AGILEHAND

Installation Manual: WP4 – BUILD: AGILEHAND Smart Sensing SUITE

AGILEHAND has received the funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101092043.

Document Information

GRANT AGREEMENT NUMBER 101092043	ACRONYM		AGILEHAND
FULL TITLE	Smart grading, handling, and packaging solutions for soft and deformable products in agile and reconfigurable lines		
START DATE	01-01-2023	DURATION	36 months
PROJECT URL	https://agilehand.eu/		
WORK PACKAGE	WP4 – BUILD: AGILEHAND Smart Sensing SUITE		
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TARGET AUDIENCE	Solution user(s)		
CONTENT	Installation manual		
ABSTRACT	The scope of this document is to guide the user(s) through the installation instructions of the solutions developed within WP4 – BUILD: AGILEHAND Smart Sensing SUITE of the **AGILEHAND** project.		

Disclaimer

TABLE OF CONTENTS

1. Introduction

1.1. Purpose of the Document

This Installation Manual provides detailed instructions for setting up, installing, and maintaining the **AGILEHAND** grading system hardware and software components. It is intended to guide technical personnel through the complete installation process to ensure the system operates reliably and effectively. This document complements the User Manual by focusing on the technical setup, configuration, and troubleshooting of the system environment.

1.2. Who Should Use This Manual

This manual is intended for technical staff responsible for installing, configuring, and maintaining the **AGILEHAND** grading system. It is designed for system integrators, IT personnel, and engineers who have experience with hardware setup, software installation, and troubleshooting in industrial or laboratory environments. Operators and end-users should refer to the User Manual for daily operation instructions.

1.3. System Overview

The **AGILEHAND** system is an AI-powered solution designed for automated grading of soft and deformable food products in industrial processing lines. It integrates specialized cameras, a processing computer equipped with GPU capabilities, and AI models based on the YOLOv8 instance segmentation model. The system supports four main use cases: orange grading by size, raspberry ripeness grading, fish processing (cutting line detection and fish steak grading), and chicken fillet grading by external quality.

This manual covers the installation and setup of hardware components, software environment configuration, and system initialization to ensure reliable image acquisition and processing for optimal grading performance.

2. Hardware Setup

2.1. List of Components

This section lists all hardware and accessories required to set up the **AGILEHAND** WP4 solution:

- Intel RealSense D456 camera (for oranges, fish, and chicken use cases).
- Photoneo MotionCam 3D-S camera (for raspberry use case).
- Tripod(s) for camera mounting.
- Bridge-like support structure (for MotionCam 3D-S camera).
- Processing computer with GPU capable of running AI models.
- USB cables to connect cameras to the processing computer.
- Mini illumination source (for raspberry use case).
- Power supplies and adapters as needed.
- Optional cleaning kit for camera lenses.

Images of the required equipment are given in **Figure 1**. Regarding the tripod and the horizontal camera mount, any models can be used as long as they are stable and safe.

Figure 1. Required equipment. Left to right, top to bottom: Intel RealSense D456 sensor, Photoneo MotionCam 3D-S sensor, Tripod (two are required for the use case involving

Photoneo camera), Mini illumination source (Apture: https://aputure.com/) for the raspberry use case, horizontal camera mount (for the use case involving Photoneo camera).

2.2. Camera Mounting Instructions

Proper camera positioning is essential for accurate image acquisition and grading performance. Mounting instructions differ slightly depending on the use case and camera model.

Intel RealSense D456 (oranges, fish , chicken fillets use cases):

- Mount Type: Single standard tripod.
- Orientation: Top-down (perpendicular to the acquisition surface).
- Height: Adjust tripod height to fully capture the target area.
- Stability: Ensure the tripod is stable and immobile during operation.
- Distance: Position the camera approximately 60 cm from the target area to ensure accurate depth map acquisition.

Photoneo MotionCam 3D-S (raspberries use case):

- Mount type: Bridge-like setup supported by two tripods.
- Orientation: Top-down (perpendicular to the acquisition surface).
- Height: Adjust the bridge height to ensure complete coverage of the fish or steaks.
- Stability: Secure the bridge with clamps or stabilizers to avoid vibrations or shifts.
- Lighting: For raspberries, position the mini illumination source close to the camera, angled toward the field of view. Avoid reflections or glare on the punnet.
- Distance: Position the camera approximately 45 cm from the target area for optimal depth accuracy.

General Guidelines:

- Ensure that the field of view (FOV) covers the entire grading zone.

- Avoid camera tilting or skewed angles — the camera must be aligned orthogonally to the surface.
- Once mounted, do not move the camera.
- Avoid reflective or glossy surfaces in the background or target area, as they may interfere with grading quality.
- Do not obstruct the camera's field of view with hands, tools, or any other objects during image capture.
- Ensure the camera lens is clean and free of dust or smudges before each session.
- Keep the area well-ventilated to prevent the camera from overheating during long use periods.
- Secure cables and power cords to prevent accidental disconnections or tripping hazards.
- If operating near machinery or in an industrial setting, use protective casing or shielding for the camera and tripod.
- After mounting, perform a test acquisition to confirm proper coverage and focus before starting actual grading.

2.3. Cable Management and Power Connections

Proper cable routing and reliable power connections are crucial for maintaining stable system performance and reducing the risk of interruptions.

Camera Connections:

- Connect the Intel RealSense D456 camera to the processing computer using a USB 3.0 cable.
- For the Photoneo MotionCam 3D-S, ensure that both power and Ethernet cables are connected securely according to the manufacturer's instructions.
- Avoid bending cables sharply or applying stress to connectors. Use cable ties or clips to secure cables along tripods or mounting structures.

Illumination Source (Raspberries Use Case):

- If not charged, plug the mini LED light source into a stable power outlet or USB power bank.
- Position the cable so it doesn't obstruct the camera view.

Power Supply for Processing Unit:

- Ensure that the processing computer is powered via a stable supply. Use an uninterruptible power supply (UPS) in environments with power instability.
- Regularly inspect the power adapter and ports for wear or looseness.

Best Practices:

- Keep cables away from walkways and operational areas to prevent tripping or disconnections.
- Label cables (e.g., "camera," "power," "illumination") for easier troubleshooting and setup.
- After initial setup, double-check all connections before launching the system.

2.4. Environmental Requirements

- Ensure the imaging area is free from excessive vibrations, dust, or moisture that may affect hardware performance.
- Maintain stable ambient lighting conditions to avoid drastic changes that could interfere with image quality.
- Avoid placing reflective or shiny objects within the camera's field of view to prevent glare and artifacts in the images.
- Maintain room temperature and humidity within the recommended operational range of the hardware components.
- Ensure adequate ventilation around the processing computer and cameras to prevent overheating.
- Keep the area around cables and power sources clear to avoid accidental disconnections or damage.

- Avoid direct sunlight on the camera or the items being imaged, as this can cause harsh shadows or glare that degrade image quality.

3. Software Installation

3.1. System Requirements

The developed solution is designed to run primarily on Linux distributions for optimal performance and compatibility. However, Windows OS is also supported for flexibility.

Hardware Requirements:

- CPU: Intel i7 or equivalent (recommended).
- RAM: Minimum 8 GB, 16 GB or more recommended for smoother operation.
- GPU: A 8 GB or more CUDA-capable NVIDIA GPU is recommended to accelerate AI model inference, especially for real-time grading.
- Storage: At least 20 GB of free disk space for software, models, and logs.
- USB Ports: At least one free USB 3.0 port for camera connection.

Software Dependencies:

- Python 3.8 or higher.
- Required drivers for Intel RealSense D456 and Photoneo MotionCam 3D-S cameras.
- Relevant libraries and packages (installed via provided setup scripts).

Additional Notes:

- A stable internet connection is recommended during initial software installation and updates but is not required for system operation once set up.
- Ensure all drivers and dependencies are compatible with the chosen operating system.

3.2. Creating a Virtual Environment

To ensure clean dependency management and avoid conflicts with system-wide packages, it is recommended to create a dedicated Python virtual environment before installing the grading system.

Steps (Linux or Windows):

1. Install **virtualenv** if not already installed:

   ```
   pip install virtualenv
   ```

2. Create a new virtual environment:

   ```
   virtualenv agilehand-env
   ```

3. Activate the virtual environment:

   - On Linux/macOS:

     ```
     source agilehandenv/bin/activate
     ```

   - On Windows:

     ```
     agilehand-env\Scripts\activate
     ```

4. Once activated, your command line prompt should indicate the active environment (e.g., (agilehand-env)), and you can proceed to install dependencies without affecting system-wide packages.

Note: Remember to activate the environment each time you start a new terminal session before running the grading system.

3.3. Installing Dependencies

After activating the virtual environment, install all necessary Python packages and system-level dependencies.

Step 1: Navigate to the project directory

cd /path/to/agilehand-project

Replace /path/to/agilehand-project with the actual path where the project was cloned or extracted.

Step 2: Install Python dependencies

Install the following key packages individually to ensure compatibility with your operating system and CUDA version:

- PyTorch:
  Visit the official PyTorch website to generate the correct installation command for your system **https://pytorch.org/**

- Ultralytics (for YOLOv8):

  pip install ultralytics

- Intel RealSense SDK (pyrealsense2)
  Install the version matching your Python and OS configuration:

  pip install pyrealsense2

- Photoneo Dependencies (Raspberry Use Case):
  For the raspberry ripeness grading use case, dependencies specific to the Photoneo MotionCam 3D-S can be installed by following the instructions provided in Photoneo's official Python examples repository: **https://github.com/photoneo-3d/photoneo-python-examples/tree/main/GigE-V/harvesters**

Step 3: Install additional system libraries (Linux only)

If you're using Ubuntu or another Linux distribution, install the following system libraries:

sudo apt update

sudo apt install libgl1-mesa-glx libglib2.0-0

4. Troubleshooting Setup Issues

This section addresses common problems users may encounter during the installation or initial system setup.

Issue	PossibleCause	Suggested Action
Virtual environment not activating	Incorrect path or missing venv folder	Confirm the virtual environment was created and you're using the correct command
Dependencies not installing	Outdated pip, incompatible OS or Python version	Upgrade pip (pip install --upgrade pip); verify compatibility in requirements

Camera not detected	USB connection issue or missing drivers	Check cable connection; reinstall drivers; ensure camera is supported by OS
RealSense SDK not found	pyrealsense2 not installed properly	Install the correct pyrealsense2 version based on OS and Python version
Photoneo camera not working	Incorrect network configuration or missing dependencies	Follow Photoneo setup guide here
Script crashes at launch	Incorrect script or missing files	Ensure you're running the correct script and that all models and configs are present
Poor or no image acquisition	Lens obstruction, lighting issues, or camera misaligned	Clean lens; verify lighting; adjust camera orientation and distance

5. Frequently Asked Questions (FAQs)

Q1: Do I need to train or retrain the AI model before using the system?
A: No. All models are pre-trained for the supported use cases. No manual training or annotation is required by the user.

Q2: Can I use the system with other products beyond oranges, raspberries, fish, or chicken fillets?
A: No. The current version supports only these specified use cases. Extending the system to other products would require additional data collection, annotation, and AI model development.

Q3: Is an internet connection required to operate the system?
A: No. Once installed, the system runs entirely offline on the local machine.

Q4: How often should the camera lens or setup be cleaned?
A: It is recommended to clean the lens and verify camera alignment at the beginning of each workday or shift.

Q5: How do I update dependencies or system code?
A: For minor updates, activate your virtual environment and re-install key packages (e.g., pyrealsense2, ultralytics, torch) according to your OS and CUDA version (refer to the official

PyTorch website). For major updates or codebase changes, refer to your system administrator or the vendor's update guide.

Q6: How do I check the installed CUDA version on Linux?
A: You can check the installed CUDA version by running this command in the terminal: **nvcc –version**. Alternatively, if you have NVIDIA drivers installed, running: **nvidia-smi**.

Q7: How do I properly stop the grading system during operation?
A: To stop the grading system, press **Ctrl + C** in the command line window where the grading script is running. This safely terminates the process. Avoid closing the terminal abruptly to prevent possible data loss or corrupted logs.