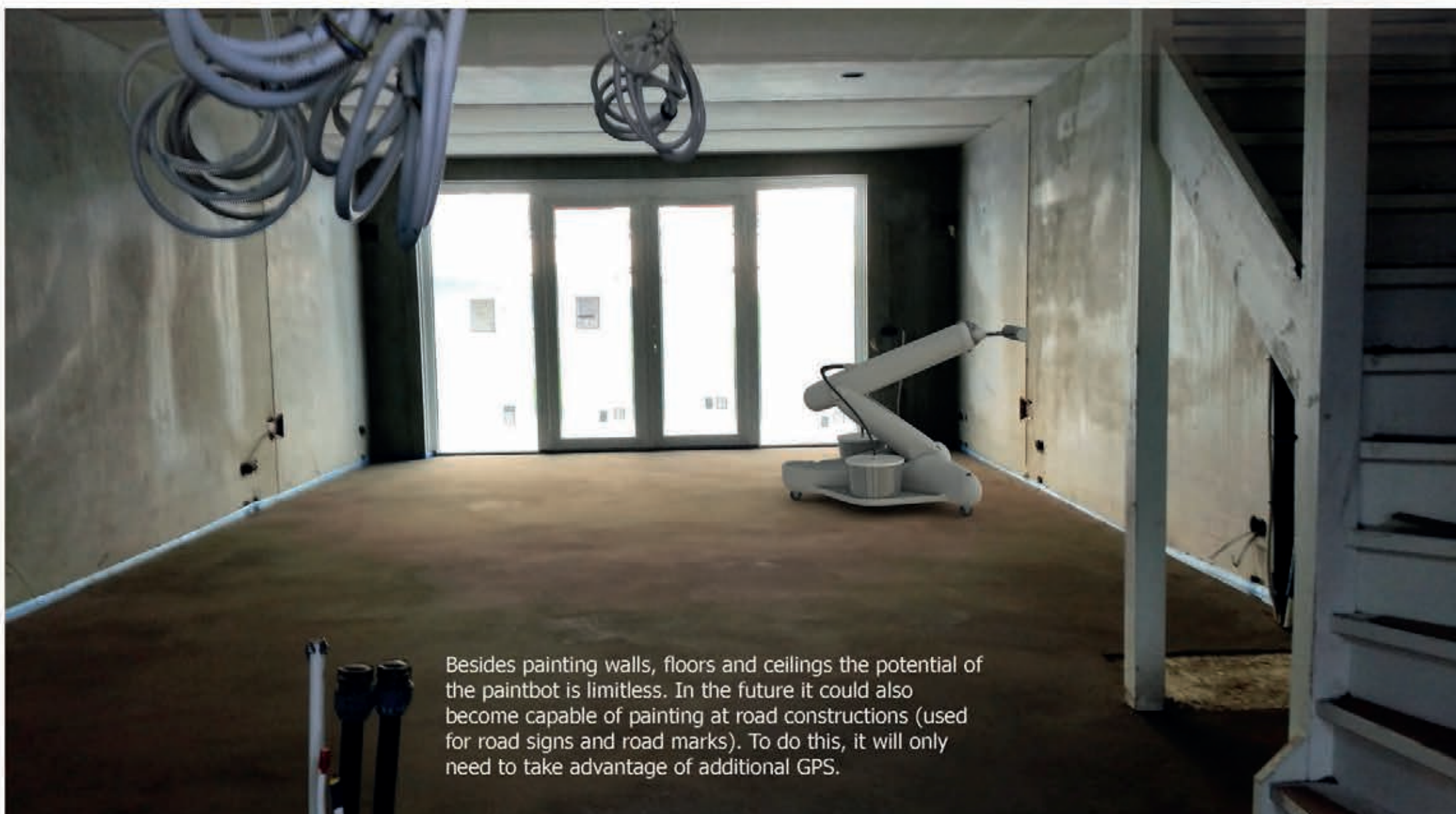


Paintbot

Autonomous Painting system

Paintbot is an autonomous painting robot that can move freely inside construction zones or outside to paint construction objects. The paintbot uses multiple sensors to recognize its environment perform its wall painting task safe and efficiently. The Paintbot will revolutionize how painting is done during large scale construction projects. The sensors will show the color of the wall, ceiling and the floor. It can scan the wall to see where it still has to paint or scan it for color abnormalities (where another paint layer is needed).



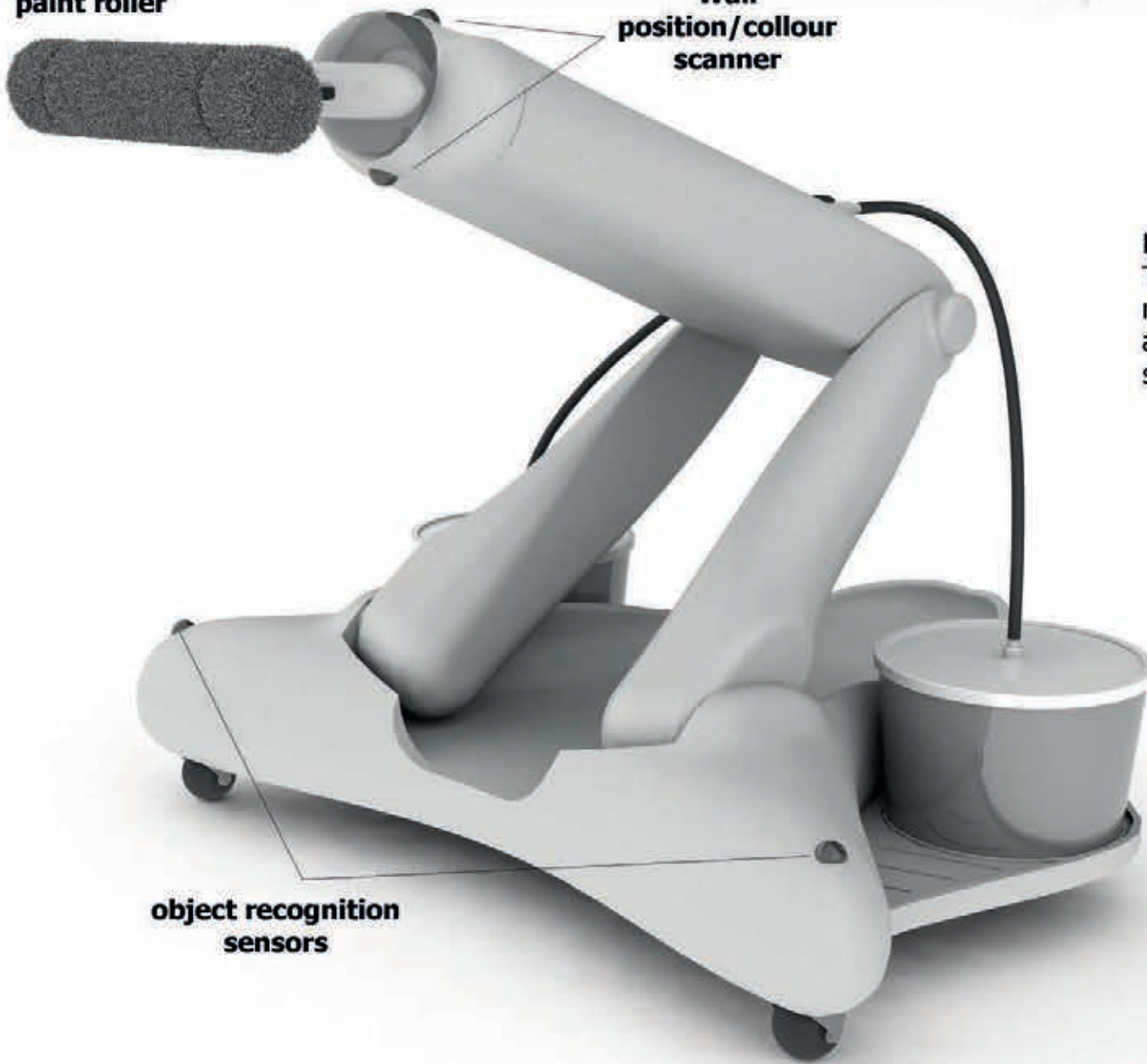
Besides painting walls, floors and ceilings the potential of the paintbot is limitless. In the future it could also become capable of painting at road constructions (used for road signs and road marks). To do this, it will only need to take advantage of additional GPS.

Paintbot



paint roller

Wall
position/colour
scanner



object recognition
sensors

Electrical system

The paintbot is an electrical powered system. The robot arms are driven by electrical motors in the axes. The wheels can all be rotated and steered separately by the movement control system.

Paint

The paintbot carry's two paint buckets. The paint buckets can have identical or different colors. When different colors are used, the paintbot can make gradients or use different colors.

The pump in the mid-section of the paint robot will pump paint in to the roller.



paint pump

paint
buckets

Paintbot



Painting the ceiling



Painting the wall



Paintbot movement

The paintbot can transform in to many shapes. This capability allows the paintbot to do many painting tasks. The paintbot can paint walls, ceilings and floors. The paintbot would typically be used to primer and paint new houses or buildings as the last stage of the building process. The construction company would import drawings of the building in to the paintbot and let it autonomous drive through the building and paint the walls/ceilings.

Angle change



Full rotation



Transport shape



Road sign painting



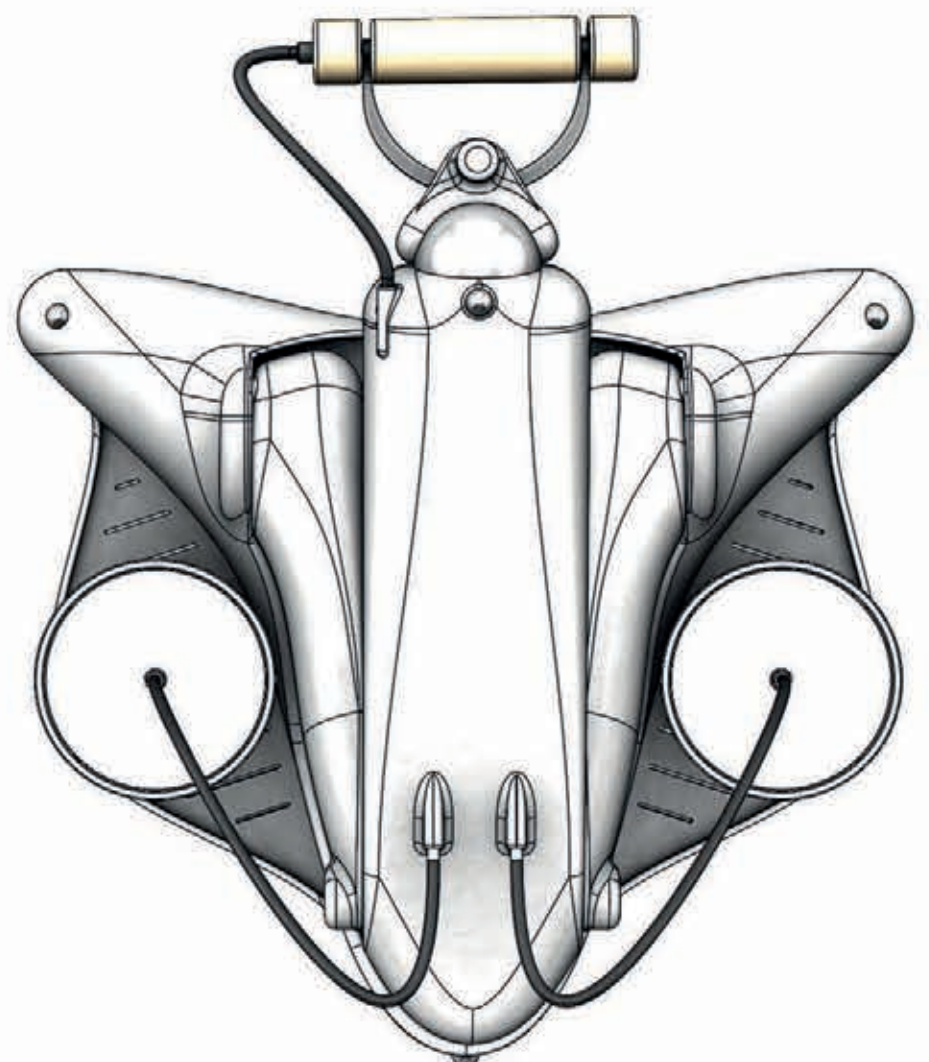
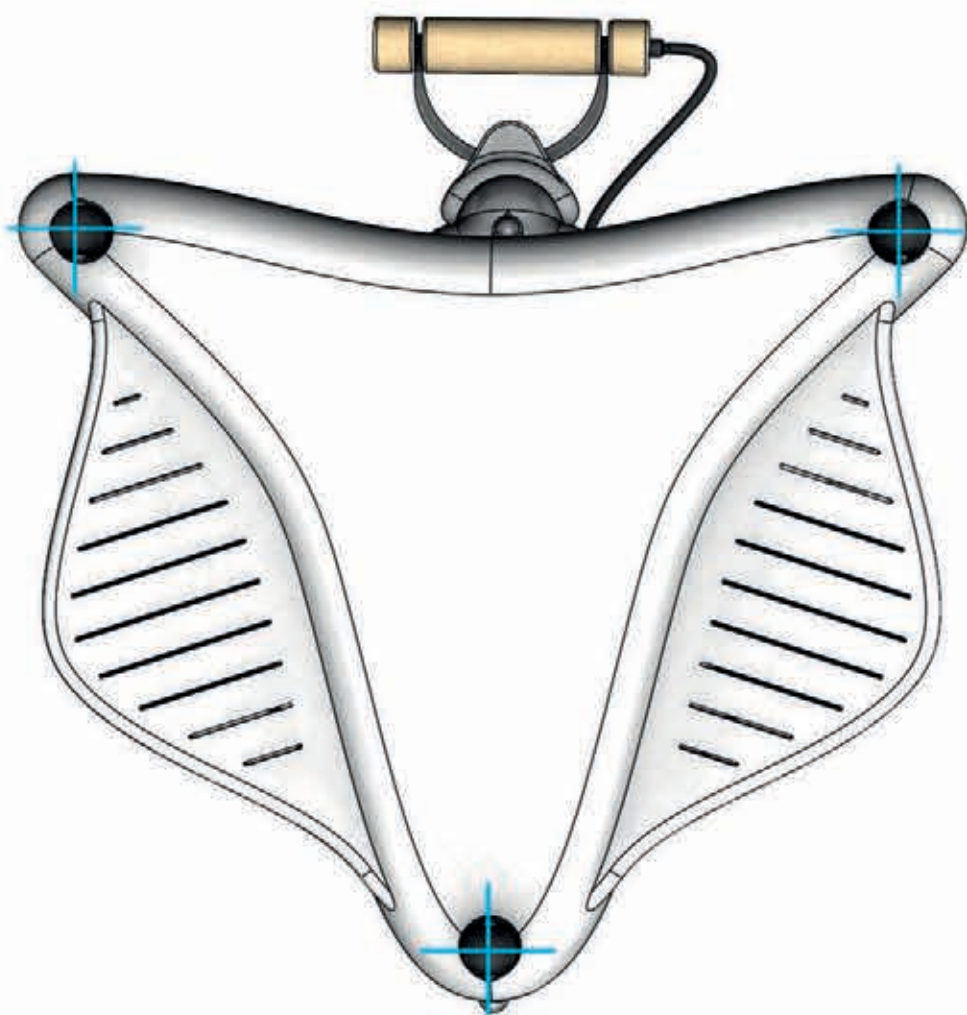
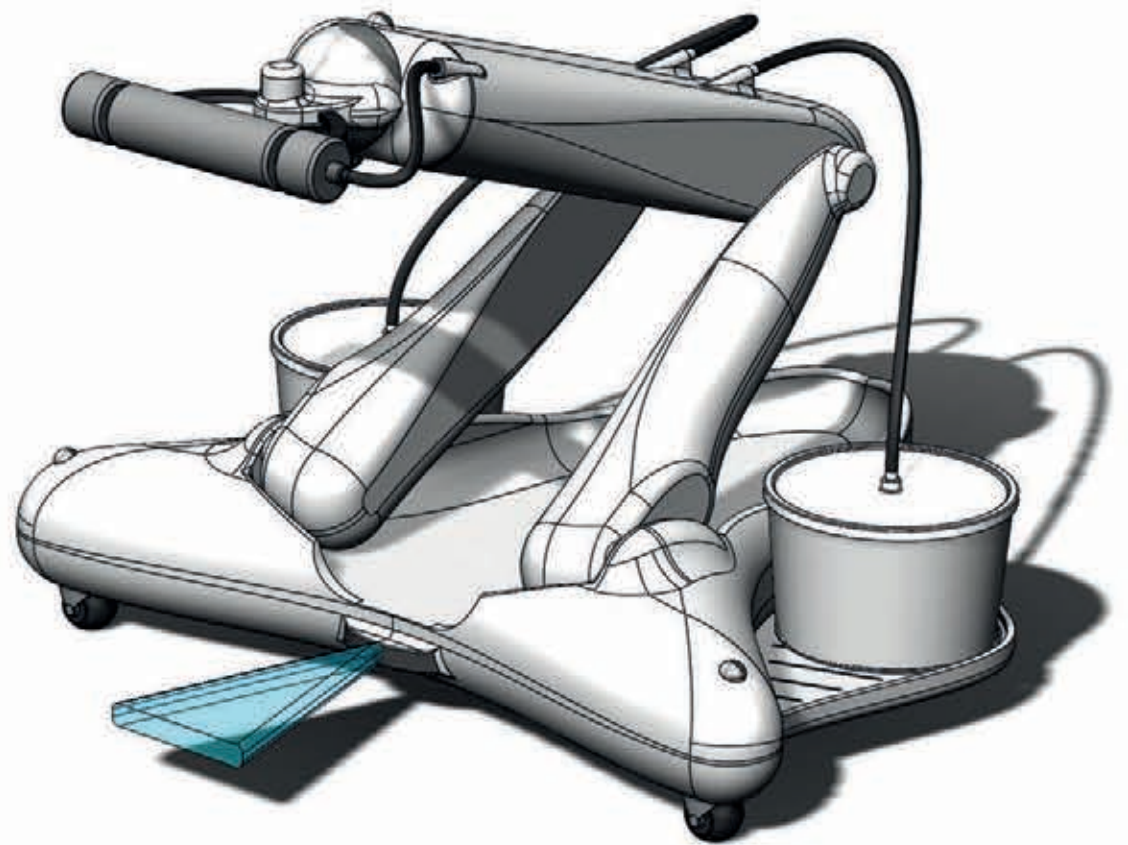
Paintbot



Driving hardware

The positioning of the paintbot is done by 3 powered wheels. The driving orientation of every wheel is controlled by a unique stepper motor. The stepper motors for driving direction can be controlled separately, to allow the paintbot to even rotate around its own axis and maneuver perfectly in to position.

All three wheels have their own stepper motor to power the wheel. This combination results in a total of 6 speed/position controlled motors for the positioning.



Paintbot



AI positioning system

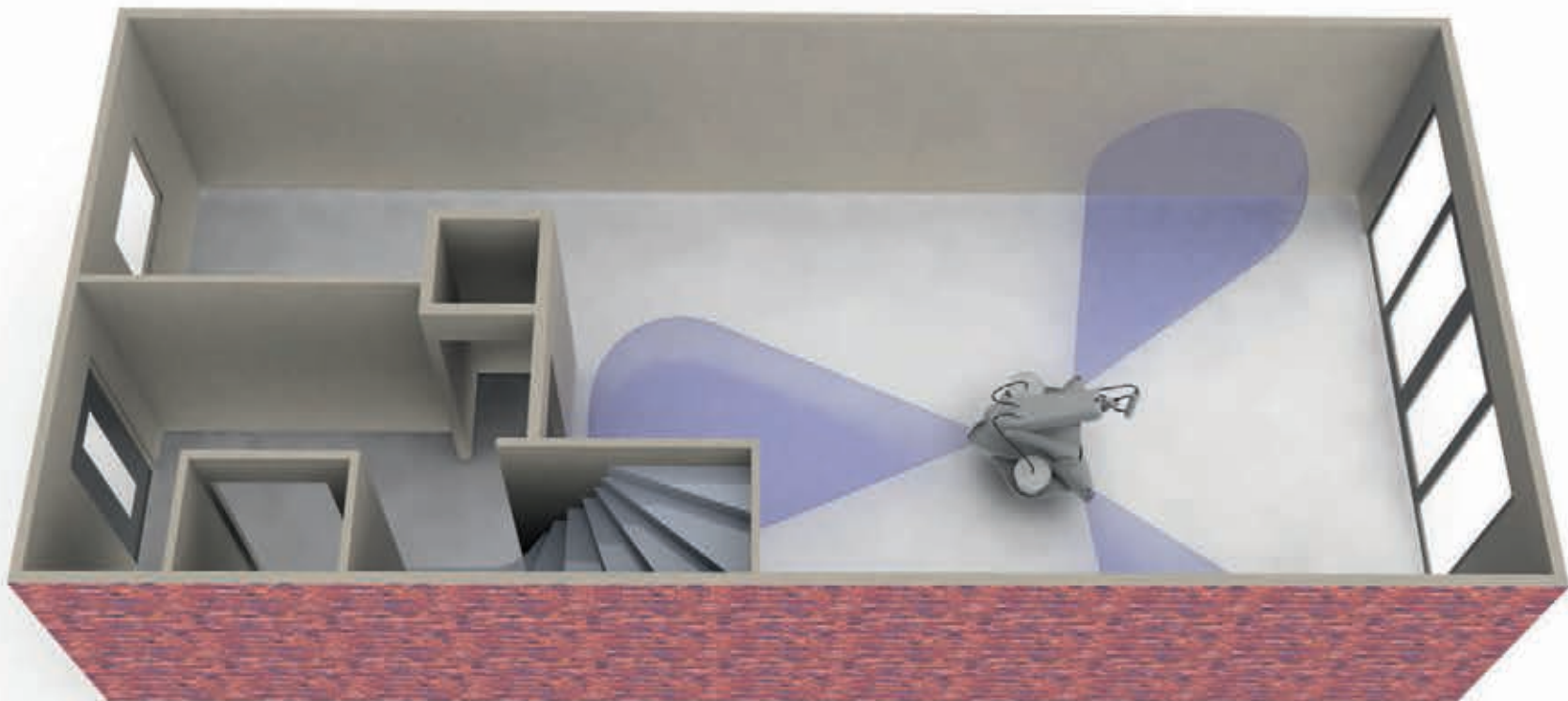
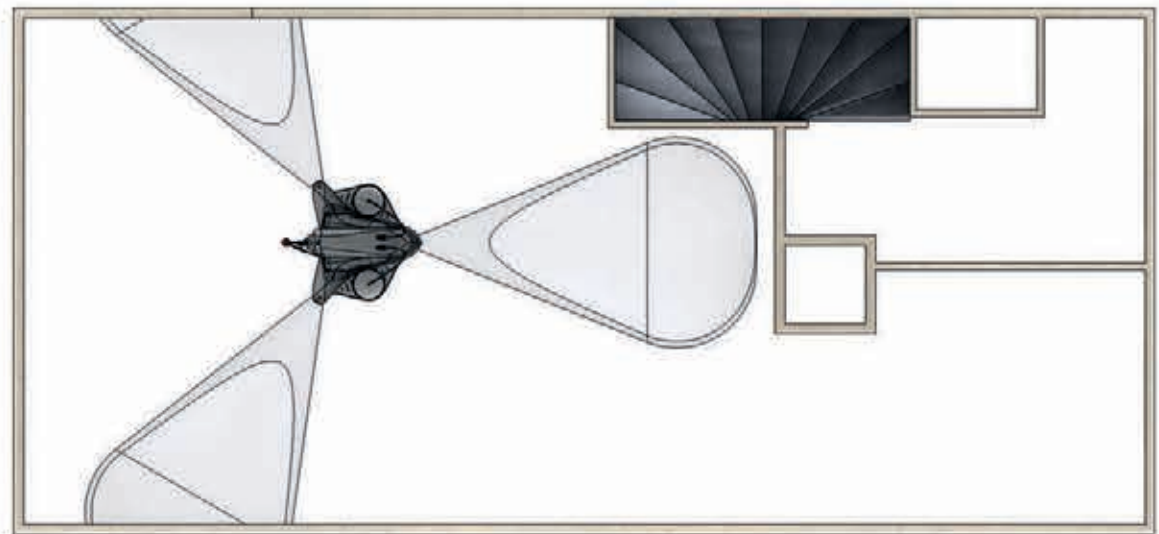
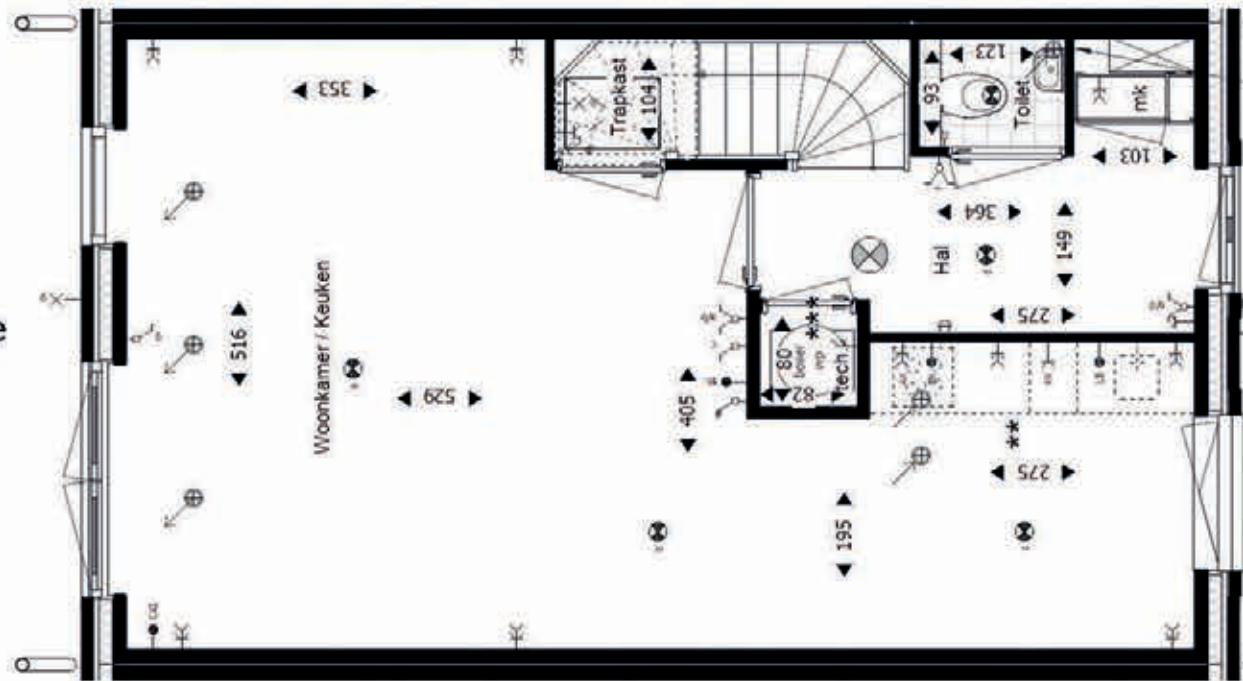
The AI position recognition consists of multiple layers.

- Location reconstruction of the paintbot within its environment.
- Paint task to paint route efficiency.
- Obstacle recognition and rerouting.
- optimizing positioning for most effective paint arm strokes.

The Paintbot uses 3 smaller ZED 3D cameras with distance/shape recognition.

The paintbot will compare the visual data to the map of the location (with integrated paint plan).

Besides the positioning, the cameras are also used to recognize objects and humans.



Paintbot



Paint arm hardware

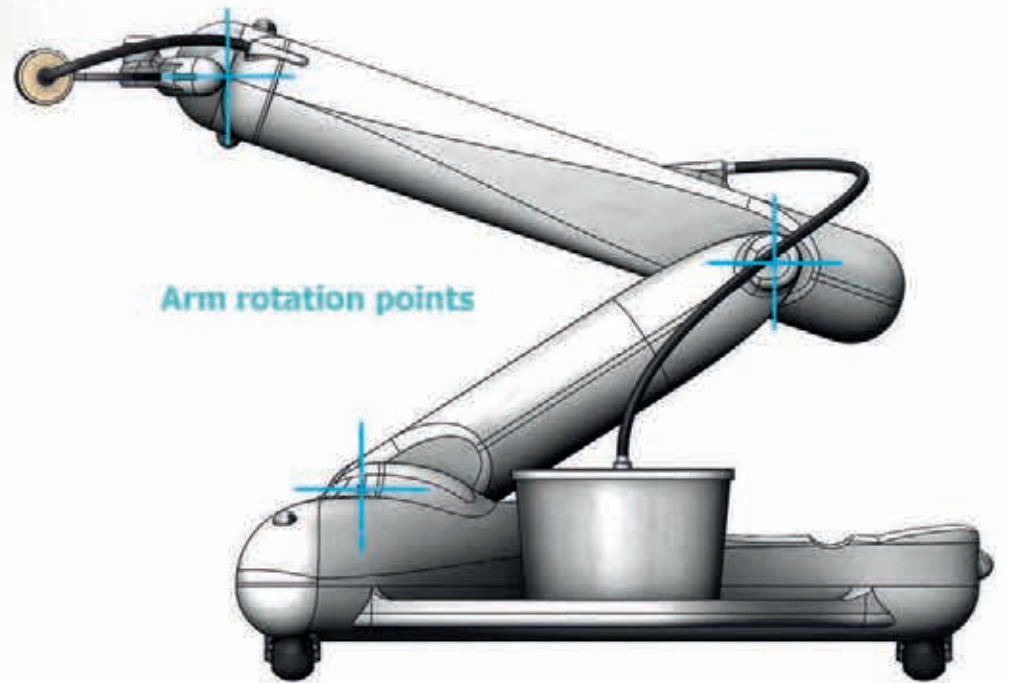
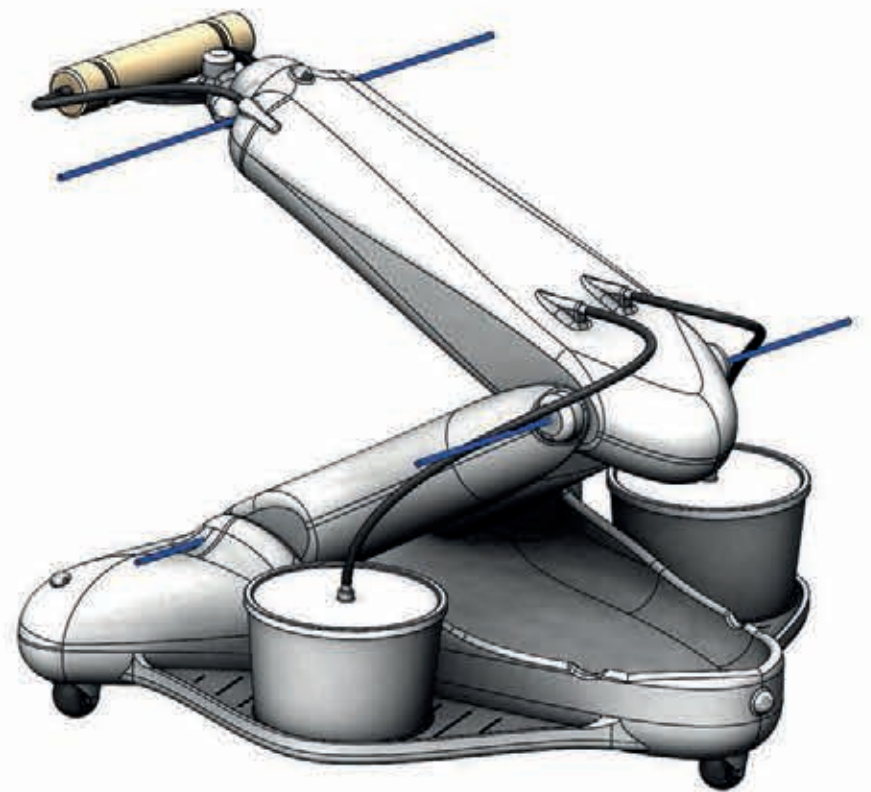
The paint arm hardware can be split up in to two sections.

- The arm stroke motors
- The roller alignment motors.

The stroke motors are used to place the painter head/roller in to the right position.

The roller alignment roller motors are used to align the roller with the movement vector.

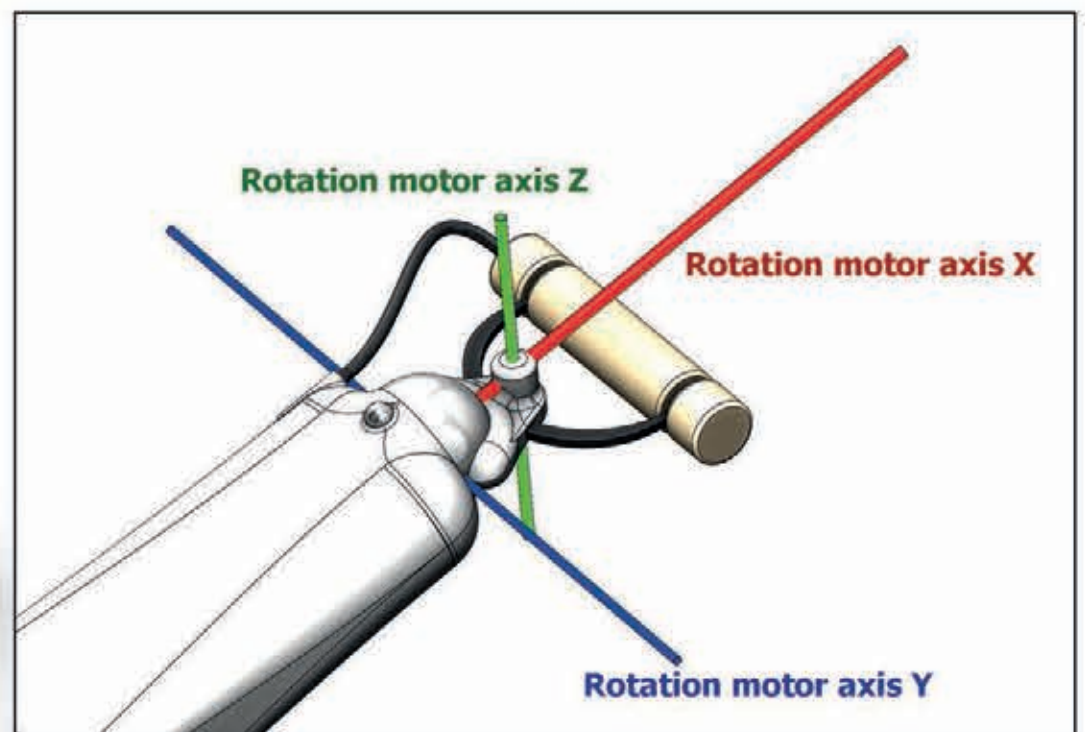
The total movement area is larg enough to reach in to corners. The eventual end results as the centerpoint of mass must remain within the footprint, to prevent falling over.



Arm rotation points



Arm movement area



Paintbot



AI paint quality improver

The paintbot can be used in many different types of buildings. With different type of buildings, come different types of walls by texture and material.

Dependent on the wall type several system settings can be optimized to create the best painting results in a minimal amount of layers (equal to paintbot working time).

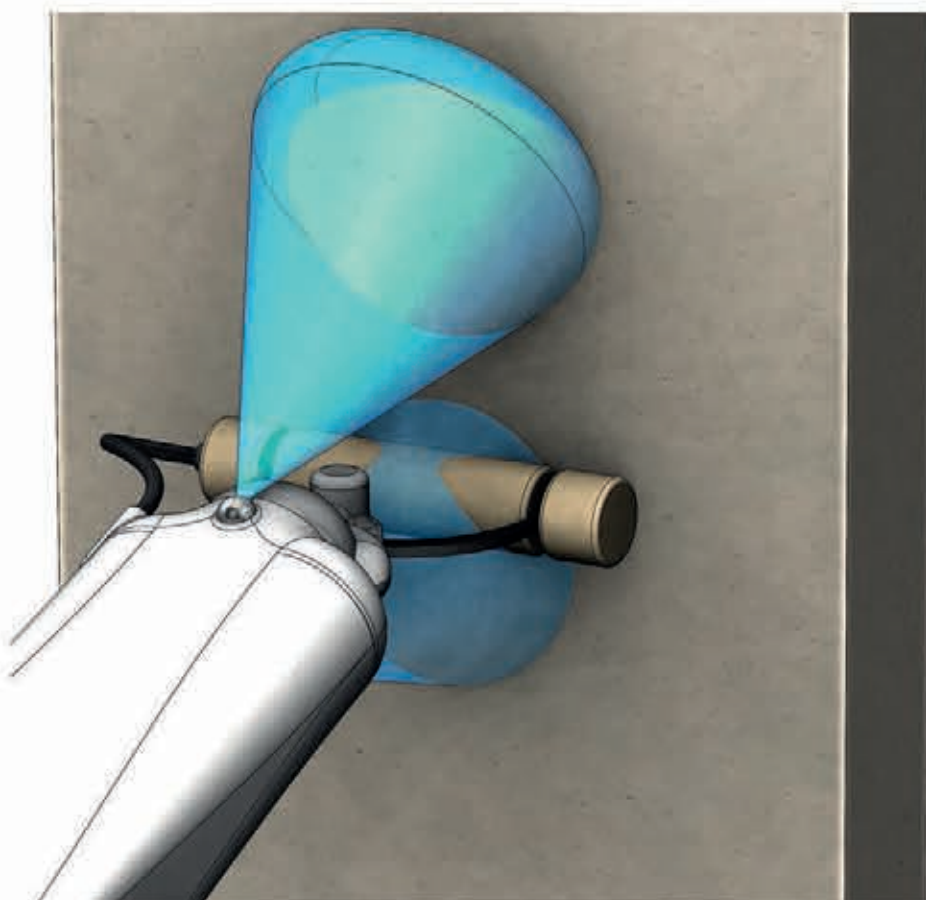
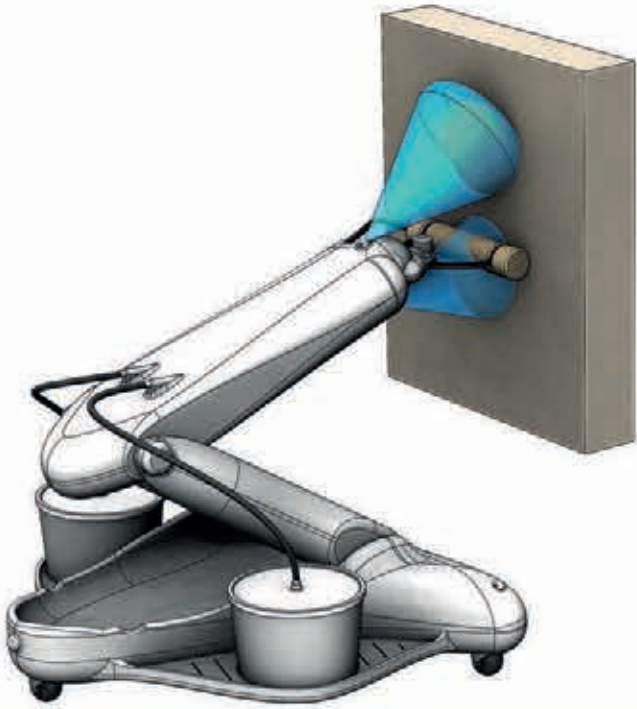
The Paint quality improver AI would control the following input variables:

- Roller pressure
- Paint pump volume per surface area covered
- Roller movement speed

The camera's monitor both sides of the roller. The AI can check the wall type before applying paint and the paint coverage result afterwards. The AI can then optimize the input variables checking the result on the following parameters:

- Paint coverage
- Texture filling of paint
- Paint drips

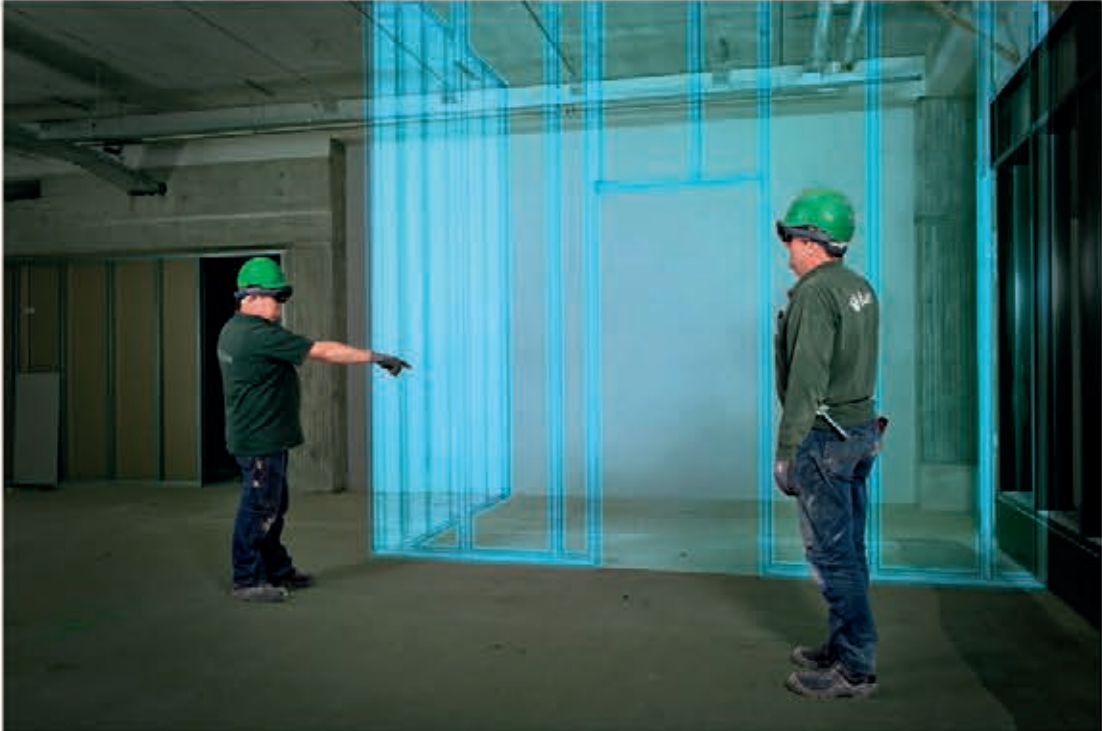
As a side task the AI can also work around objects like "powersocket" by using image recognition.





Augmented paintbot programming

There is not always a technical drawing available and the paintbot can also be used for small tasks. To program the paintbot for smaller tasks, a hololens (augmented reality device) can be used. The device scans the environment and allows the user to indicate in the real world what walls have to be painted.



Paintbot

Board selection Nvidia jetson TX2

The board has to be capable to combine the paintbot drive movement AI with the AI for paint optimisation. As both these subsystems need cameras a total of 5 camera inputs are necessary.

The board will also need a significant compute power to calculate multiple paint strokes and pick the most efficient ones. As so my selection came to the Nvidia jetson TX2. Additionally the TX2 CAN interface is very handy for the servo motor control.

Paintbot system Input	Paintbot system output
Orientation recognition 3d camera 1	Wheel 1 rotation motor (servo)
Orientation recognition 3d camera 2	Wheel 1 drive motor
Orientation recognition 3d camera 3	Wheel 2 rotation motor (servo)
	Wheel 2 drive motor
Sensitive edge 1 (collision detection)	Wheel 3 rotation motor (servo)
Sensitive edge 2 (collision detection)	Wheel 3 drive motor
Sensitive edge 3 (collision detection)	
	Arm main motor 1 (servo)
USB/ cardreader (map data/paintplan)	Arm main motor 2 (servo)
WiFi (Hololens input program)	
Force sensor paint head roller compression	Paint head motor x (servo)
	Paint head motor y (servo)
	Paint head motor z (servo)
On/off button	
Emergency kill button	Paint pump
	Paint input selector actuator
Lidar	
Sweep holder	On/off indicator
	Battery indicator
Paint detection (OPTO)	System diagnostic output