



# MANOMOTION *SafertHands*

## Product Data Sheet



December 2023



## MANOMOTION *SaferHands*

SaferHands is ManoMotion's revolutionary product for saving hands in industrial scenarios. The product utilizes proprietary AI technologies, combined with standard cameras to drastically reduce industry-related hand injuries.

By detecting hands and anticipating their movements, an application leveraging hand tracking can generate signals to shut down machinery or alert the operators when their hands are in danger - while remaining compliant and introducing new level of safety.

SaferHands is the first AI-certified technology for human safety.



## Key Values

- **Reduction of human injury to near zero**

The average cost per human injury ranges upwards of USD 600 to about USD 26,000 in industry today.

- **Reduction of maintenance costs**

Today damages to machines caused by accidents, broken parts, etc introduces high costs to repair or replace parts.

- **Downtime of machines to a minimum**

Prediction of accidents can reduce downtime of machines to few seconds to avoid accidents and restart smoothly.

- **Intelligent detection**

Existing technologies of laser beams and light curtains cannot distinguish humans from other objects and cause false detections.

- **Reaction time below 20 ms**

Customizable based on processor

# Use Cases

Any potentially dangerous machine with the possibility to mount a camera that can detect hands in dangerous situations and take appropriate action (shut off, flash lights, sound sirens etc) when a danger is detected.

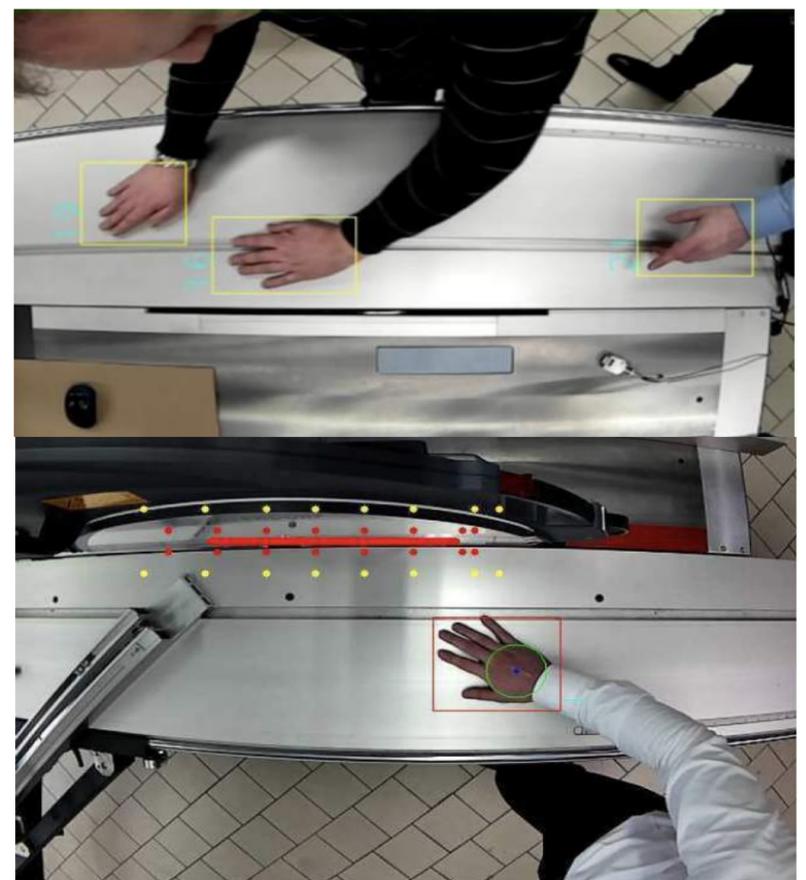


- Saw machines
- Cutting machines
- Industrial roller mills
- Press machines
- Collaborative robots

# Features

- Detection of multiple hands in the camera view
- Detection range from 30 cm up to 1.2 meters
- Tracking of bounding box and basic skeleton for each hand in real time
- Support of specific type of gloves
- Camera position on top of the machine looking downwards
- Single channel camera solution
- Accuracy 99%
- FPS 50+

The solution is fully customizable for other hardware setups. Other cameras and boards can be used, and another board can be used to achieve double channel safety level.



# SaferHands Kit Overview



The SaferHands kit detects and tracks hands in the Safe Zone, Warning Zone and Danger zone. The three zones can be user defined and customizable by QR codes provided in the package.

The safety signals can be provided through a visual feedback on the screen, signal lights and standard I/O port of the Nvidia Jetson board.

## What is included in the SaferHands Kit?

- ManoMotion SaferHands software - pre-installed
- Nvidia Jetson Xavier NX package
- Camera mount and adjustable camera holder
- Signal lights (Green, Yellow, Red) connected to the I/O of the Nvidia Jetson
- QR codes for setting up the warning and emergency zones
- Display for visualisation purpose



**Jetson Xavier NX board and cover box including LED signal lights**  
 GPU 384-core NVIDIA Volta™  
 8GB RAM  
 19V power supply  
 3x UART, 2x SPI, 2x I2S, 4x I2C, 1x CAN, PWM, DMIC & DSPK, GPIOs



**Camera**  
 See3CAM\_CU30 (industry standard)  
 3.4 MP onsemi AR0330 image sensor  
 USB camera - Color  
 Fixed Focus  
 Rolling shutter  
 Low light performance  
 On-board high performance ISP



**Camera mount and holder**  
 Standard S-mount cover for camera  
 Adjustable camera holder for different heights and table mount



**Display**  
 5" built-in or standalone 7" display for visualization of the outputs  
 Standard HDMI connection cable and power cable compatible with Nvidia Jetson board.

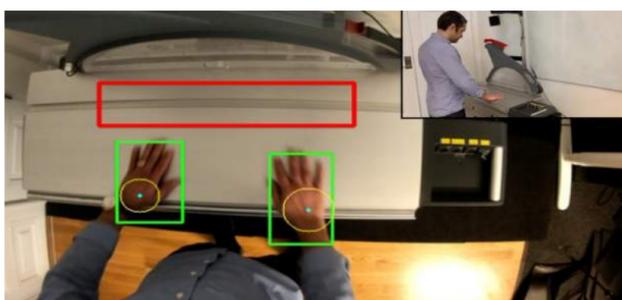
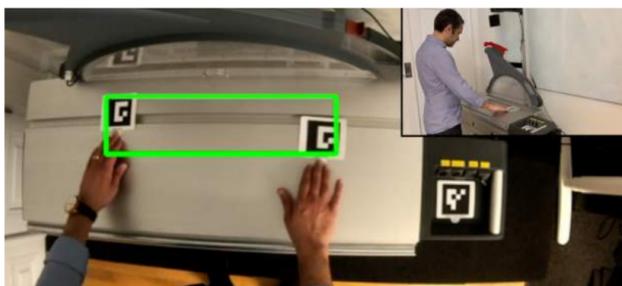


**QR codes**  
 5 printed QR codes for calibration and customization of the safety zones.  
 Needed for one time setup or modification of the safety zones with the startup software.

## Output Signals

- Safety signals: Safe, Warning, Emergency (Standard output provided through Nvidia Jetson I/O).
- Hand position, skeleton features (included and customizable).
- Predictive signals, hand speed, acceleration, etc. (Not available in the standard package).

## How to setup and test SaferHands?



- Connect SaferHands package to power, connect display and mount the camera according to the instructions.
- Define and calibrate the warning and emergency areas using the provided QR codes and calibration instructions.
- System is ready to operate, see the visual output through the display and signal lights on the SaferHands box.
- Standard output is provided through the GPIO and can be connected to other control devices and switches.

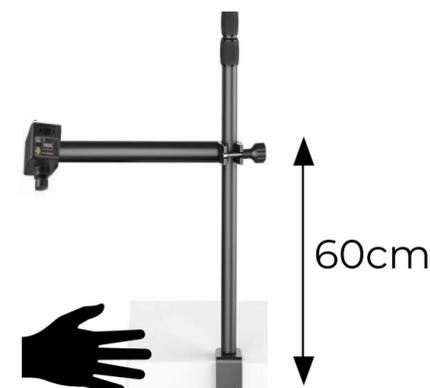
# Appendix

## Calibration of the Camera, Warning and Emergency Zones

1. Connect the SaferHands Kit to power. By default the software will start up automatically. The pre-defined Warning and Emergency zones will appear on the screen. The Warning and Emergency zones are marked with Orange and Red rectangles respectively.
2. The camera is shipped with an adjustable camera holder. The optimal distance from the camera to the desired tracking surface is around 60cm. Rotate and adjust the camera lens to adjust the focus and see a clear picture of objects on the surface.

**NOTE:** It is important that the arrow on the camera mount points towards the user's side after the installation. The camera must directly point to the surface of tracking.

**NOTE:** Use a fast USB cable (at least USB 3.1) to connect the camera to ensure the transfer rate. The speed of the camera should be around 5ms with the correct cable.



3. The Warning and Danger zones can be defined independent of each other. Ideally, the Danger Zone is expected to be completely inside the Warning Zone. The logic for different zones for being activated is as explained below:
  - Danger Zone is activated if at least one hand bounding box is either inside or touching the Danger Zone
  - Warning Zone is activated if at least one hand bounding boxes is either inside or touching the Warning Zone and if the Danger Zone is not activated

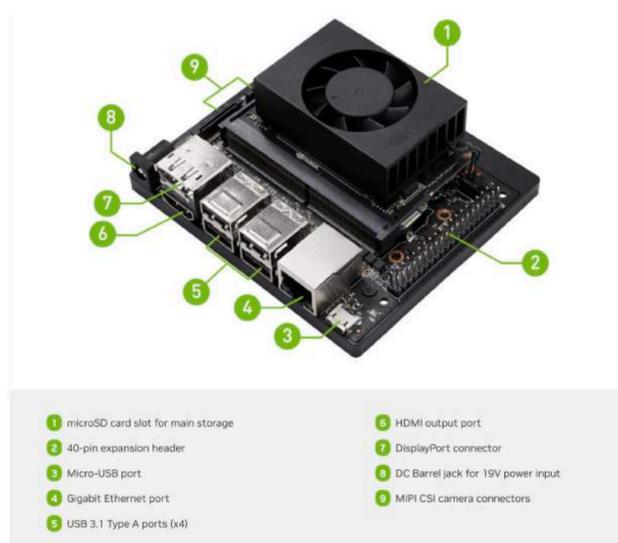


4. Each hand outputted by the software has a flag indicating its position relative to these zones. (0)
  - Hand is outside both Zones. (1) - Hand is inside or touching the Danger Zone. (2) - Hand is inside or touching the Warning Zone and not in the Danger Zone

5. The default software is configured with a predefined Warning and Danger zones visible in the screen. These can be modified by following the steps given below:
  - Use the Calibration Enabler Marker (1 copy) and Zone Markers (2 copies of both Danger Zone Marker and Warning Zone Marker) provided in the package.
  - Put the Calibration Enabler Marker in the camera view to start the zone area calibration process. Adjust the focus of the camera if the message "Place Zone/Status Markers" is not shown on the image. While keeping the Calibration Enabler Marker in camera view, put the 2 of the same Zone Markers to define the zone as a rectangle containing the Zone Markers. Adjust the rectangle by moving Zone Marker positions. Use 2 Danger Zone Markers to define the Danger Zone and 2 Warning Zone Markers to define the Warning Zone. Both can be defined separately or together.
  - Once the zones are finalized, remove the Calibration Enabler Marker from the camera view without moving the Zone Markers. This will fix the zones until step 3 is repeated.
  - Once the Calibration Enabler Marker is removed, the Zone Markers can be removed.

## How to connect SaferHands output signals to industrial machines

We provide the safety signals through the standard GPIO provided by a 40-pin header available in the Nvidia Jetson Xavier NX package. By default the three main signals including Safe(19), Warning(13), and Danger(11) are connected to green, orange, and red LEDs available in the package. Alternatively the signals can be connected to external machines or controllers of external safety system designed specifically for industrial machines. The provided signals by ManoMotion are accessible from the following pins.



<https://developer.nvidia.com/embedded/learn/get-started-jetson-xavier-nx-devkit>

Pin 7- High when the system detects any errors while running. For instance when no frames received from the camera or errors while processing the received frames.

Pin 11- High when one or more hands are in the Danger Zone.

Pin 13- High when one or more hands are in the Warning Zone and none are in the Danger Zone.

Pin 15- High if the system has detected hands anywhere in the frame.

Pin 19- High when the system is safe to operate.

Sysfs GPIO	Name	Pin	Pin	Name	Sysfs GPIO
Jetson Xavier NX J12 Header					
	3.3 VDC Power	1	2	5.0 VDC Power	
	I2C1_SDA I2C Bus 8	3	4	5.0 VDC Power	
	I2C1_SCL I2C Bus 8	5	6	GND	
<b>system_error</b>	GPIO9 AUDIO_MCLK	7	8	UART1_TX /dev/ttyTHS0	
	GND	9	10	UART1_RX /dev/ttyTHS0	
<b>danger</b>	UART1_RTS	11	12	I2S0_SCLK	157 gpio445
<b>warning</b>	SPI1_SCK	13	14	GND	
<b>hand_detected</b>	GPIO12 Alt: PWM	15	16	SPI1_CS1	196 gpio484
	3.3 VDC Power	17	18	SPI1_CS0	195 gpio483
<b>system_active</b>	SPI0_MOSI	19	20	GND	

# FAQ

## **1. What are the compatible hardware/processor and OS with SaferHands software?**

SaferHands is shipped with NVIDIA Jetson Xavier NX and Linux OS. The software is compatible with Jetson Nvidia Nano and Windows boards. However not all Windows boards have digital output for sending the safety signals.

## **2. Is there any standard output signal on SaferHands to connect to an industrial machine?**

SaferHands uses GPIO to communicate safety signals. Descriptions of these signals are available in the product data sheet.

## **3. Is there any support provided by ManoMotion for installation of the SaferHands?**

SaferHands is available as ready to use. Tutorials and documentation are provided to assist you with camera and GPIO installation.

## **4. Is SaferHands safety-certified as a standalone solution?**

No, but SaferHands integration to specific industrial machines has been safety certified.

## **5. How can we certify our product with the SaferHands add-on?**

This depends on the level of certification and the certification agency. ManoMotion can assist you with this process.

## **6. Does SaferHands support dual-channel safety requirements?**

No, but the dual channel support can be considered in the future updates of SaferHands.

## **7. Is there any support provided for customisation of SaferHands for a specific industrial environment?**

Yes. ManoMotion can customize SaferHands to achieve the best performance in your environment. Contact us for more information.

## **8. How many hands can be detected by SaferHands simultaneously?**

Three hands. This feature can be customized.

## **9. How does SaferHands perform in a new industrial environment in terms of accuracy?**

This depends on many factors. The best way to evaluate the quality is to prepare an evaluation data from the environment to be supported. ManoMotion can assist you with this process.

## **10. What is the longest and closest range that the camera can detect hands?**

The optimal distance is from 50 cm to 100 cm. This feature can be customized.

## **11. Does SaferHands detect the human body if the camera is positioned towards the human operator?**

No. SaferHands is developed to detect human hands only. Body detection can be included in the customizations, if desired.

## **12. Can SaferHands be an alternative to the existing safety solutions such as laser curtains etc. or is an add-on to the existing safety solutions?**

SaferHands is designed to work as a standalone safety solution but requirements of some industries are different.

## **13. Is SaferHands compatible with failsafe protocols such as Profisafe?**

The Nvidia Jetson boards are not directly compatible with Profisafe protocol. However, there are solutions to convert the signal to a compatible format. ManoMotion can assist in that process if required.





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