

**MASTER THESIS** Intelligent Robotic Depalletizing System for Blank Feeding**STUDENTS** Daniel Baldrigue Andrade, Georg Lundqvist**SUPERVISOR** Volker Krueger (LTH), Daniel Cederström (Tetra Pak AB)**EXAMINER** Jacek Malec (LTH)

# Let the Robot Do the Lifting

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Manual depalletizing of paper-wrapped Tetra Pak cartons is a back-breaking and costly process. This thesis shows that an UR10e cobot, a depth camera, and state-of-the-art open-source AI can unload an entire pallet. Factory trials reached 51 boxes per hour, well above the 30 box/h requirement and 90 % successful grips. The study proves that smarter perception and adaptive suction can relieve workers and boost line productivity.

**Lifting boxes is nobody's dream job.** Every pallet arriving at a Tetra Pak plant holds dozens of heavy, paper-wrapped cartons. Right now, people must lift them one by one, slow for production and expensive in the long run. Automating this chore is a textbook goal of Industry 4.0 and the fully automated, 'dark factory' vision, where dull or risky tasks are left to machines.

**What is the challenge?** At first glance, the job looks simple: take a box and move it, but several hidden hurdles trip up ordinary robots. The cartons arrive wrapped in soft, slightly porous paper that leaks air, and not every ordinary suction cup can grip reliably. Each pallet is placed a little differently, so the robot never sees exactly the same scene twice, and it still has to work safely near human colleagues.



**How does it work?** The solution to this problem is a collaborative robot with suction cups and a depth-camera attached to the robot end-effector. The robot will then use an open source AI detection and segmentation model to detect a box and then use the suction cups to move it to the conveyor belt.

**What did the factory test show?** Through testing in factory facilities, the performance of the system was determined with the following key performance indicators:

- *Throughput:* 80 cartons in 94 min → 51 box per hour, comfortably clearing the 30 box per hour.
- *Reliability:* 90 % of cycles completed without any operator intervention.
- *Readiness:* The system advanced the project from Technology Readiness Level 4 to Level 5.

**Bigger picture** By taking over this repetitive, muscle-straining task, the system frees staff for higher-value work and keeps lines running without pauses. With further engineering, the same approach could handle every Tetra Pak carton format, pushing the factory floor closer to truly lights-out production and making automation work for people, not the other way around.