UVD Robot Model B

Version 1.1. April 2019

UVD ROBOTS

INFECTION PREVENTION

1. Introduction

This manual is intended for users of the UVD-Robot Model B, to ensure correct usage, provide safety information and proper maintenance instructions.
It is recommended that the entire manual is read and understood before proceeding with using the UVD Robot but a quick guide is also provided for fast usage of new personnel.

2. Intended use

The UVD-Robot can be used for disinfecting patient rooms, corridors or larger areas as long as it gets close enough for a long enough period of time to disinfect the targeted areas in regards to what needs to get disinfected.

In order for the UVD-Robot to disinfect an area automatically, the area will need to be mapped first and set up for a proper disinfection routine, contact your assigned technical staff in order to get this done before proceeding with a disinfection, if this has not already been done.

The UVD-Robot is intended for disinfection purposes only!
Using it in any other fashion or with any other equipment installed not supplied by the manufacturer voids its warranty and the full functionality of the UVD-Robot can not be guaranteed.

3. Safety

3.1 Description of safety system

The UVD Robot uses a redundant safety system. A redundant safety system ensures safety in three different and parallel ways in order to minimize the risks with the operation. These three safety systems uses sets of different components and have different architectures.

The three safety systems used are:
- A Software Safety system, located in the robots software.
- A Hardware Safety System, located on the robot.
- A Door safety system, using the tablet which is then attached to the door before the disinfection process starts.

3.1.1 Software safety system

The first thing the robot does is check to see if there are some software constraints on its sensor inputs. This allows the UV-C light bulbs to be turned on, if, and only if:

- The system is running under the conditions of normal operation and low CPU use.
- If the connection with the Hardware system and the tablet exists and is active.
- If none of the human input devices indicates that the disinfection has to stop (i.e. the emergency stop or the soft emergency stop from the tablet).
- If the disinfection process has been done in a specifically defined order.
  (i.e. the person has to do the checklist, then press the physical button on the robot and afterwards press disinfect on the tablet. If one of these steps is not done or done in another order, the robot will never light).

3.1.2 Hardware safety system

The hardware safety comes from the constraints of a specific order of events and a parallel system that does not allow the lights to be on more than a specific amount of time. The events are:

- The tablet connection exists and is active.
- The tablet sends an initialising signal.
- The physical button is pressed.
- A minimum amount of time passes, so the person has time to get out of the room (default time for this is 8 seconds).
- The level of battery is sufficient.
- A maximum amount of time is never achieved. If more time than this is passed, the system stops (default time for a max disinfection is 30 minutes).

3.1.3 Door safety system

The tablet incorporates sensors that allow the UVD robot to know if the tablet has been moved or not. This approach is taken for two major reasons: even though the robot is now safely turning on the lights, it could be that a person gets to open the door or this, somehow, opens by itself. In order to avoid this situation, the tablet is placed on the door and thus this can measure if the door is in movement that the tablet is placed on.

The tablet has a low sensitivity movement threshold, which, if it is overcome, stops the disinfection process. Furthermore, when the process starts, the tablet and the robot establish a connection with a deadman signal. This is such a signal where every few milliseconds a signal is sent and processed. If this connection exists and is active, the disinfection process can take place. This not only ensures an immediate stop if the door is moved but also ensures that the device and the robot are working as intended during disinfection operation.

3.2 Description of hazardous levels

	DANGER is used to indicate a hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
	WARNING is used to indicate a hazardous situation which, if not avoided, could result in death or serious injury.
	CAUTION is used to indicate a hazardous situation which, if not avoided, could result in minor or moderate injury.
	NOTICE is used to address safety-related practices not related to physical injury (for example, maintenance information that, if not followed, might result in equipment damage).

Overview of the different levels of hazard are given here:

- **UV-C light exposure danger. Strictly follow safety checklist**
  Danger of personal injury if safety checklist is not performed correctly. Human exposure to UV-C light will result in severe injury to skin and eyes.

- **Check for fractions on UV-C lamps**
  Danger of personal injury If a lamp breaks, ventilate the room for 30 minutes and remove the parts, preferably with gloves. Put them in a sealed plastic bag and take it to your local waste facilities for recycling.
- **Remove hazardous objects**
  Danger of personal injury and/or damage to robot. Remove objects from robots paths to avoid possible collisions
- **Drive responsibly**
  Danger of personal injury and/or damage to robot if operated irresponsibly. Avoid edges, stairs, obstacles.

- **Update maps**
  Danger of personal injury and/or damage to robot if maps are outdated. Update maps with edges, stairs, obstacles etc. that can cause a harmful situation.
- **Use original charger**
  Use of other charger may result in damage to the batteries and may cause fire.
- **Lithium battery**
  Danger of personal injury and/or damage to robot if it is not treated as intended. Turn off the robot when not in use.
  If exchanging of a battery should be necessary, connect the batteries correctly. Keep them within the specified temperatures given on the batteries. Do not disassemble, puncture or crush them and keep the batteries dry.

⚠ **CAUTION**

- **Avoid inclinations above 5%**
  Danger of personal injury and/or damage to robot if gradients exceed 5%. Given that the robot will be able to enter an uncontrollable slip.
- **Use only on dry and even surfaces**
  Danger of personal injury and/or damage to robot if surfaces are wet or slippery. Robot will be able to enter an uncontrollable slip
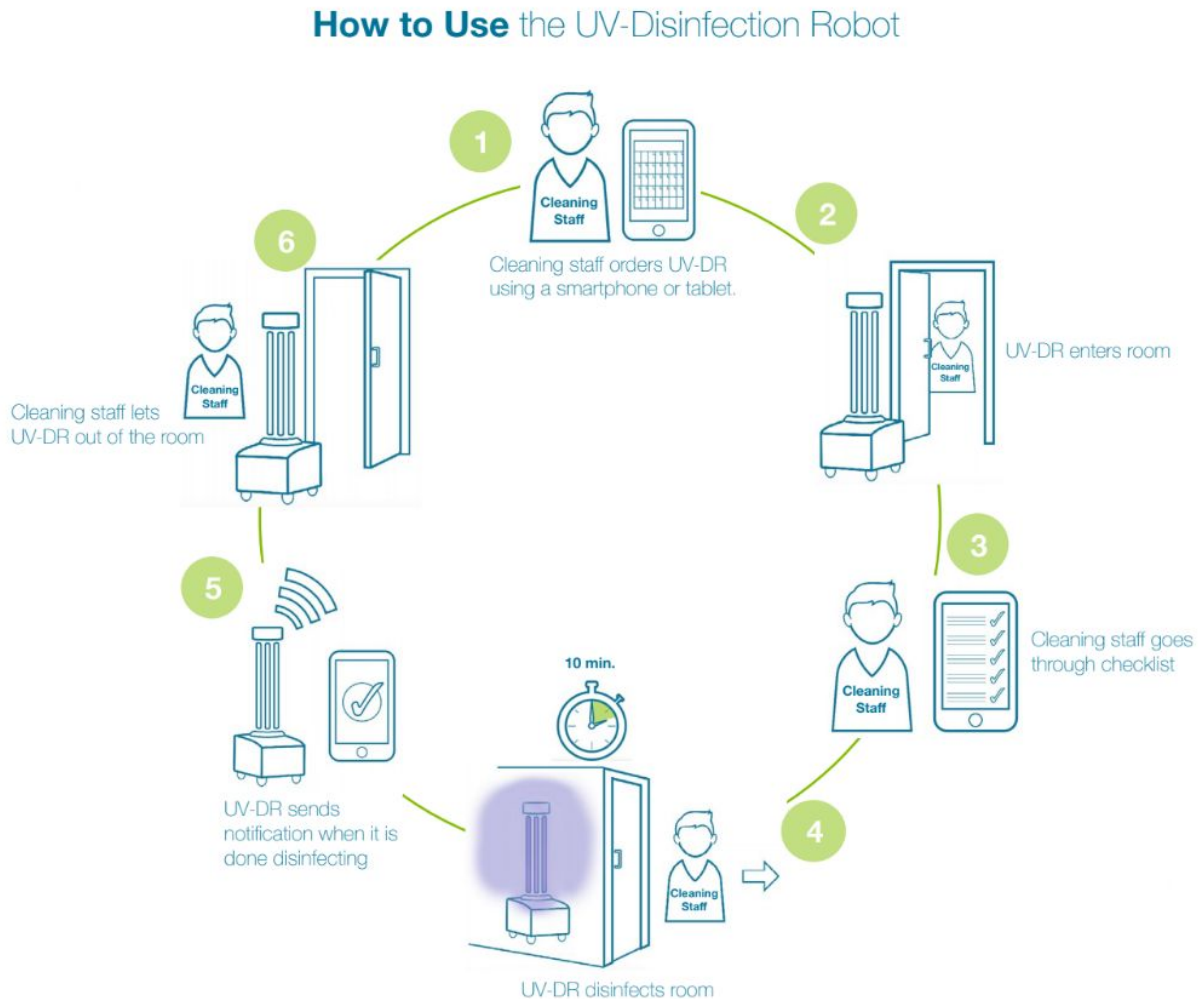
NOTICE

- **Indoor use only**
  Risk of damage to robot. The robot should never be used outdoors
- **Remove unwanted objects on floor**
  Risk of damage to robot. The robot can not detect objects lower than 5 cm of height and may run over these.
- **Avoid excessively humid environment**
  Risk of damage to robot or robot components. Ambient humidity in the robots environment must be within a reasonable level.
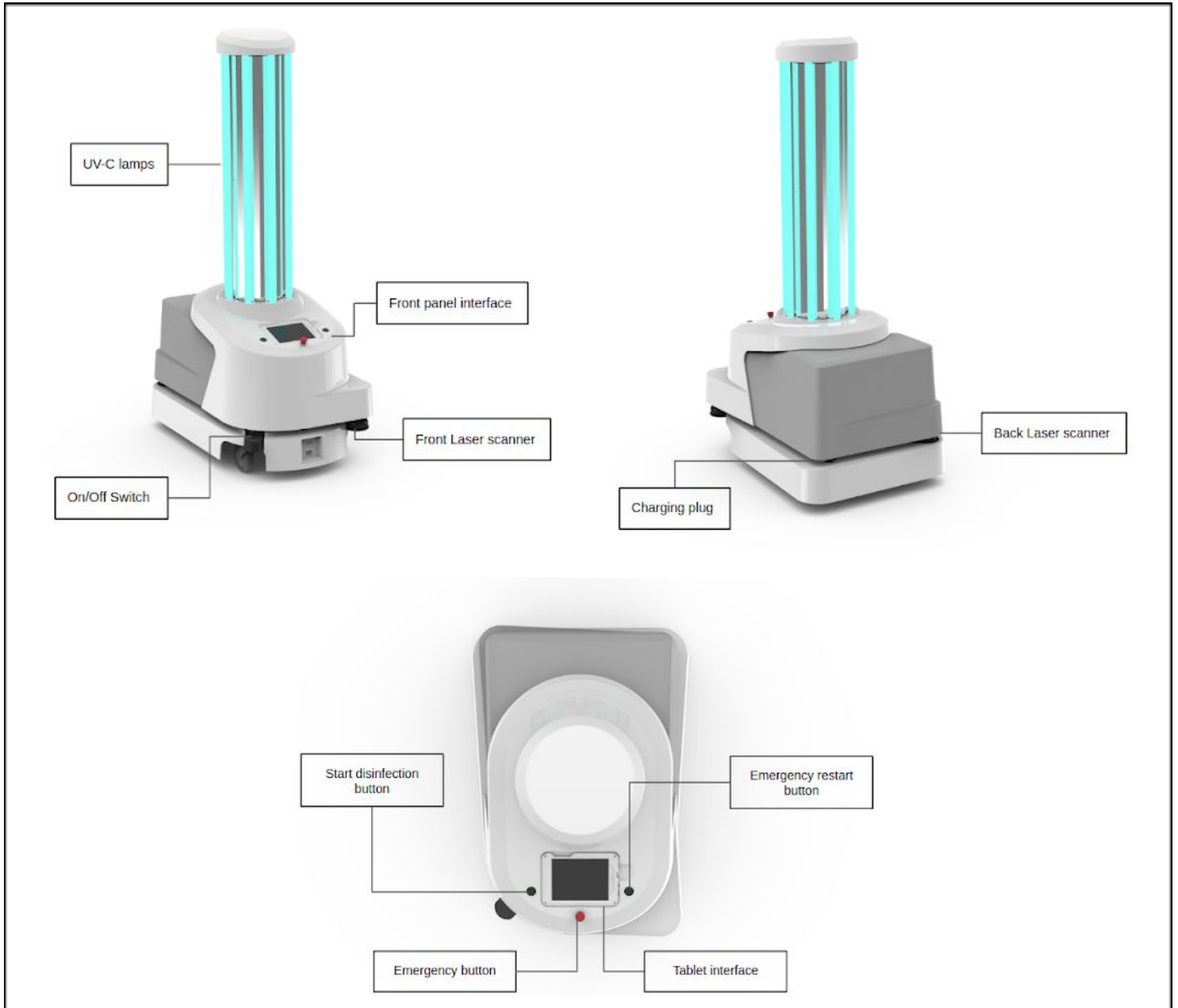
4. The UVD Robot

4.1 About the UVD Robot

The UVD Robot is an autonomous, flexible and module built disinfection robot. The autonomous drive system means that the cleaning personnel easily can call the robot via a tablet or phone. It will navigate to the desired position while the staff is doing the initial cleaning. After initial cleaning, the robot is sent into the room, its activated and the personnel can continue their planned work while disinfection is ongoing. After disinfection, the robot signals the personnel and it will be ready to continue to a new room.

Visualisation of cleaning process:

How to Use the UV-Disinfection Robot

1. Cleaning staff orders UV-DR using a smartphone or tablet.
2. UV-DR enters room
3. Cleaning staff goes through checklist
10 min.
UV-DR disinfects room
5. UV-DR sends notification when it is done disinfecting
6. Cleaning staff lets UV-DR out of the room

4.2 Overview of components

4.2.1 On-robot components

4.2.2 Off-robot components

Various possibilities exist in order to mount the tablet onto disinfection room doors. The most common one is the expandable tablet holder going over a door.
Leaning the tablet up against the door has also proven to be an effective way of ensuring that the functionality of the emergency stop is still functional.

4.3 General specifications

Charging Time:
With manual charger: Full charge up to 8 hours   0-80% takes around 5.5 hours
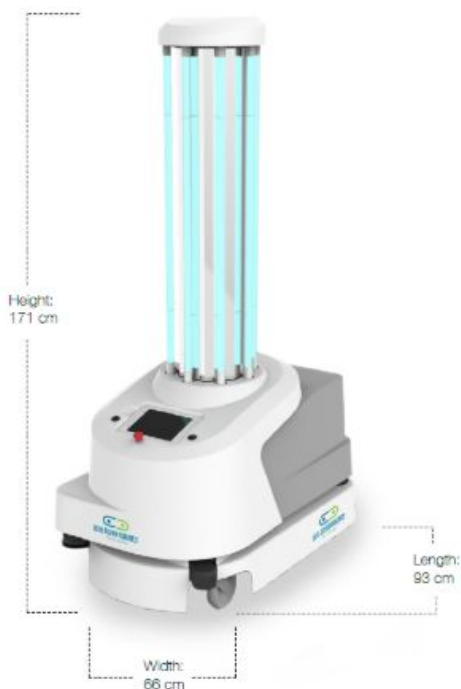With docking station: Full charge up to 5 hours   0-80% takes around 4 hours
Max current drawn at charging: 16 A per charger
Maximum incline for moving up a ramp: 5%
Battery: 4 x Li-NMC, 24 V, 40 Ah

UV-Disinfection Robot Specifications

- Max Speed: 5,4 km/h
- Total Weight: 140 kg
- Dimensions: L: 93 x W: 66 x h: 171 (cm)
- Operating Time: 2-2.5 hours (disinfects 9-10 rooms)
- Disinfection Coverage: 360 degrees
- Disinfection Time: 10-15 min. pr. room
- Connectivity: Wireless (Wi-Fi based)
- UV-Wavelength: 254 nm (UV-C rays)
- Charging Requirements: 220-240 VAC, 50 Hz, 6 Amps
- Safety: Software & Sensors Based
                           Emergency Stop Button

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5. Quick guide on how to use the UVD Robot

1. Take out the tablet from the robot and swipe to turn it on. Enter the UVD app.

2. If automatic setup follow steps 3-10, if manual mode disinfection follow steps 11-13

3. Press (+) button and choose a zone/headline to order the robot to move to the designated zone/room you wish to disinfect.

4. Once at the room, open the door for the robot and press "Done". The robot will now move into the room.

5. Go through the safety checks and confirm that they are done by pressing the boxes next to them.

6. Push the blinking red button on the UVD robot to initialise the disinfection function. You now have about 8 seconds to leave the room before you can start up the disinfection process by hanging the tablet on the door and then pushing the button that will appear on the tablet called "Start disinfection".

7. Once the robot is done with its disinfection, it will move into its end position.

8. After the robot has reached its end position, a disinfection report will appear on the tablet.

9. Click "Done" at the bottom of this and now the tablet will ask you to put it back into the robot.

10. Once the tablet is back in its socket in the robot, the robot will drive out of the room, and if no further jobs has been assigned to it, it will either move back to its docking station or just glow green if it has not been assigned a docking station.

    For manual mode!
11. Drive the robot to the desired position for the disinfection operation.

12. Push the symbol that resembles an alarm clock, furthest to the left.

13. Set the timer to how long you wish the disinfection to last, it takes 3 minutes for the bulbs to warm up so the time should always be 3 minutes + desired amount of minutes.

14. Follow steps 5, 6 and 9. The disinfection process has now been concluded.

6. Elaborated usage of the UVD Robot

This section lists the individual parts of operating the robot. It is possible to print out specific pages for daily users to give them easy access of this information

6.1 UVD Robot setup

Setting up the robot implies:

- Creating maps
- Creating disinfection positions
- Adjusting disinfection times
- Setting up network parameters together with IT-dept
- Setting up interfaces for job ordering and adjusting movement sensor on checklist tablet

All these tasks are to be done by a UVD Robots technician. But maintaining the complete setup, can be accomplished by receiving proper training from a UVD Robots technician.

Once the robot is set up, it is possible to operate it with ease in order to start disinfecting. In addition, the manual disinfection mode makes using the robot even easier to use for disinfecting, since it does not require mapping setup.

6.2 UVD Robot automatic workflow (Step by Step)

1. **Charging:**
- Ensure the robot has been charging. Now take out the charging plug, turn the robot on and turn on the tablet too.
- After approx 20 secs, push the 'start' button next to the red E-stop button on the robot.
- Make sure tablet the is connected to the robots wifi and open the UVD Robots app
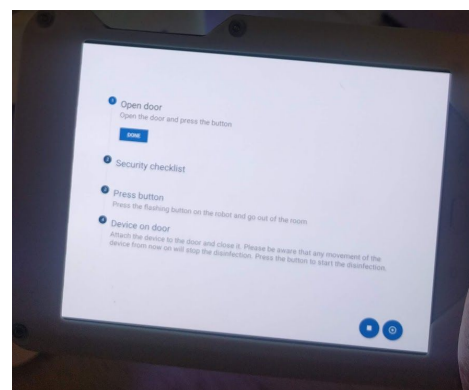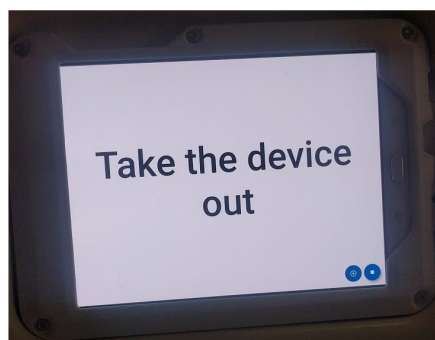
2. **Assign job:**
- Now press the plus sign (+) in the app. And you will see a list of rooms you can disinfect
- Choose a room, press and step aside as the robot will drive to the entrance of it
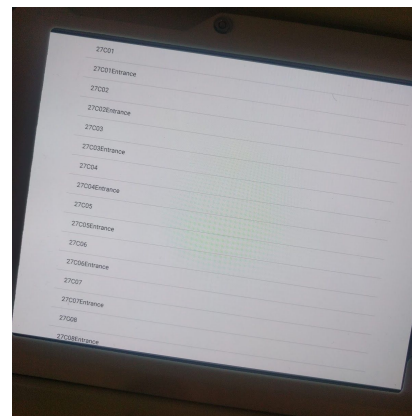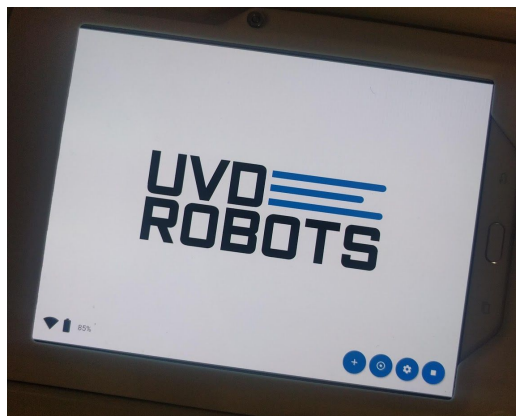
3. **Robot arrives at room:**
- Take the tablet out of the robot and open the door.
- Point 1 on tablet: Press the 'Done' Button. The robot will now drive inside the room
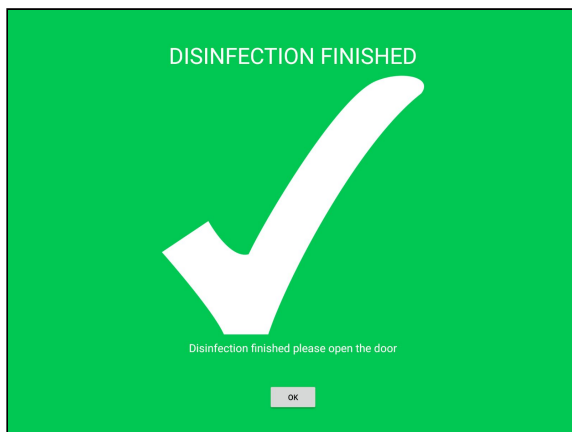
4. **Start disinfection:**
- Point 2 on tablet: Execute the checklist by checking of the boxes to the left of the text, and also make sure room interior is placed correctly
- Point 3 on tablet: Press the glowing button on the robot and close the door
- Point 4 on tablet: Hang or place the tablet on the entrance door. Once tablet is not moving and everything is secured. Press red 'Start Disinfection' button
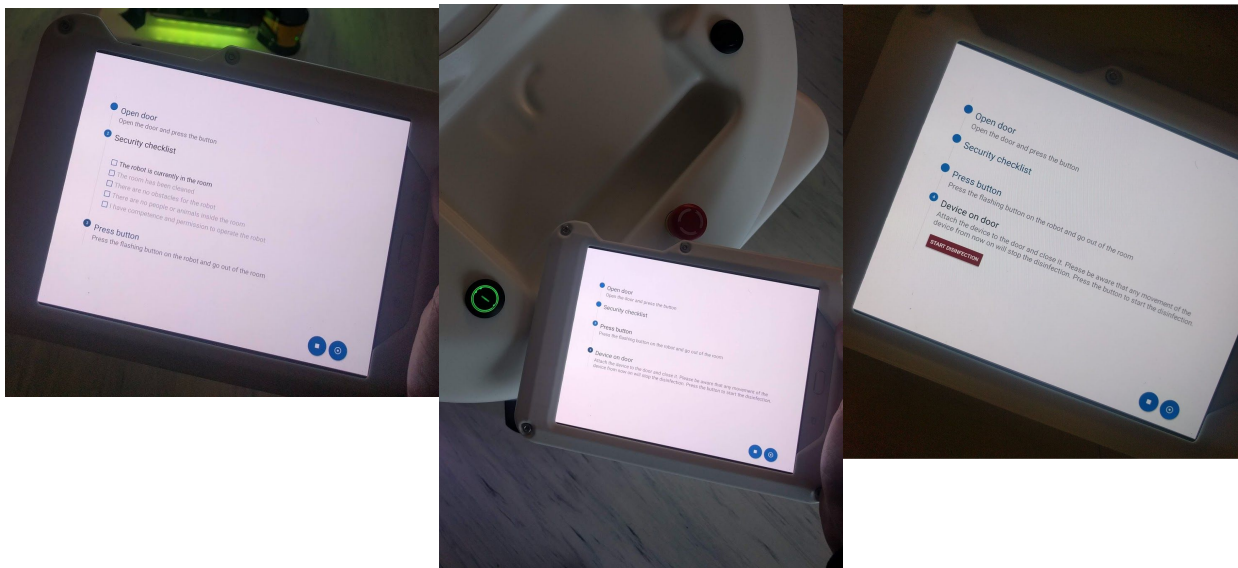

5. **Disinfection done:**
- Press done, open the door and place the tablet into the robot and make sure it is turning the right way, like on the picture below. The robot will now drive outside the room by itself. And to its charging area if that feature is enabled inside the app.
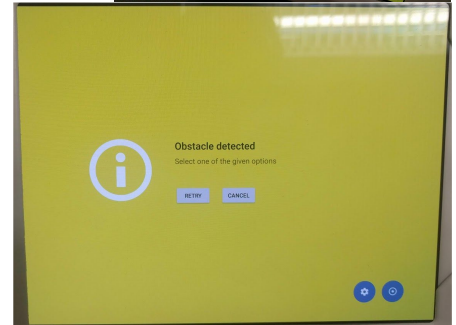
6. **Extra features and troubleshooting:**
-   Disinfection interrupted. Press retry and perform checklist. Robot will continue from where the error occurred.
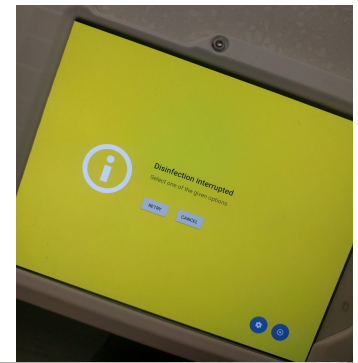
-   Obstacle detected. If something is blocking robots path, it will end by saying obstacle detected. Press retry or cancel

-   On the tablet there's a settings icon. In there, on **first tab to the left**, you can choose if robot automatically should go to charging area or not.
    On **second tab to the left**. You can increase the deadman frequency if robot keeps saying 'Disinfection interrupted'. You can also adjust the tablet movement sensor sensitivity. This enables either less or more movement on the tablet to be allowed.
    On **third tab to the left**. Connection between tablet and robot is configured
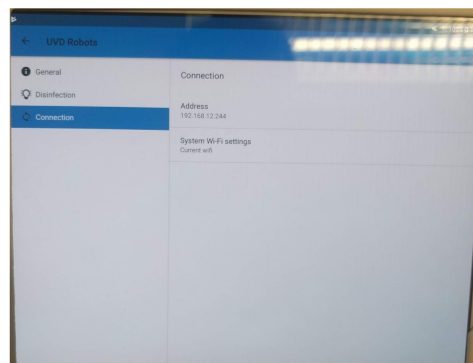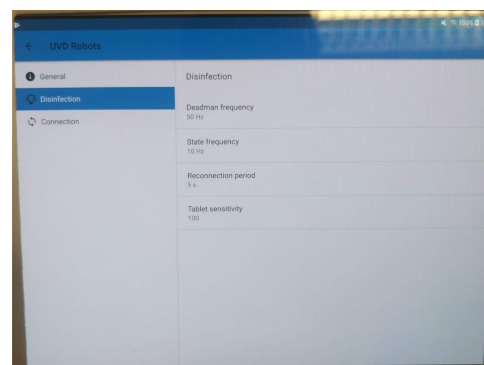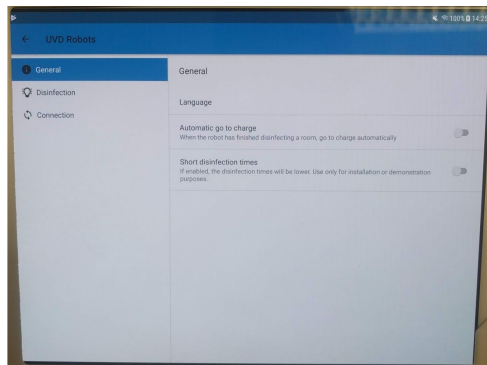
6.3 Turn on/off UVD Robot

Turn on: Make sure a charging cable is not attached to the robot. Locate the blue button in the bottom front corner. Press and hold for 1-2 seconds to turn the robot on.
Wait 10 secs. Locate and press the green blinking button next to the red emergency stop button on the robot.
Wait until the robot stops blinking yellow and has a constant either yellow or white glow beneath it. The robot is now ready for operational use.

Turn off: Locate the blue button in the bottom front corner. Press and hold for 1-2 seconds to turn the robot off. Wait 30 secs until the robot lights are off, then the robot is completely turned off.

Note: If you want to restart the robot, don't turn it on again until the robot is completely off.

6.4 Charging a UVD Robot

Automatic charging in docking station:
- Make sure the docking station is fixed to the wall and cannot move
- Keep objects away on 1 meter on each side of it
- Once the dock is set up in the interface and power is connected, nothing else needs to be done

Manual charging with cable:
- Plug cable into robot while it is **off**, not while it is on.
- Leave robot charging until next use.
- Make sure to unplug charge cable before giving a job to the robot, and preferably before turning the robot on, otherwise it will remain in emergency stop mode.

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6.5 Objects of attention

As a user, one of your most important tasks is to prevent any possible collisions. The objects shown here needs special attention. As in some situations, the robot can have a hard time spotting these.

MAKE SURE THESE ARE KEPT AWAY FROM ROBOT OPERATING AREAS. Or kept at specified places.

If new shelves, sinks or similar things are installed, please notify your local UVD Robot technician.
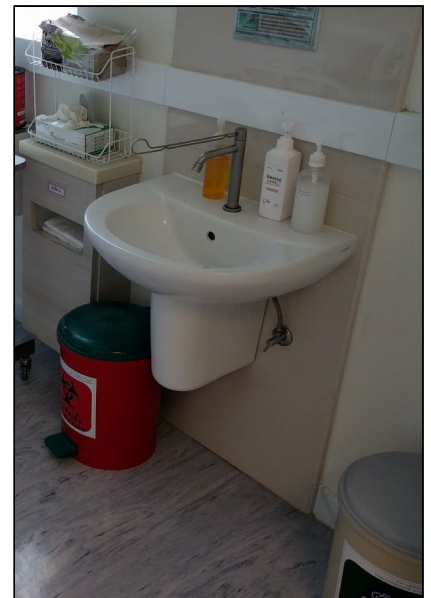
7. FAQ / Troubleshooting

- The tablet charges itself when placed correctly into the socket on the robot, so it is not necessary to worry about charging this, just ensure that it is placed correctly into the robot, otherwise it wont charge.

- When driving the robot around in a hospital, especially in an area which is not mapped, ensure that the UVD app is closed down, this can be done by pressing the button below the tablet screen and swiping the UVD app to the left.

- Charging times will be higher when using the manuel charger if the robot is on, therefore it is always a good idea to charge the robot when it is OFF.

- Do not be afraid to use the emergency button on the front of the robot, it is what it is there for, after using it, then remember to press the start button again.

- If any problems should occur such as "AGV internal error" then the error is inside the robots movement interface/MIR interface and can usually be resolved by turning the robot off and then on again. If however this does not resolve the issue, then contact your local UVD Robots technician for instructions on what to do.

8. Maintenance instructions

Maintenance instructions, which needs to be performed on a weekly basis

General maintenance:

- Spot visual damages or dis-functionalities on robot. Contact your local UVD Robot technician if needed.
- Listen for unusual sounds. Contact your local UVD Robot technician if needed
- Clean outer sides of robot

Specific points requiring special attention for cleaning and inspection:

- UV-C bulbs are checked for functionality and fractures.

    During a disinfection, the UV-C bulbs can be inspected through windows, if all bulbs light blue and at the same intensity.

- The UV-C bulbs are covered by a glass cover, which is wiped off or if damaged, swapped with a new glass cover.

- When UV-C bulbs are checked for damages. If the bulbs are damaged. Ventilate the room for 20 min, and dispose of the glass material. The Bulbs contain gasses which should not enter human airways.

- Do NOT clean the reflector behind the UV-C bulbs as even the best of cleaning cloths will leave a scratch on it.

- White surfaces on the robot should be cleaned on a weekly basis.

- Clean the tablet.

Notes on cleaning chemicals used: Do NOT use alcohol based products as it can wear plastic coatings over time. Use cleaning detergents instead. As the robot disinfects itself, then this will be sufficient.

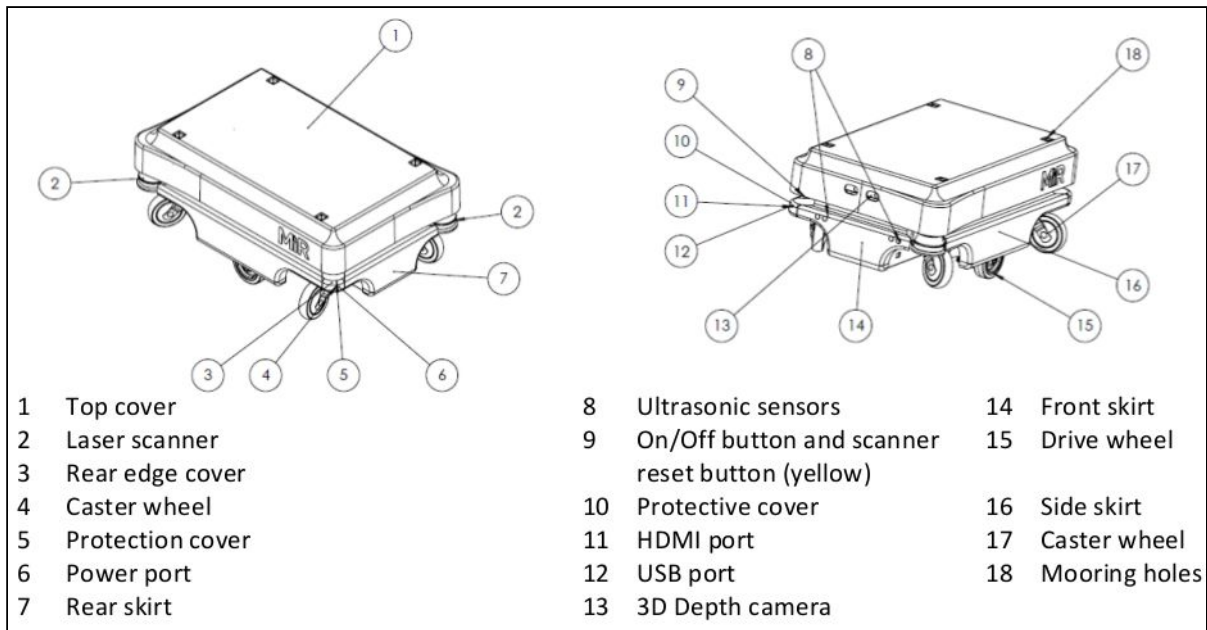|					
1	Top cover	8	Ultrasonic sensors	14	Front skirt
2	Laser scanner	9	On/Off button and scanner reset button (yellow)	15	Drive wheel
3	Rear edge cover				
4	Caster wheel	10	Protective cover	16	Side skirt
5	Protection cover	11	HDMI port	17	Caster wheel
6	Power port	12	USB port	18	Mooring holes
7	Rear skirt	13	3D Depth camera		

Illustration of the mobile platform above. Following points has special interest

- 2. The 2 laser scanners are visually inspected for marks, and are wiped off with a dry cloth
- 4 + 17. Caster wheels are checked for wear and movement restrictions
- 9. On/Off button is cleaned

9. Declaration of Conformity

EU declaration of Conformity

According to the EU Machinery Directive 2006/42/EC, Annex II 1.A

Manufacturer:

UVD Robots ApS

Niels Bohrs Allé 185

DK 5220 Odense SØ

Person authorized to compile the technical file:

Thomas Rubæk

Blue Ocean Robotics ApS

Niels Bohrs Allé 185

DK 5220 Odense SØ

Description and identification of the machinery

Product:	UVD Robot model B - Serial No. 17000200 and higher
Commercial name:	UVD Robot
Function:	Autonomous mobile robot with UVC disinfection system (battery powered)

The UVD Robot automatic drives in hospitals and industrial facilities and via UVC light disinfects surfaces in selected areas following a user predefined disinfection process for each room or location.

Each robot has its own wifi network and is controlled from a user interface, which is accessed via a browser on a PC, tablet or smartphone.

It is expressly declared that the machinery fulfills all relevant provisions of the following EU Directives or Regulations:

2006/42/EC   Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast) (1)

Reference to the harmonized standards used, as referred to in Article 7 (2):

EN 60204-1:2006/A1:2009 Safety of machinery - Electrical equipment of machines - Part 1: General requirements

EN ISO 12100_2010-11   Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO12100_2010)

EN ISO 13849-1:2015   Safety of machinery - Safety related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015)

EN ISO 13849-2:2012   Safety of machinery - Safety related parts of control systems - Part 2: Validation (ISO 13849-2:2012)

EN ISO 13850:2015   Safety of machinery - Emergency stop function - Principles for design (ISO 13850:2015)

EN 60204-1:2006-6   Safety of machinery - Electrical equipment of machines - Part 1: General requirements

EN 1175-1:1998+A1:2010   Safety of industrial trucks - Electrical requirements - Part 1: General requirements for battery powered trucks

Reference to other technical standards and specifications used:

EN 1525:1997-09   Safety of industrial trucks - Driverless trucks and their systems

DS/EN 61000-6-2:2005   Electromagnetic compatibility (EMC) - Part 6-2: Generic standards

DS/EN 61000-6-4:2007   Electromagnetic compatibility (EMC) - Part 6-4: Generic standards

Odense, 2. August 2018

Per Juul Nielsen, CEO

10. Notes

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