Device to pick&lift objects from the ground with natural user interface

Author: Ing. Vítězslav Beran, Ph.D.,

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Content

This document presents the novel device to pick&lift objects from the ground with natural user interface. The document includes the design of construction and technologies to build proposed device and its applications.

Description

The device is a robotic system with following attributes.

- The device picks and lifts the objects from the ground.
- The device operates in indoor environments.
- The device communicates with the operator by sounds and voice commands.
- The device autonomously maps, localize and navigate itself in the environment.
- The device search for objects on the ground.
- The device localize the user in the environment using sound source localization.
- The device includes three active elements:
    - the mobile basement - moving the device in the environment,
    - the lifting stroke - lifting the loading frame and the paddle up and down (to ground level)
    - the loading frame and the paddle - loading the objects on the ground.
- The active elements can be driven by one or two drives.
- The device load the object on the ground and lift it up.
- The device includes a power system: batteries, power management electronics, charging connector, charging control electronics, and battery status indicator.
- The device anonymize the sensoric and other perceived signals to operate in privacy.

Construction

The device includes three active elements:

1. the mobile basement
    - two wheels (cca 20-30cm), each wheel controlled by one motor placed inside the wheel
    - one omni-wheel
    - rig for the lifting stroke
    - vision system (e.g. lidar, depth sensors, microphone array, camera, sonars)
    - battery, electronics, control circuits
2. the lifting stroke
    - frame traveling on the rig
    - threaded rod rotated by one motor
    - loading frame holder with nut on the threaded rod
    - landing sensors
3. the loading frame and the paddle
    - box without the front side fixed to the lifting holder

- the paddle - 4-side frame without bottom fixed to the box by linear travel and controled by one motor (for ejection and closing in and out of the box
- landing sensors

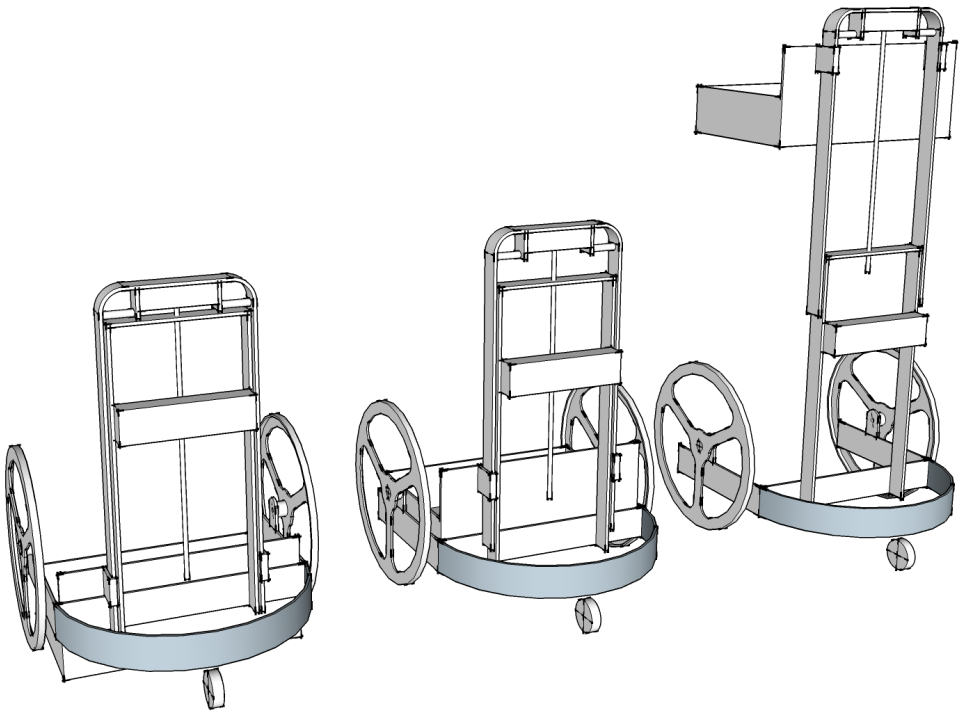

Figure 1. Device construction schema in various lifted height level (down, middle, top).

Object loading principle

1. the device autonomously search and localize the object on the ground
2. the device positions itself in front of the object
3. the loading frame is lifted cca 20-30cm above the ground
4. the paddle is ejected
5. the loading frame is dropped to the ground
6. the paddle is closed

Figure 2. Object loading principle (steps 3., 4., 5., 6.)

Technologies

The designed system is based on a number of technologies and functional subsystems:

- dialog system for human-robot communication in natural way based on sounds and keyword-spotting without any additional devices,
- sound-source localization,
- robot mapping, localization and navigation in the domestic environment,
- object detection and classification,
- anonymization features,
- autonomy to error-recovery, charging,
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Mock-ups and functional samples

Various mock-ups and functional parts has been re-designed and constructed by the author to run user experiments and applicability analysis.

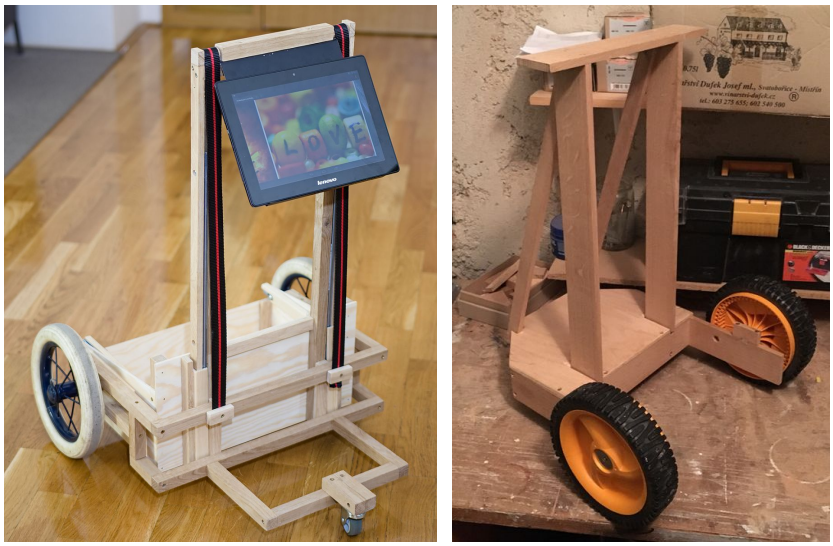

Figure 3. The contruction mock-ups.

Application - Senior buddy

An application challenges includes: non-invasive design (light nonintrusive robot) , affordability, adaptability. The design is developed with the needs of the movement in the domestic environment (operation under the table, between furniture etc.) and an easy manual robot manipulation (extremely low weight). Communication style and appearance is designed to perceive the robot as a device, not a close personal fellow (to be a helper, not a subject for deep personal relationships).

The device is applicable to be a robot for seniors - promoting the independent living for seniors in their home environment, robot for kids - cleaning the room in funny and engaging way etc.

Extended device features

Human fall detection, detection of lying person requiring assistance, checking and remembrance medication and regular diet.