Au automatic warehouse for pharmacies driven by vision
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The automatic warehouse implemented by SYCO s.a.s. for the pharmacy of doctor Magnani in Moncalieri (Torino Italy), that will soon enter the market, distinguishes itself among other similar systems for several features.

At the basis of its design, in fact, there is a complete split from the traditional industrial warehouses, to be more similar to a mobile robot moving in an unstructured environment. As a consequence, a reduced attention is paid to the principal motion system (and its precision), with respect to more intelligence, dexterity and sensorization of the end effector.

Sensors play a fundamental role in this implementation, and they are primarily vision systems.

1. **Identification through vision** The medicines before entering the warehouse are identified in a qualification station composed of three video cameras which cover three orthogonal faces of the box. Contemporaneously, box dimensions are measured, barcode read, and expiration date recognized, through Optical Character Recognition (OCR).

2. **Handling lots** The loading of the warehouse is designed to handle, along with singletons, lots of identical medicines unitarily, with lot sizes at the limit of the shelf depth. For this, our shelves have a depth of 400 mm, value much greater than the other systems.

3. **Adaptive precise positioning** The linear motion system and shelf rigging do not require the high precision needed, for the correct handling of medicines by other implementations. In fact, the autonomous capability of the end effector and its sensors, based on vision, allow to merge large motions at high speed and safe distance with tolerances in the order of centimeters, with approaches at high precision adaptively in the order of sub-millimeters.

   This feature allows to build low cost shelves, specifically with wall cantilever mounting, to avoid vertical obstacles in front of the end effector.

   Assembled the shelves under customer specifications, the system identifies the profile coordinates of each shelf and store them in the database. This is needed for fast motions at safe distance. Nevertheless, during the final approach the coordinates are continuously updated in real time at each mission, to guarantee fine positioning with accuracies below the millimeter, updating, on the main time, the data base to account for possible future warps of the structure.

4. **Intelligent end effector** The end effector has five degrees of freedom, with the possibility to store medicines up to its maximum depth, equal to the shelf one, of 400 millimiters. This dexterity, not only allow high precision adaptive approaches to the shelves, but also to extract, from a row of medicines, the selected one, e.g. based on the expiration date, without need of unnecessary missions.

5. **Picking driven by vision** Positioning and picking medicines is performed adaptively, taking into account also the depth. Rows of medicines are positioned in variables size cells created and destroyed dynamically according to the needs. Cells are created using the vision system when a new line has to be stored near the previous ones, and in similar fashion the system behaves at the picking. With vision pattern recognition the desired product is evaluated and centered accurately in the final approach, actually the box can occupy the nominal cell position with a tolerance of centimeters.
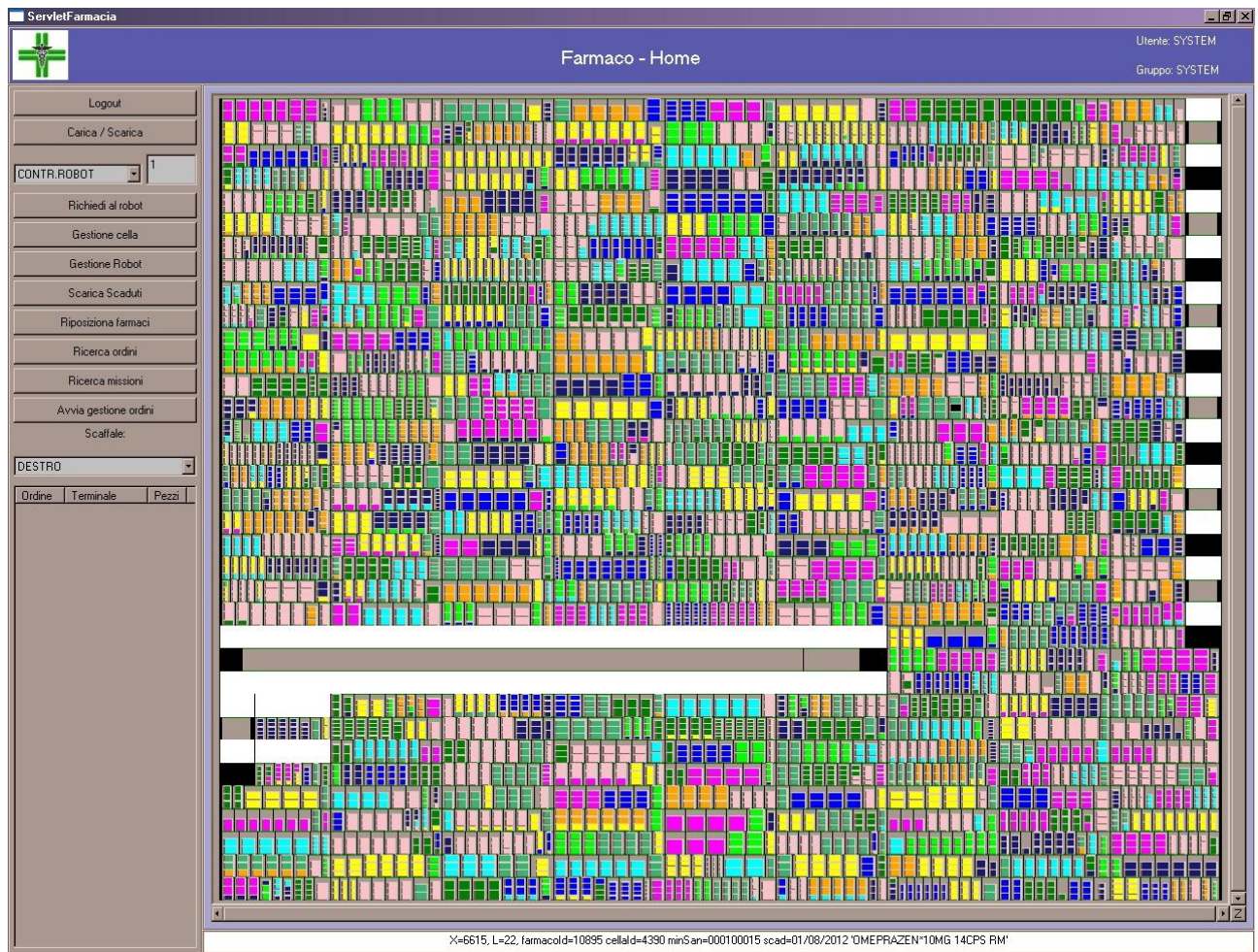
From the one side this reduces the need of precision in the motion, and from the other allows hybrid operations where the operator can perform hand operations without the need of great precision. This is helped by graphical presentation of the medicines on the shelf by the computer.

6. **All actions on the end effectors** At different of other systems motions are basically confined to the end effectors. In fact, a part from a conveyor belt and a loading pusher at the input no others moving elements are considered. Separate exits for each pharmacist, up to six in the actual implementation, are served directly from the end effectors.

7. **Efficiency and reliability** The picking systems in front of each pairs of counterposed shelf lines, that compose a basic unit of the warehouse, serve their own shelves, without interfering each other for maximum productivity, but, if necessary serve both shelf lines.

8. **Cost reductions** To maintain low costs, with the exception of the end effectors, which is proprietary, motion system, vision systems (webcam) and computing system (standard PC) are all selected from large consumer products.

9. **Sophisticated computing system** A sophisticated programming selects the position of the rows of medicines in function of their turn over, and plan picking missions (eventually multiple) taking into account expiration dates, minimizing waiting times for pharmacists and increasing productivity. Moreover, during the periods of inactivity, the system provides automatically to the defragmentation of the warehouse, compacting lots of similar medicines, improving the efficiency.

10. **Managing expiration dates** Expiration dates of each medicine, read automatically at the entrance in the warehouse are considered at each picking mission. Moreover, automatic processes take care

to download, during inactivity due medicines. Handling of due dates allows the system to suggest the pharmacist the most appropriate medicine, among equivalent brands.