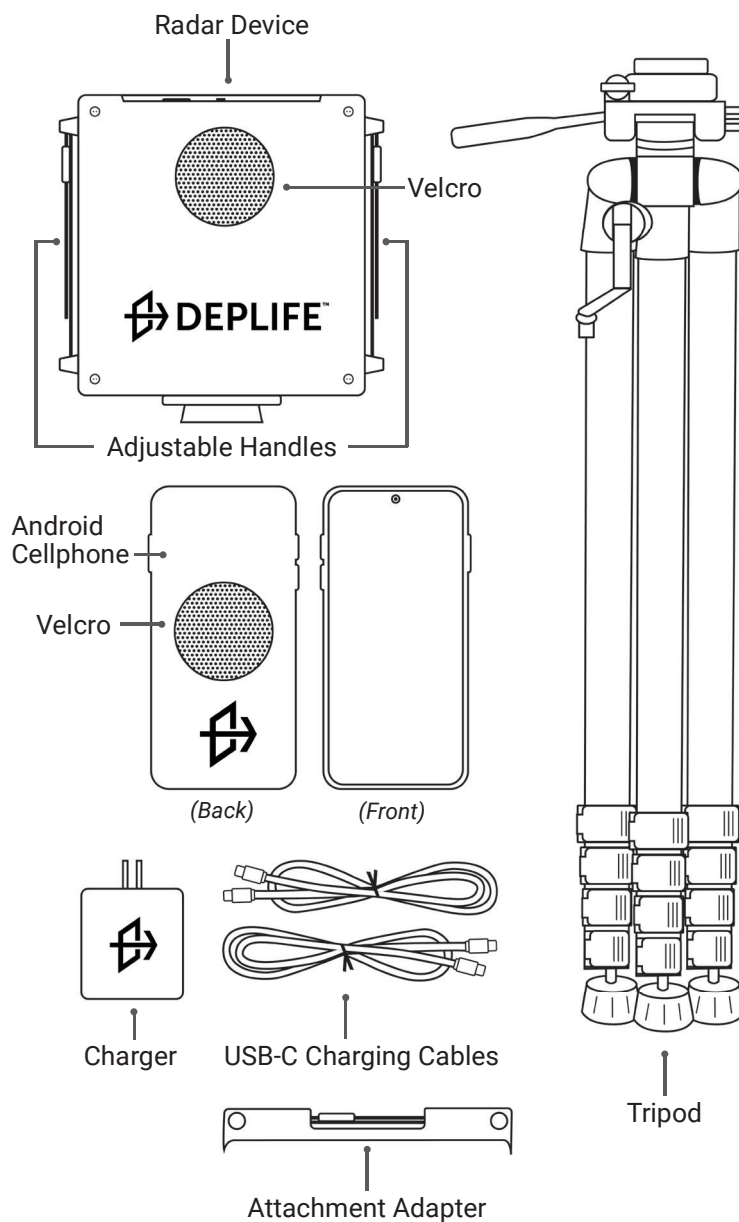
DepLife received funding from the Department of Homeland Security Science & Technology Directorate Contract #70RSAT20CB0000011 and STP Project.

DepLife System Capabilities

- Detect and track a moving person instantaneously or a stationary person in less than 10 seconds.
- Penetrate through common interior and exterior walls.
- Hands-free operation after deployment.
- Real-time monitoring with immediate response to motion.
- Phone app that pairs with radar with 2 different raw-data visualization options.
- Algorithms that discriminate living vs. non-living motion and give placement feedback.
- Switch between covert and overt alerts.

Included:

- DepLife Radar Device
- Android Cellphone
- 1 Tripod
- Attachment Adapter
- 1 Dual USB-C Wall Charger
- 2 USB-C charging cables
- 2 Adjustable handles
- Rubber protector
- Printed User Manual

DEPLIFE™

Radar Device

Velcro

Adjustable Handles

Android Cellphone

Velcro

(Back)   *(Front)*

Charger   USB-C Charging Cables
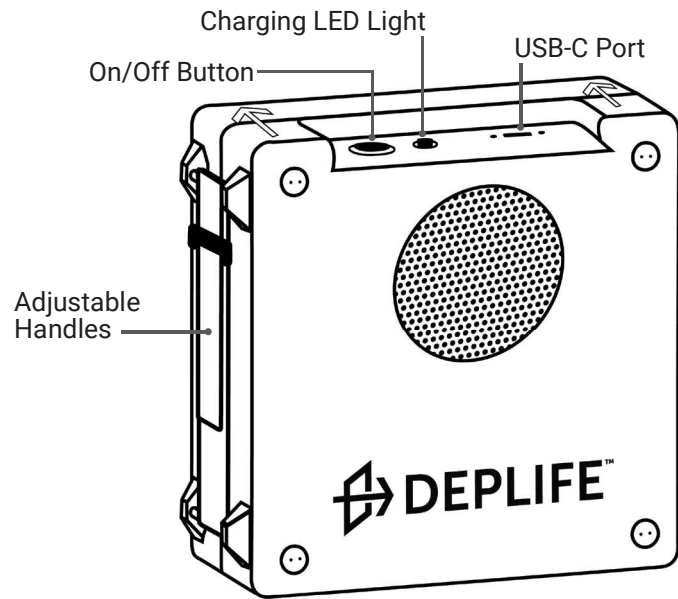
Attachment Adapter

Tripod

2. Radar System Layout

The DepLife system is composed of 3 main components – the encased radar device, the tripod which it mounts to, and the Android cellphone device which connects to the radar and streams results.

a. Radar Device

- **POWER ON & OFF DEVICE**
  To power on the DepLife radar system, there is an On and Off button that when turned on becomes illuminated with a green ring around the button.

Charging LED Light

On/Off Button

USB-C Port

Adjustable Handles

- **BATTERY LEVEL**
  The battery level of the device is indicated in the app, allowing the user to monitor the status of the system during extended deployment.
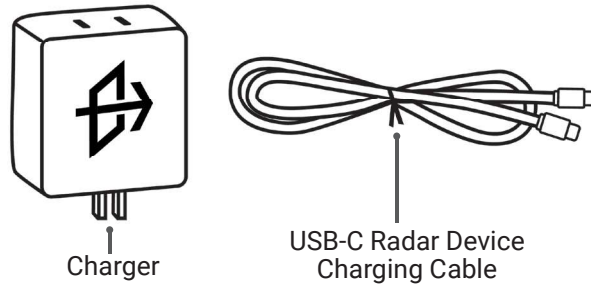
  The device has a battery runtime of 10 hours, with the recommended use of a fully charged system at the beginning of each deployment session. Additionally, the device can be operated while charging if needed.

- **CHARGING THE RADAR**
  To charge the radar, connect the radar system using the USB-C port on the top side of the device. When the radar is connected to the charger, the Charging LED Light will turn on. Once the device is fully charged, the LED will turn off. You can also connect to the device via the DepLife app and get a battery reading.

  To charge the system, use the provided USB-C Cable and power supply, it will take between 3 to 4 hours to fully charge.

  Do not use other USB-C charging systems, such as laptop chargers or laptop USB ports. The charging process can take much longer if a different charger is used.

Charger   USB-C Radar Device
                           Charging Cable

- **OPERATING ENVIRONMENT**
  - Indoor and outdoor use.
  - Designed to operate best at altitudes up to 8,000 ft.
  - Temperature limitations:
    - Operating temperature from -4 °F (-20 °C) up to 120 °F (49 °C).
    - Charging temperature from 32 °F (0 °C) up to up to 113 °F (45 °C).
    - Store between 14 °F (-10 °C) and 95 °F (35 °C) for up to 6 months.
  - Relative humidity up to 85%.
  - 100-240V AC 50/60 Hz.
  - Max 1.2A.
  - Can be operated in rain or snow.

- **CLEANING AND DECONTAMINATION**

  To clean your DepLife unit, unplug all cables and turn it off (press the power button once and the green ring around the button will go out). Wipe the unit with a soft, slightly damp, lint-free cloth. Avoid getting moisture in openings.

  To disinfect your DepLife unit, using a 70 percent isopropyl alcohol wipe, 75 percent ethyl alcohol wipe, or soap and water, you may gently wipe the exterior surfaces of your device. Avoid getting moisture in any openings, and don't submerge your device in any cleaning agents.

b. Cellphone

The phone comes pre-loaded with the DepLife App that connects to the radar and streams results. The Android device can be charged with the USB-C cable and adapter included with the radar system.

The user guide is also available on the settings tab of the App.

c. Tripod

The tripod is stored separately in its own carry-bag.

d. Accessories

In addition to the radar device and cellphone, the pelican case also includes: a rubber protector, two adjustable Velcro handles, wall charger and cables, a DepLife Attachment Adapter for attaching the radar to unmanned systems like ground robots or other tactical equipment, a tripod in a separate carrying case, and a printed User Manual.
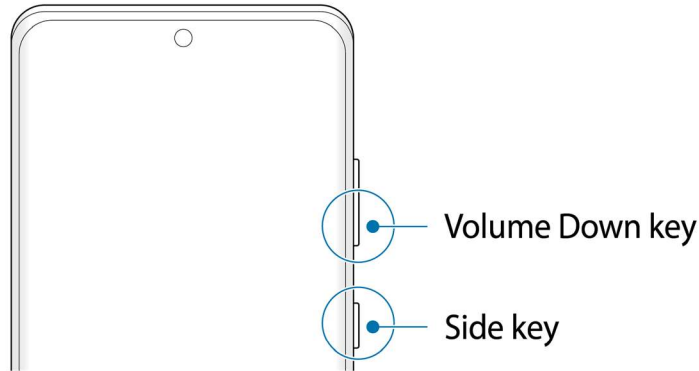
3. Deployment Technique

a. Turning the Cellphone On and Off

- **TURNING THE CELLPHONE ON**
  Press and hold the Side key for a few seconds to turn on the device.

- **TURNING THE CELLPHONE OFF**
  To turn off the cellphone, press and hold the Side key and the Volume Down key simultaneously. Alternatively, open the notification panel, swipe downwards, and then tap.
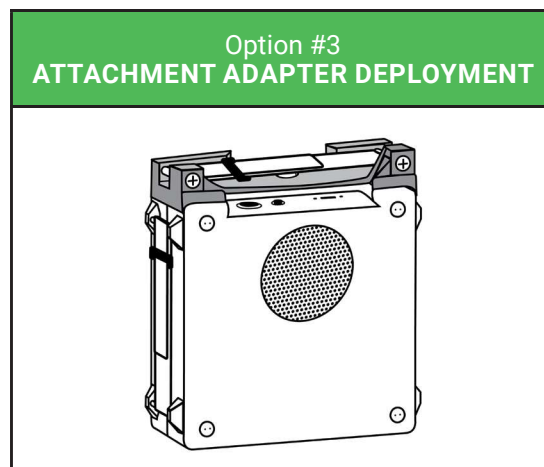

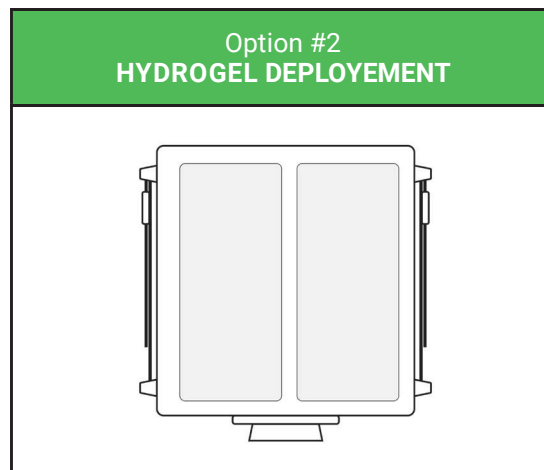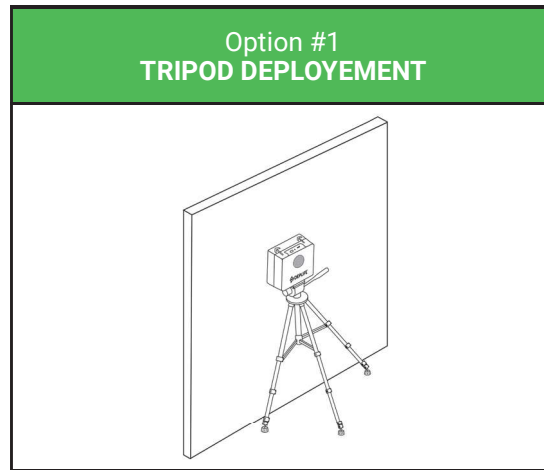Volume Down key

Side key

- **ACCESSING DEPLIFE APP**
  Once the phone is on, swipe up to open the home screen. Press on the DepLife Icon to open and start the App. Ensure the correct Radar ID is specified in the settings and the radar will automatically start streaming (See section 4).

  If the device is not automatically connecting, please check the Radar ID in the Settings Tab.

> This Ultra-Wideband (UWB) device is not designed or intended for handheld operation. Its use in a handled manner is strictly prohibited as it is not compliant with the technical requirements for handheld UWB systems outlined in 47 CFR § 15.519. The user is responsible for ensuring the device is operated in a non-handheld con-figuration and must be kept 6 inches from the user.
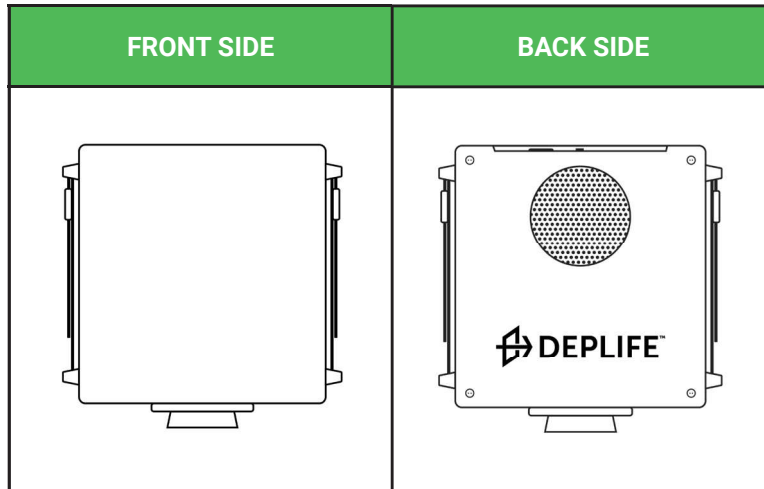
b. Mounting and Deployment

There are multiple deployment options for the DepLife device, allowing for a wider variety of scenarios in which the system can be useful. The rubber protector can also be utilized for more protection in the deployments.

Option #1
TRIPOD DEPLOYEMENT

Option #2
HYDROGEL DEPLOYEMENT

Option #3
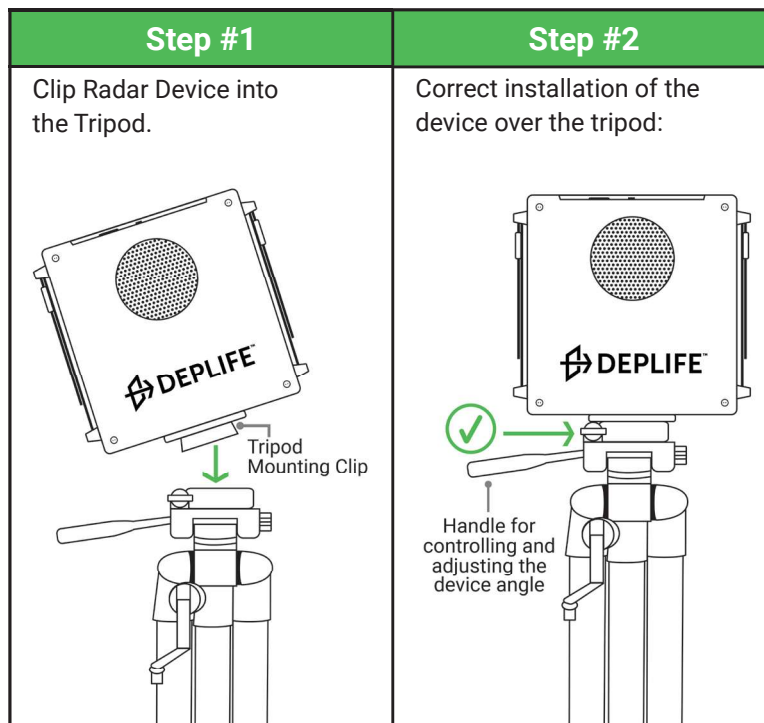**ATTACHMENT ADAPTER DEPLOYMENT**

TRIPOD DEPLOYMENT

The first method of deployment is with the provided tripod. To use this method, the DepLife radar device clips into place on the tripod.

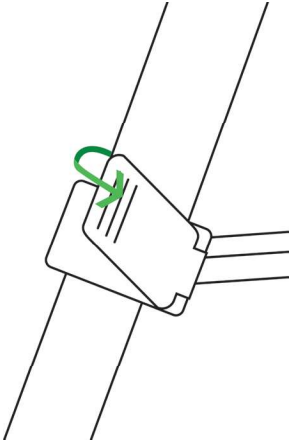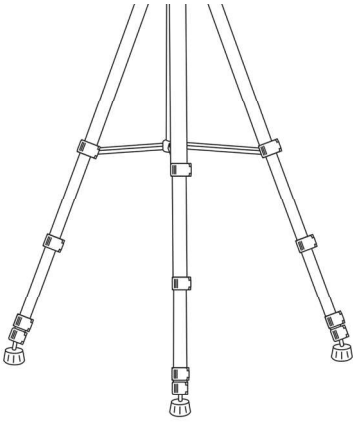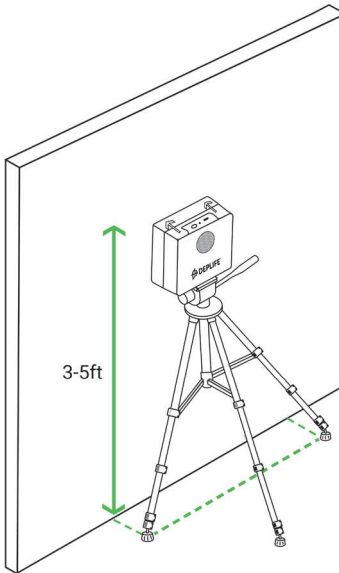| FRONT SIDE	BACK SIDE

The front side of the device is the side without the Velcro circle and should be aligned so it is facing the wall while using two tripod legs that will be on the floor leaning against the wall.

Our recommendation is having the height of the device be 3-5 feet to obtain the best result of the location of a sitting or standing suspect. The tripod height can be adjusted with the length of the legs as well as using the hand crank on the tripod.
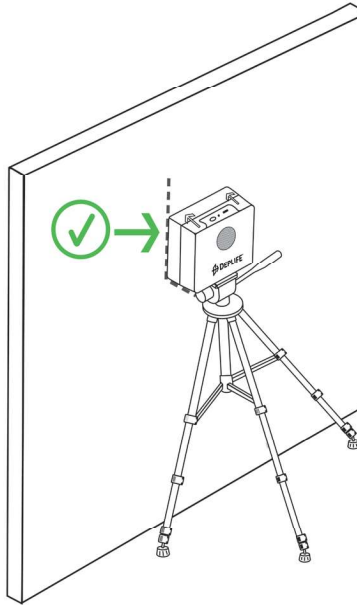
INSTRUCTIONS FOR DEPLOYMENT

Step #1	Step #2
Clip Radar Device into the Tripod.	Correct installation of the device over the tripod:
Tripod Mounting Clip	Handle for controlling and adjusting the device angle

Step #3	Step #4
Open the flip lock to extend the tripod legs. The tripod height can be adjusted with the length of the legs as well as using the hand crank on the tripod.	Extend the tripod legs and adjust the height. For further stabilization, the third leg can be extended to contact the ground and then locked in place.

Step #5

There is a handle to the side of the tripod to adjust the forward-back tilt of the system to help the user lean the system against the wall.

Loosen the handle, lean the radar such that it is fully flushed against the wall, and lock the system in place.

Our recommendation is between 3 to 5 feet height.

3-5ft

The recommended location is central on the wall. If the radar is blocked by an impenetrable obstacle either within the wall or on the other side of the wall inside the room being scanned, an alert will pop up within the DepLife App. The **'Radar Placement Data'** tab can be used to guide you to a good placement.
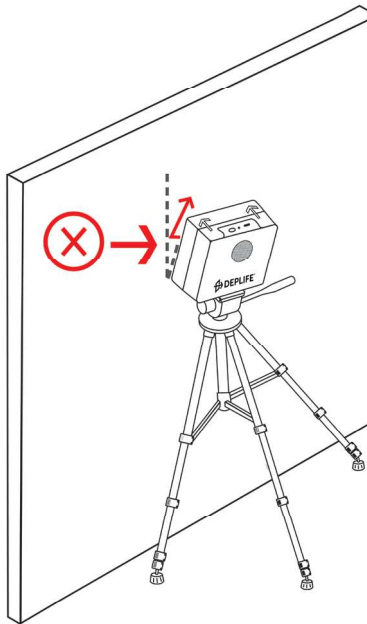
Good Placement

When placing the radar against the wall, it is imperative to set the radar such that the case is completely flushed against the wall. To ensure this, loosen the handle when placing the radar, tilt the system such that it is fully pressed to the wall, and lock the handle.
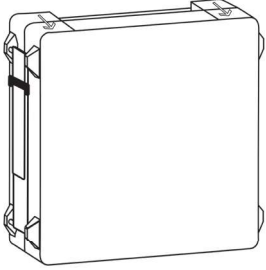

Bad Placement

If the radar is slightly tilted, signal from behind the radar may show as interference (such as motion from the user). Signal may leak through EMI seal within case and bounce off the wall to the user.

HYDROGEL DEPLOYMENT

The second method is using hydrogel strips, which are not provided.

INSTRUCTIONS FOR DEPLOYMENT

Step #1	Step #2
Remove any rubber protectors or debris from the front of the radar system.	Place the hydrogel strips on the front of the case.

Step #3
Before attaching the radar system to the wall in a fixed location, a placement assessment should be conducted by holding the system by hand against the wall and review the placement tab on the DepLife App to ensure it is in a good spot.

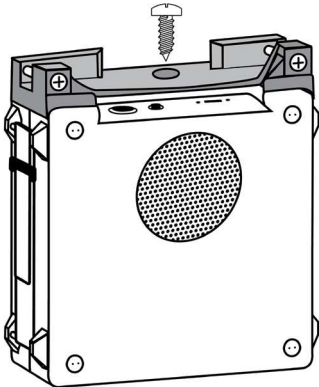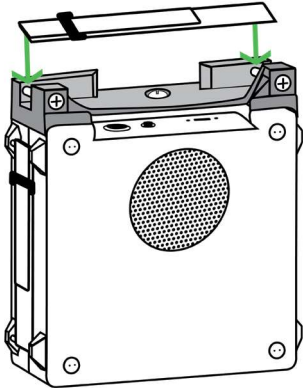| Step #5 |
|---|
| Once the location is verified, place the device firmly on the wall to begin collecting data. Verify attachment unhanding the device to insure adhesion. |

Note: This method is recommended for scenarios in which a specific wall is to be monitored for movement for extended periods of time, as multiple deployments require multiple hydrogel strips to be deployed (hostage scenarios, evacuations, etc.). Ensure good placement before gluing the device to the wall.

ATTACHMENT ADAPTER DEPLOYMENT

The third option for use attaching the device to an unmanned robot or tactical equipment that can be used for deployment. Examples of this would be a quadruped robot arm or other ground robot arm attachment to carry the device to approach a wall or enter a space and scan for live motion. The arm or clamp of the device can be able to grasp the adjustable Velcro strap on the adapter.

INSTRUCTIONS FOR DEPLOYMENT

Step #1	Step #2
Tighten the screw to attach the adapter to the mounting hole at the top of the radar system. With fingers or screwdriver (not provided).	Using the Velcro strap, tighten to the bottom of the clamp or arm on any robotic system.

Confirm correct installation of the device and verify stability.

- **ADDITIONAL RECOMMENDATIONS FOR TRIPOD, HYDROGEL, AND ATTACHMENT ADAPTER DEPLOYMENT**

OPTIMAL PLACEMENT
If time allows, it is recommended for the user to monitor for optimal placement location, which can be done by holding the radar against the wall in various locations while receiving feedback from the radar placement tab, indicating depth of Field of View at each specific location.

SCANNING MULTIPLE WALLS
Additionally, taking readings in multiple locations will increase overall field of view into the building, as each scan illuminates areas that perhaps were not visible in prior scans. To create larger images of where potential subjects are in a building, scanning multiple different walls pointing into the same structure is most ideal.

SINGLE SCAN
Multiple scans on the same wall are also beneficial. These tips should be used if the user is in a relatively safe environment and if there is time to do so. Otherwise, taking a single scan also provides high-confidence information on the movement directly on the other side of the wall the radar is deployed against.

c. Wall Construction

- **SEE-THROUGH MATERIALS**

The radar system is able to penetrate most common construction materials, such as:
  - Drywall
  - Stucco
  - Wood-based materials
  - Vinyl siding

Looking through thicker materials, such as concrete or brick walls is possible, however may cause the signal to weaken in which the radar is not able to penetrate the usual 30 feet range.
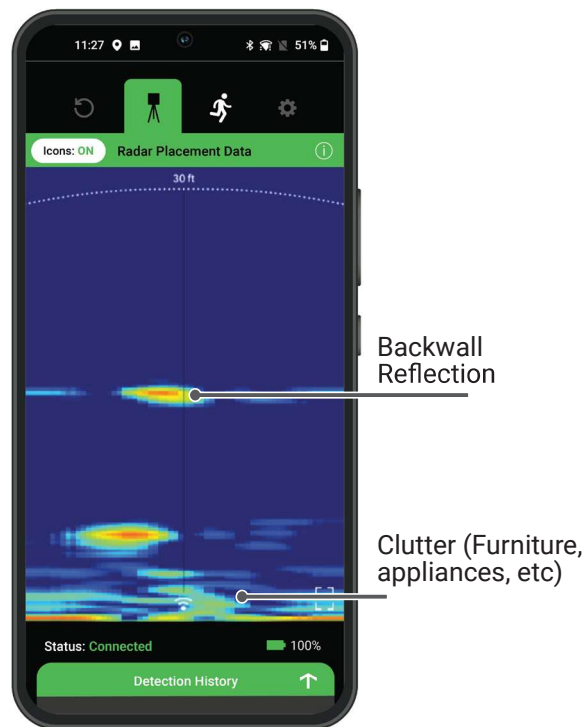
- **IMPENETRABLE MATERIALS**

The radar is unable to penetrate any of this materials or objects:
  - Metallic objects
  - Metal beams
  - Iron rods
  - Televisions
  - Refrigerators
  - Washing machines
  - Any UV coated exterior windows.

d. Placement Feedback

In order to ensure optimal placement, there is a tab specifically dedicated to determine if the radar is blocked and will alert the user to move the radar. It determines this by scanning for raw reflection strength of objects in the scene such as walls or furniture further in the room. If the screen appears mostly blank, the system cannot see very well into the scene. This visualization shows the locations of these static reflectors using the same birds-eye view as the other tabs. This is the initial visualization for the user when opening the App.
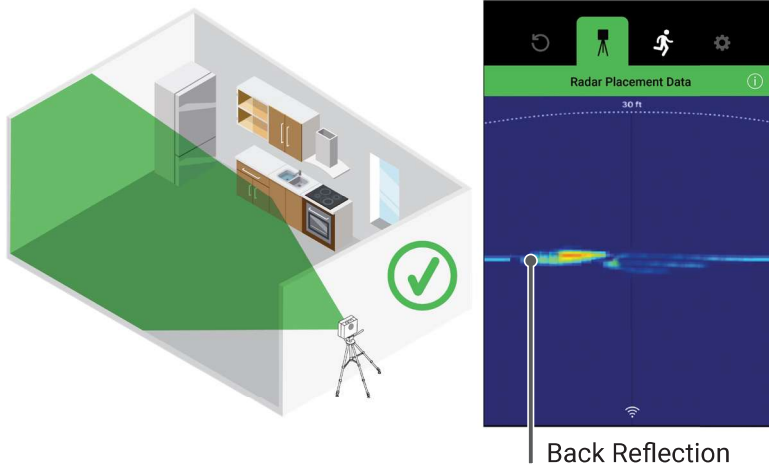

DATA INTERPRETATION

In addition to this visualization, there are algorithms that help interpret this data and alert the user of potential bad radar placement. Bad placements can be caused due to large metallic objects on the other side of the wall blocking the radar, thick cement or metallic beams within the wall, or other potentially impenetrable objects. If this is detected, the user will receive an alert banner on the screen to move the radar.

EVALUATE PLACEMENT

When evaluating the placement of the radar, it is recommended to use the **'Radar Placement Data'** visualization tab on the application with Icons turned off. This tab shows the unfiltered raw radar return, showing the locations of reflectors in the scene. When the radar is blocked, there will be a very strong reflection around zero feet from the first wall and then nothing else in the scene. This is indicative that the radar is unable to sense further into the scene.
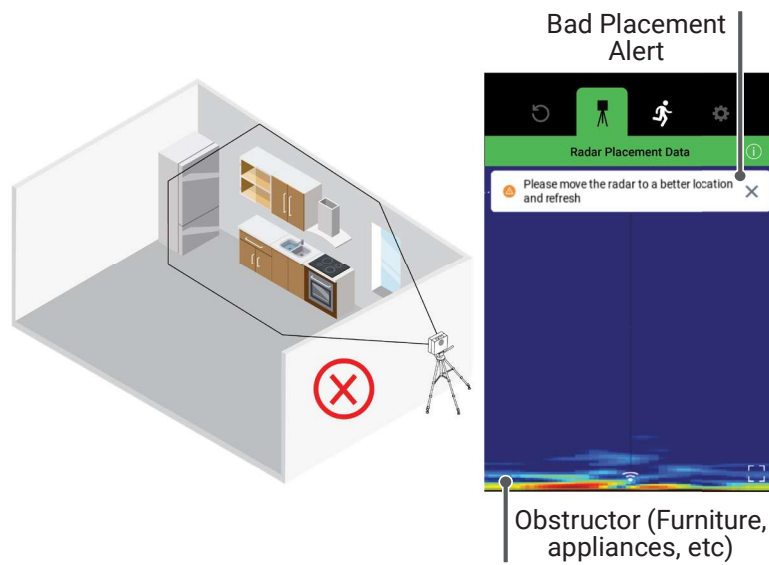
GOOD PLACEMENT ALERT

As seen below, when the radar is moved to a good location, any layout of the room will be reflected on the screen. There are also often strong reflections off backwalls present in the scene, allowing the user to infer the depth of the room being scanned that is shown below at approximately 15 feet from the radar.

Back Reflection

When a clear backwall reflection is present, the system is able to see at least to that distance. It is possible to penetrate through multiple layers of walls, however, the probability of the signal being blocked by some object increases with the number of walls penetrated. The signal weakens through each additional wall it scans through— multiple interior walls are possible, however multiple exterior walls are significantly more challenging.

BAD PLACEMENT ALERT

If a bad placement banner arises, it is an indicator that the radar is not able to see into the adjacent room. Please move the radar and monitor for back wall reflections.

Bad Placement
Alert

Obstructor (Furniture, appliances, etc)

PLACEMENT CHALLENGES

If the radar is placed in a bad location, the signal may leak backwards towards the user. For this reason, if there is an alert for bad placement, the user should be aware that indicated motion on the radar is likely caused by movements by or near the radar, and that the normal 5 feet required radius from the radar needs to be increased. This becomes particularly challenging when the radar is placed in a narrow room with a reflective backwall on the other side, such as a hallway.

Generally, it is more challenging when the radar is placed in locations with dense walls, such as closets or narrow hallways. In these environments, the user must be much more cautious in monitoring movement near the system.

ADDITIONAL PLACEMENT RECOMMENDATIONS

- The user can test this by moving near the system and assessing the distance at which their reflection disappears.
- In a good location, once the user backs away about 5 feet from the system, their signal will disappear.
- In a bad location, the user motion may be tracked further. This radius is location specific.
- In order to take multiple readings when assessing the placement of the device, the user can attach the cellphone to the radar via the velcro attachment and can hold the device by hand while receiving feedback from the app. In this context, the user can only assess placement feedback.
- Motion readings are not possible while the device is handheld, as the user will likely be the cause of said detected movements.

e. User Reflection

Certain walls are prone to a *user reflection*, in which the signal bounces backwards towards the user. This can cause a false positive from motion caused by the user or anyone near the radar.

For this reason, it is imperative to deploy the system and back away from the device. Motion near the device should be monitored – if someone walks near the device, hit the reset button in the top left corner and wait 10 seconds for a full reset.

Additionally, the device must be set such that the radar is fully leaned against the wall without any gaps between the case and the wall to render the system seal useful and minimize user reflections.

4. Radar Connectivity to Wi-Fi

RADAR ID

You can find the Radar ID on the Device System Label. The Radar ID in the DepLife App must match the desired radar device. To access the radar ID, go to the settings menu on the DepLife App, click on the general tab, and then Radar ID.

The phone will automatically look for and connect to the Wi-Fi based on the radar ID in the app settings. The radar will immediately start operating with the DepLife App opened.

To switch between multiple deployed radars, simply change the radar ID in this menu and the App will automatically connect to the specified device.

- It is recommended not to connect to other networks with the phone if possible, to prevent the phone from switching away from the radar Wi-Fi to another network during operation.

- The connection status to the radar shows in the bottom left corner of the App.

- If the system does not connect, ensure the radar is powered on and the radar ID in the settings matches the streaming Wi-Fi SSID from the radar system.

5. Application User Interface

a. Application Overview

The DepLife App connects to the radar and automatically begins streaming data. The visualization is composed of a cross-range colormap in birds-eye view with icons showing the results.

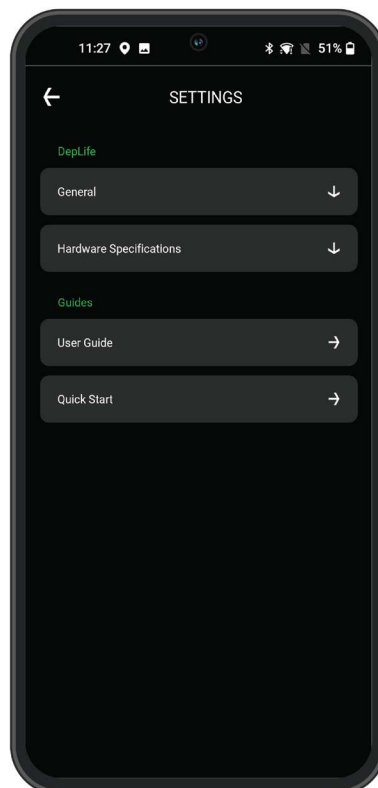| Tab Selection Icons	What it means		Connection Status	What it means
↻	Reset Radar, Clear Data		Disconnected	No radar connected
▣	Radar Placement Data		Connected	Phone connected to radar Wi-Fi network
🏃	Motion-Sensing Data		Starting	Radar starting up
⚙	Settings Menu		Ready	Radar streaming

The app allows the user to:

- Select between visualization tabs
- Access various display settings
- Displays wifi connectivity
- Displays radar status
- View detection history
- Refresh, which clears radar data and resets the detection history

Navigation Icon	What it means
Icons: ON / Icons: OFF	Radar Detection
(i)	Tab Information
⌐¬ (Full Screen icon)	Full Screen
▬ 85%	Radar Battery Level
↑	Pull-Up Detection History Menu

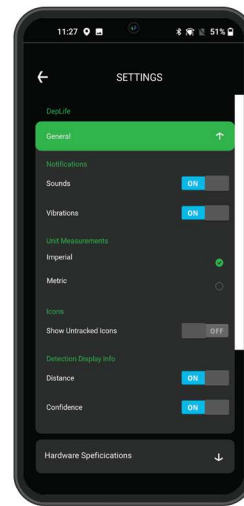| Radar Detection Icons	What it means
(person icon)	Stationary Life Detected (with confidence rating)
(movement icon)	Movement Detected
(running person icon)	Living Movement Detected

b. Application Settings

When you click the Settings Menu icon, you can find the general streaming display settings, hardware settings, and access to guides.
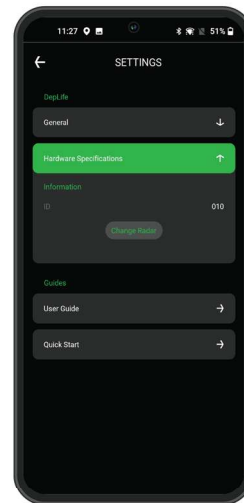
GENERAL

- Enable/disable sound or vibration alerts.
- Switch between unit types.
- Enable/disable the display of Untracked Icons, which are low confidence and indeterminate detections by the algorithm.
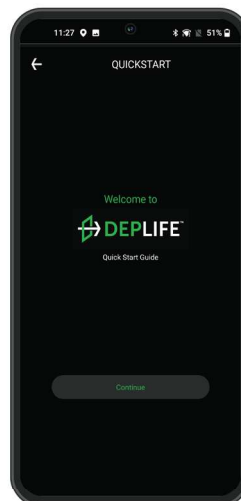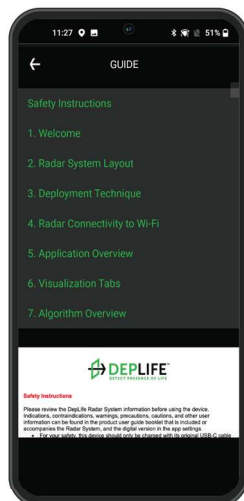- Show/omit information on the icons such as distance or confidence percentage (%).

HARDWARE SPECIFICATIONS

- View the current radar ID the app is set to connect to.
- Switch between radars if multiple devices are active.

USER MANUAL AND QUICK START

Access to a digital version of this User Manual and a Quick-start guide, allowing for on-the-go information to help train users and interpret results as easily as possible.

6. Visualization Tabs

There are two different visualization tab options, each showing different filtered results of the raw radar data.

- The first visualization that opens with the app is the **'Radar Placement Data'** visualization, giving the user an immediate estimation of how far into the room the radar is able to penetrate.

- To start detection, once placement is ideal remember to step away from the system and switch to the other tab.

- The **'Motion-Sensing Data'** detection tab shows a motion-filtered radar data colormap with human icons for users to be able to easily interpret results.

> **The detection tab shows icons that are intended to help build additional intuition in interpreting the system response as the user becomes more familiar with the device.**
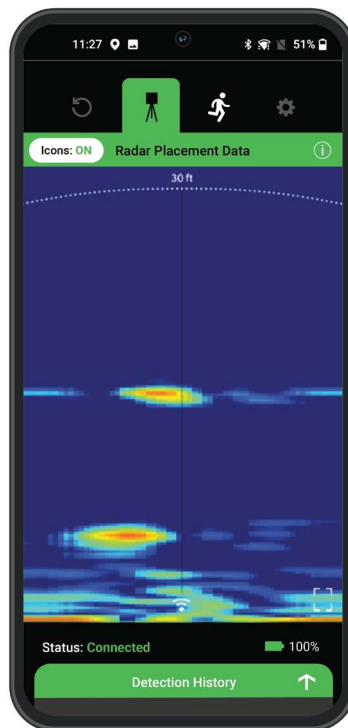
Radar Placement Data

Motion-Sensing Data

a. 'Radar Placement Data' Tab

The first tab is the **'Radar Placement Data'** tab is used to assess how well the radar can see into the room based on where it is currently deployed.

It works by showing the location of static reflections in the scene, such as those generated by furniture or walls. This gives the user a general idea of how far into the room the radar can see and can be useful in the following scenarios:

• Assessing an initial placement of the radar, with immediate feedback if blocked by an impenetrable object.

• Evaluating general building layout information, with strong clear reflections from walls that can indicate depth of room.

This visualization does not highlight motion in a room unless a subject is extremely close. When the app is initially opened, the motion algorithms do not begin until one of the other tabs is clicked. This allows the device to be shifted around without generating false positives until a desired location is found and the user has backed up sufficiently. To start the detection open any of the other tabs.
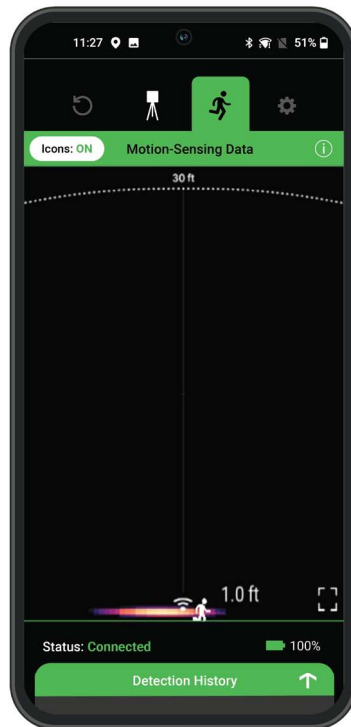
b. 'Motion-Sensing Data' Tab

The **'Motion-Sensing Data'** tab allows for responsive motion feedback by refreshing at 10 fps, resulting in a video-like feed.

This tab is most useful in the following scenarios:
- A moving person pacing through a room.
- A closer stationary person with a strong detection.
- Interpreting scenes with multiple people in a room, giving insight into potential reflected false positives.
- Laying or sitting subject(s) in a room.
- Scenes having very little detected motion.

This visualization may not highlight scenarios with very weakly moving stationary persons in a room, particularly if they are further away (15 feet or more).

Bright spots are indicated by motion in real-time. The device requires at least 10 seconds for a confident reading.

7. Technology Overview

a. Radar Background

This is a radar-based device that rapidly transmits electromagnetic pulses that reflect off of objects and/or people within the field of view. Over time, the device builds a 2-dimensional birds-eye image that highlights the location of motion, as well as strong reflectors.

STRENGTH OF REFLECTION

The strength of the reflection depends on the size, shape, material, and relative location of the reflecting object. The strongest response comes from metallic objects, as well as flat surfaces perpendicular to the radar such as walls or televisions. As these pulses are analyzed over time, it becomes possible to map the locations of moving subjects. The more a subject moves, the easier they will be to detect. For example, a pacing subject will be detected instantaneously, whereas a standing or sitting subject may take up to 10 seconds to detect.
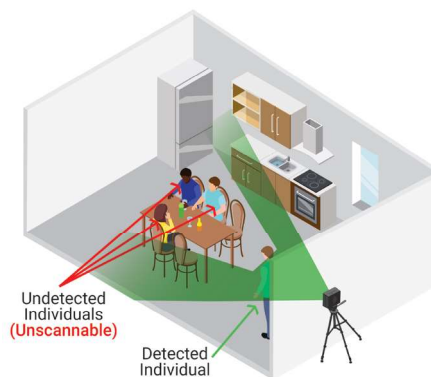
INDOORS

Using a radar indoors generates a complex response based on the exact placement of the system and the environment being scanned. Objects such as vertical metal beams within walls may obstruct the system view into certain parts of rooms. Different placements, such as near these beams may cause different parts of the room to be visible by the radar. Use the Radar Placement Data tab to get an assessment of the locations of bright reflectors such as back walls and furniture. Test multiple placements to assess the best location for the radar.

METALLIC OBJECTS

Certain metallic objects generate a strong response from the device, such as back walls, refrigerators, washing machines, aluminum whiteboards, UV-coated external windows, and other large metallic objects. When subjects move near these objects, there may be occasional false positives at the locations of these objects. Lots of motion, such as a subject pacing back and forth, will exasperate this effect.

MULTIPLE SUBJECTS

Additionally, if there are multiple subjects in the room, they may create a shadow effect in which they block the radar path from reaching subjects behind them. This is particularly prevalent with closer subjects, as they occupy a larger portion of the radar beam. For this reason, it can be difficult to accurately depict the exact number of subjects in a room.

Undetected Individuals
(Unscannable)

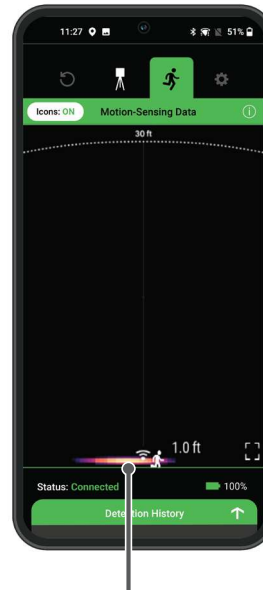Detected Individual

b. Fundamental Algorithm Explanation

The algorithms developed for this system are designed to detect and track moving and stationary subjects.

The primary strength of this device is distinguishing an empty scene from one with a subject in the scene.

Once there are multiple persons moving around in a room, the motion interaction between the subjects and their multi-path reflections becomes very complex to analyze.

Additionally, if there is a close subject detected they are very likely shadowing the radar from seeing movement further in the scene.

This means that there could be scenarios in which a room is filled with people, but the radar only shows one very strong detection Generally, the device is limited to accurately depicting up to 2-3 persons, depending on their movement.
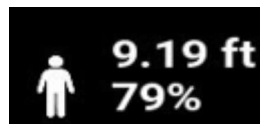

Detected Individual

c. Higher-Order Algorithm: Discrimination and Confidence Percentages

There are additional algorithms implemented that filter detected motion from living beings vs non-living motion. For stationary subjects, a confidence metric is generated and plotted near the respective stationary subject icon.

This metric evaluates the confidence that the detected motion is indeed caused by a living object, rather than a mechanical motion such as a ceiling fan or laundry machine. As the track is active for longer, the confidence metrics can make better and better estimations.

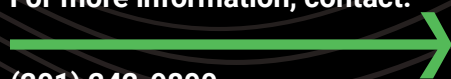*Stationary subject icon with distance and confidence.*

Technical assistance can be obtained
by contacting MaXentric Technologies at
7590 Fay Ave., Suite 301, La Jolla, CA 92037.

MaXentric
Technologies LLC

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For more information, contact:

(201) 242-9800
deplife.net