



MiRo-E Owner's Guide

- Throughout, we refer to MiRo-E including all supplied equipment as “the robot” (“its”, etc.), to the user as “you” (“your”, etc.), and to ourselves – Consequential Robotics – as “we” (“us”, etc.).
- This guide covers safe operation, basic husbandry, warranty, disposal, and regulatory information. Please ensure you have read and understood the whole of the guide before handling or operating the robot.
- Failure to follow the guidance herein (or in the general documentation, as applicable) may jeopardise the safety of people, animals, and/or property and may, in addition, void your warranty.
- This guide is not and could not be exhaustive—it aims only to alert you to the sort of hazards raised by working with the robot, some of which may be unfamiliar and/or unexpected. You must perform your own risk assessment to determine how to operate the robot safely in your environment.
- If you are in **ANY DOUBT** about safe operation of the robot, disconnect and remove battery, disconnect charger, etc., and contact support for advice. Start at <http://labs.consequentialrobotics.com/miro-e>, which you should also visit to obtain the most up-to-date version of this guide.
- Please take safety seriously—but do not be afraid: the robot is engineered to be very safe if handled and managed as intended. This robot is intended to be touched, to be stroked, and to be loved.

Nothing in this guide is intended to modify the terms of the LICENSE agreement under which the robot is supplied to and used by you.

Emergency procedures

- In case of emergency (e.g. fire, spillage, etc.) or when instructed to do so by this guide, and provided that it is safe to do so, you should immediately **MAKE THE EQUIPMENT SAFE** as follows (perform only applicable steps):
 - Use the local circuit breaker to withdraw power from the outlet into which the charger is plugged.
 - Disconnect the charger from the outlet.
 - De-power the robot immediately by rapidly cycling the power switch through the emergency sequence "OFF→ON→OFF".
 - Disconnect the charging cable from the robot.
 - Disconnect and remove the battery pack from inside the robot.
 - Move all equipment to a place of safety such as outside well away from people, animals, or property.
- If there is no immediate risk to safety, you can turn the robot off underneath and wait for a normal shutdown before disconnecting the charger and removing the battery pack.
 - If the robot fails to shutdown in the usual way, leave the switch off and power will be withdrawn automatically after two minutes. Please note that during this two minute period the robot may be able to move. Proceed to disconnect the charger and remove the battery pack.
 - To de-power the robot immediately, rapidly cycle the power switch through the emergency sequence "OFF→ON→OFF".
- Since emergency procedures may require removing the battery pack, you should have the necessary tools close to hand when working with the robot.
- Practice these procedures in advance to ensure you can complete them safely and quickly if required to do so in an emergency.
- You should always follow your local security and emergency procedures before following advice in this document that is specific to the robot.

General advice

- The robot is safe for use only by persons who have been given instructions concerning its safe use and who understand the hazards it poses and who are prioritizing safety above all else. Please take safety seriously!

- The robot is safe for use only in applications for which it was intended.
- The robot is **NOT A TOY** and should not be allowed to be used in play. The robot should not be handled at all by children under 3 and children under 14 should be allowed to handle it only with close supervision.
- The robot is **NOT A MEDICAL DEVICE**.
- Some hazards may only be raised, or may be elevated, if the robot is used by or around untrained members of the public or vulnerable persons.
- Some hazards may be unexpected or unfamiliar to some users—many people have not experienced robots before. In addition, animals may be particularly disturbed by the robot’s operation.
- The robot poses at least the following specific classes of hazard:
 - The robot is a battery-operated device and poses a fire hazard and a chemical leakage hazard.
 - The robot’s charger is a mains-operated device and poses an electrocution hazard and a fire hazard.
 - The robot is a mobile interactive physical device and poses hazards of physical and emotional harm.
 - The robot exchanges data with the local network and poses an information security hazard.
- Do not use any supplied equipment (robot, charger, etc.) that shows any sign of damage, or that has previously overheated or exhibited other unexpected behaviour (such as making noise, generating smoke or unexpected odours, etc.), or if you suspect that any damage has occurred, or if you suspect that the equipment has been compromised by user intervention, by age, etc.
- If you detect or suspect any damage or compromise, and if it is safe to do so, immediately **MAKE THE EQUIPMENT SAFE** as described above and contact support.
- Do not use the robot in an environment that poses additional hazards. For example, do not use the equipment outdoors, or in areas where it could have liquids spilled on it, etc.
- Misuse of the robot (use for any purpose or in any way other than as required by the product’s intended application) may pose unexpected hazards and may, in addition, void the product warranty.

- The robot is intended to be extended in some constrained ways by the end user—for example, it is reasonable to connect additional components via the expansion ports. Besides such reasonable expansion, you should not allow foreign objects into the robot.
- All equipment is designed for use in reasonable **indoor** conditions (the robot should **NOT** be used outdoors). It may be damaged and/or may cause a hazard if operated at temperatures below 10C or above 30C, or in humidity of less than 20% or greater than 80%, or in direct sunlight or near to a heat source such as a radiator, or near to a source of ignition.
- **DO NOT** allow the robot to be unattended when in a powered state.

Electrical safety

- The robot is a battery-operated device and poses a fire hazard and a chemical leakage hazard.
- Only use the supplied battery pack to power the robot.
- Care must be taken in handling the batteries. Misuse could lead to short circuit or puncture which could, in turn, lead to overheating, fire, or leakage of chemicals.
- Do not force the connection between the battery and the robot—connection with incorrect polarity may cause a short circuit. If it is difficult to connect the battery pack to the robot, contact support.
- Do not allow the robot to be powered when any cover is removed; do not allow foreign objects (such as screwdrivers) into the robot when it is powered. There is a risk of short circuit.
- The robot's charger is a mains-operated device and poses an electric shock and electrocution hazard and a fire hazard.
- Take the usual precautions that apply when using any mains-operated equipment: disconnect the charger from the outlet in case of a storm, do not touch any part of the robot with wet hands, do not misuse extension cables and multi-outlet adapters, be vigilant against cable damage, consider and comply with region-specific regulations, and so on.
- Only use the supplied charger to charge the robot or the battery pack, and only charge the robot or the battery pack with the supplied charger. In addition, only use the supplied mains cable with the charger.

- The charger does not have a power switch—maintain easy access to the mains plug whenever the charger is plugged in, so that it can be disconnected quickly and safely in an emergency.
- When charging, ensure the charger and the robot (or battery pack) are in a well-ventilated area far from any flammable materials and that a fire management strategy is in place (including that an appropriate fire extinguisher is close to hand and that you are trained in its use).
- **DO NOT** leave the charger unattended when plugged in—you must be available to handle any hazards that should occur during charging.
- When charging is complete (charger light turns green) remove the charging cable from the robot or the battery pack and unplug the charger immediately.
- If any liquids are spilled onto any part of the robot, including the battery pack or the charger, you should, if it is safe to do so, immediately **MAKE THE EQUIPMENT SAFE** as described above and contact support. **DO NOT** take chances—if you are in **ANY DOUBT** follow your local emergency procedures that apply in case of an electrical and fire hazard.
- If a battery pack begins to hold charge for less time than it did when it was new it should be replaced without delay.
- You should charge any battery pack at least every three months to avoid premature deterioration.
- Disconnect and remove the battery pack from the robot when leaving it unattended for any length of time.

Physical and emotional safety

- The robot is a mobile interactive physical device and poses a tripping hazard and a falling hazard and a pinch point hazard and a general hazard of harm to vulnerable persons or animals.
- The robot is low to the ground and may not be seen—it poses a trip hazard.
- The robot may drive itself off edges and fall on someone or something below—it poses a falling object hazard.
 - Please note: The robot is equipped with “cliff sensors” which are intended to reduce the chance of driving off edges (“cliffs”). However, these sensors can provide incorrect information under certain conditions so you

cannot rely on them to prevent the robot from driving off edges. They also do not protect the robot from driving backwards off an edge.

- It is recommended that the falling object hazard be mitigated by only operating the robot on solid floors without accessible cliffs, or on raised surfaces that are wholly and securely “fenced” to prevent falling.
- If the robot is operated with any parts removed (such as the collar, or any plastic casing) then it has “pinch points”, where body parts could be caught and crushed—it poses a pinch point hazard. The robot should not be operated unless all covers and other parts are in place.
- The robot may move or make noises or flash lights on its own and unexpectedly which may lead to negative and/or unexpected responses in vulnerable persons or animals. Due consideration should be given to whether and how the robot is introduced to these groups, and to what harms may result from such an introduction.
- The robot’s behaviour may be misinterpreted. For instance, in demonstration mode it may approach the same location repeatedly, which might be interpreted by some persons as aggressive or frustrating behaviour, for example. Such behaviour may therefore pose a hazard of negative responses from and/or harms to vulnerable persons or animals.
- **DO NOT** leave the robot unattended when it is switched on.
- The packing materials included with the robot as supplied may pose, for example, choking or suffocation hazards. Ensure all packing materials are safely put away out of reach of children or disposed of appropriately.
- Small parts supplied with the robot as spares may also pose hazards to children, and these should also be safely put away.

Information security

- The robot offers general purpose computation, posing a general information security hazard, and publishes information recorded from sensors, posing a hazard of leakage of that sensor data.
- The robot includes an “on-board computer” (Raspberry Pi running Raspbian) which is intended to connect to the local wireless network, posing the same information security hazards common to any networked computer. The robot should only be used in a network environment that has been secured by a competent person.

- The on-board computer ships with a standard (default) user login password—you should change this password immediately as the on-board computer is first connected to the network (i.e. when you provide network credentials).
- The operating system of the on-board computer must be regularly updated to ensure that newly-available security patches are applied in good time. Failure to keep the system updated will increase the risk of compromise. You are responsible for keeping the on-board computer system secure—a big part of that will usually be to ensure that security fixes are applied promptly.
 - As shipped, the on-board computer is configured with the Debian package `unattended-upgrades` which is intended to perform default security updates automatically and as required. You should ensure that this system is configured correctly and able to function normally in its network environment, or—alternatively—follow your own preferred policy to maintain system security.
 - Once software release R190828 (published 28th August 2019) or any later software release has been installed on the robot, the unattended upgrades system is disabled, and future system updates will be performed when a robot software update is invoked. You should therefore perform a robot software update regularly—please see the robot software update page of the general documentation for details.
 - Whichever software release is installed, you may manually update the operating system at any time, in the usual way.
- The on-board computer exposes various network interfaces. You should operate the robot only within a secure network environment—e.g. not connected to the public internet—until and unless you are satisfied that the risks of doing so have been managed satisfactorily. Some of these interfaces are listed below, for information.
 - The on-board computer exposes a ROS interface to the network. This interface can be used to access robot sensor data—including camera and microphone streams—**without providing further credentials**, which risks leaking video and audio data to unintended recipients. You should take appropriate steps to secure this ROS network against access to suit the needs of your application. Information on preventing unwanted access to a ROS network is available at <http://wiki.ros.org/Security>.
 - If running only on-board controllers (such as the demo controller) you do not need to expose the ROS interface to the network—use the

value “loopback” for the setting “network address mode” to avoid exposing this interface.

- The on-board computer runs an SSH server (sshd) to allow secure remote login. This server is configured using only the system-provided tools and can be reviewed in the usual way.
- The on-board computer runs a Bottle Web Server to allow uploading of control scripts to the robot from the MEI. This server may unintentionally present broader access to the system. All code associated with our instantiation of this server is available for review on board in the directory at `~/mdk/share/web`.
- The on-board computer may expose other interfaces not listed here, including some authored by third parties, which may pose unknown hazards; you should review the on-board computer to assess these.
- **DO NOT** ignore the possibility of compromise of sensor data. The hazard posed is that video and audio streams recorded by the robot’s eyes and ears may be delivered to unintended recipients. This hazard may be especially serious if the robot is used by or around vulnerable persons (including, but not limited to, children). You should ensure that a competent person has secured these data streams against such unintended delivery **BEFORE** allowing the robot to connect to a network.
- The on-board computer includes a micro-SD card on which user data may be stored. There is always a risk of loss of this data (for instance, the card itself may fail, or the power supply may fail leading to corruption of the card). This poses a data loss hazard so you should never store data only on the on-board card.
 - Do not plug in the charger cable when the computer is running—this will cut the power to the computer without warning, and may lead to data corruption.
- Because of the significant hazards to information security posed by connecting the robot to the network, it is safer not to make this connection unless it is required by your application (you can operate the robot in demonstration mode, for example, without a network connection).

Husbandry

This section is more about protecting the robot rather than protecting you, but a damaged or compromised robot may pose additional or elevated hazards, also.

- Use common sense when handling the robot. It is not especially fragile, but neither is it intended to be treated roughly.
- Lift the robot only by the body shell, supporting its weight from underneath—do not pick up the robot by the head, this may damage the robot.
- Do not drop the robot from any height—it is not designed to absorb the shock of falling.
- Do not force any of the robot’s joints to move when they are under power or the robot may be damaged. If the joints are unpowered (for example, when the robot is powered off) you can gently move the joints as required.
- Do not otherwise apply force to or pull on any of the robot’s appendages (head, nose, ears, tail, eyelids, etc.) at any time. Doing so may damage internal components and will void the warranty.
- Do not push the robot along on a surface (or manually turn the drive wheels) at any time. Doing so may damage internal components and will void the warranty. Rather, if you need to move the robot, lift it as described above.
- Do not adorn the robot in any clothing or materials other than those supplied. Adding additional thermal insulation may lead to overheating, which might pose a fire hazard as well as being damaging to the robot. Blocking the operation of any sensors may exacerbate other hazards.
- Do not operate the robot in a dirty environment—including, for example, on carpets or rugs that have any kind of detritus in them. Material may be drawn up into the robot’s mechanisms, and any damage that occurs as a result of such operation may not be covered by the warranty.
- Operate the robot only on a solid, level, smooth (non-abrasive), surface to avoid damage to the drive motors, wheels, tail slider or roller, or associated mechanisms. Thin carpet should not pose a problem, but thick carpets or rugs may overload the motors and lead to damage or failure. Operation on typical exterior surfaces (e.g. tarmac, concrete) is likely to damage the ground-contacting parts of the robot and such damage will not be covered by the warranty.
- Do not allow any liquids into contact with the robot.
- Keep the robot clean, but do not use abrasives, aerosols, or any cleaning fluids in contact with the robot (a quick wipe with a slightly damp cloth is fine, but ensure the robot is powered off and the charger is not connected first, and allow sufficient time for all of the robot’s parts to dry completely before using the charger or the robot again after cleaning).

- Store the robot with its battery pack disconnected and removed.
 - However, as indicated above, charge the battery pack at least every three months during storage, to maintain its condition and lifetime. You can use the included adapter to charge the battery “off robot”, if desired.
- Look out for signs that the batteries are running low and stop and recharge them when this happens to avoid any reduction of their lifetime. Signs of a low battery are (i) the low battery alarm sounds (see documentation), (ii) the robot makes “long blinks” often when in demonstration mode, (iii) any joint is particularly noisy during movement.
- Do not lubricate any joint, modify the robot, disassemble any part of the robot, or attempt any repair, except exactly as indicated in the Maintenance section of the documentation.
- Do not mistreat the robot in general—for example, do not place objects on top of it, do not paint it or subject it to high temperatures, do not strike it or apply high pressures to it. Any damage may pose additional or elevated hazards and so it is critical to safety that the robot remain in good order. As indicated above, if you suspect that the robot is damaged in any way, and if it is safe to do so, you should immediately **MAKE THE EQUIPMENT SAFE** and then contact support.
- Transport the robot in its original packaging.
- And, whatever you do, don’t feed the robot after midnight.

Warranty

- We provide a one-year warranty covering manufacturing defects only, provided that the robot has only been used in the application for which it is intended and that it has not been subjected to misuse or abuse or subjected to an unreasonable lack of care (for specific exclusions, see below).
- During the warranty period, which begins on the shipping date, we will repair or replace (at our option) the robot free of charge utilising new or refurbished replacement parts.
- To take advantage of this warranty, the robot must be returned to us in its original packaging for inspection at your cost. We will return the robot to you following repair, or otherwise supply a replacement robot, at our cost, and in a reasonable time.

- We shall not be obligated to repair or replace the robot, or any part thereof, if we reasonably believe that these actions have been necessitated in whole or in part by: normal wear and tear, accidental damage, fault or negligence on the part of anyone interacting with the robot, misuse or abuse of any kind, electrical fault external to the robot, interfacing with or modification to any part of the robot where not performed by one of our own engineers other than as expressly indicated in the documentation, Act of God.
- Repaired or replaced parts, or robots, will remain warrantied until the expiry date of the original warranty (i.e. until one year from the date of original shipping).
- Depending on where the robot is supplied, local regulations may confer on you other consumer rights. We will meet the requirements of any such regulation as required by local legislation.

Disposal

The robot will eventually reach the end of its working life, and will need to be disposed of. Please help us to manage our impact on the environment by taking the responsibility of correct disposal seriously.

The “crossed-out wheeled bin” icon, alongside, is attached to this product to indicate that the robot is “Electrical and electronic equipment” (EEE). Since 2002, it has been mandated by the WEEE (Waste EEE) directive of the European Union that end users dispose of WEEE separately.



EEE contains components and materials that can be recycled or reused and therefore should not be disposed of in household waste. For starters, there’s a perfectly good Raspberry Pi in there—don’t bin that, use it for another project! And the NiMH battery pack may run out of strength after many uses, but the material it is made of can be recycled very effectively. Your local waste management facilities will be able and willing to receive any parts of the robot that you do not reuse yourself—please follow their recommended procedures for EEE.

As an alternative to your local waste facilities, we will gladly receive the robot for recycling at any of our sites and we will make no charge for this service.

Correct disposal of the robot will benefit your environment and your economy—incorrect disposal may harm both. The raw materials from which the robot is built are valuable to our society, and letting them go to waste is undesirable. It has been estimated that correct disposal can lead to as much as 90% of the material

in EEE finding its way into new products, instead of being buried or burned, a huge saving in raw materials and in the energy required to produce and process these.

Consequential Robotics Ltd. is a registered producer of EEE in the UK (our registration number is WEE/BU4223YD).

Regulatory information

EU

This equipment is in compliance with the essential requirements to carry the CE mark: 2014/30/EU, 2011/65/EU, 2015/863.

USA

This equipment complies with the requirements of FCC part 15. Contains FCC ID 2ABCB-RPI3BP.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that the interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that of the receiver.
- Consult the dealer or an experienced radio/TV technician for help.

AU

This equipment is in compliance with test standard AS/NZS CISPR 32:2015.

Contact

This equipment is manufactured by Consequential Robotics Ltd., 2 Munden St, London, W14 0RH, UK, info@consequentialrobotics.com, +44(0)117 318 3885.