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Inventory location and retrieval system

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ABSTRACT

This disclosure describes scalable techniques to locate and retrieve inventory items or components from an inventory. Remote modules are co-located with inventory containers and deployed in a warehouse. The remote modules are constructed from low-cost, off-the-shelf equipment and communicate wirelessly with a central server. The central server publishes wirelessly a list of inventory items to remote modules. The module displays the number of items to be picked up using, e.g., color-coded and/or seven-segment LED displays. Once a worker picks up or places an item from a container, the corresponding remote module updates the count of items and returns status to the central server.

KEYWORDS

- Inventory management
- Warehousing
- Location and retrieval
- Parts management
- LED module

BACKGROUND

In various industrial contexts, e.g., assembly lines, pharmacies, data centers, warehouses, etc., distinct components are stored in distinct containers. Workers frequently access such containers and pick up components from such containers, e.g., to fill a prescription in a pharmacy, to build a computer in an assembly line, to repair a server in a data center, etc. For efficient utilization of workers' time, a worker needs to be able to find the right component at the right time and place for the task on hand. Present technologies of parts or inventory

management are generally based on wired communication and proprietary communication protocols, and have limited flexibility.

DESCRIPTION

This disclosure describes an expandable inventory location and retrieval system that facilitates quick location, selection, and acquisition of inventoried components by warehouse or assembly workers. The techniques described herein utilize visual identification that enables fast and accurate parts management.

Per the techniques of this disclosure, two different types of units are utilized.

1. A small, low-cost, and easy-to-produce remote module that can be deployed at any location in a warehouse, assembly, or parts management environment. The remote module is co-located with a components container and has a visual identification display, e.g., based on color-coded and/or seven-segment LEDs. It communicates over a publish/subscribe protocol, e.g., MQTT, and utilizes a wireless physical layer, e.g., Wi-Fi.
2. A central server that wirelessly communicates with the remote modules and publishes various commands to the remote modules, e.g., the number of items to be placed into or picked up from associated containers.

The described techniques make use of commonly available components and technologies for the modules and can be implemented using a cloud-based infrastructure. This makes the technology extendable and integrable with a broad range of software and systems. The remote modules utilize low-voltage DC power, e.g., 5V or 12V, and can be powered with small solar panels that utilize ambient light as a power source. With the server-module communications being wireless, there is good deployment flexibility in varied environments.

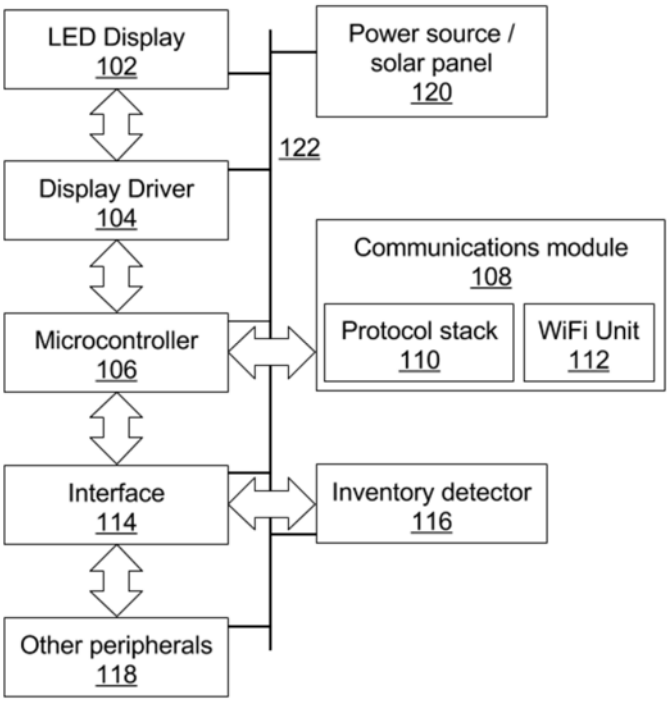

Fig. 1: Schematic of the remote module

Fig. 1 illustrates a schematic of the remote module. A display (102), based for example on RGB color-coded and/or seven-segment LEDs, displays status and messages relating to the container that the module is associated with. For example, the display can indicate, based on communication with the central server, that the container is to be selected by the worker for component retrieval, the number of components to be retrieved, the number of components left, an out-of-stock indication, etc. In some implementations, a module includes multiple displays. The display is driven by display driver (104).

A communications module (108) communicates with a central server using a communications protocol stack (110) and a wireless physical layer, e.g., a Wi-Fi unit (112). In some implementations, the communications protocol is a publish/subscribe protocol such as MQTT. A microcontroller (106) coordinates and controls constituent units of the remote

module. In some implementations, the communications module is integrated with the microcontroller.

The microcontroller is accessible via an interface (114) using, e.g., a serial-parallel interface (SPI), I2C, or other common serial/interface protocols. The LED display driver and the LED display is coupled to the microcontroller via the interface. An inventory detector (116), e.g., a button-push, bar-code scanner, physical-contact switch, etc. is coupled to the microcontroller via the interface. The interface also enables other peripherals (118) to be connected. The remote unit is powered by a power source (120), e.g., a solar panel driven by ambient light. Power is distributed to various constituents of the remote module by power-supply bus 122.

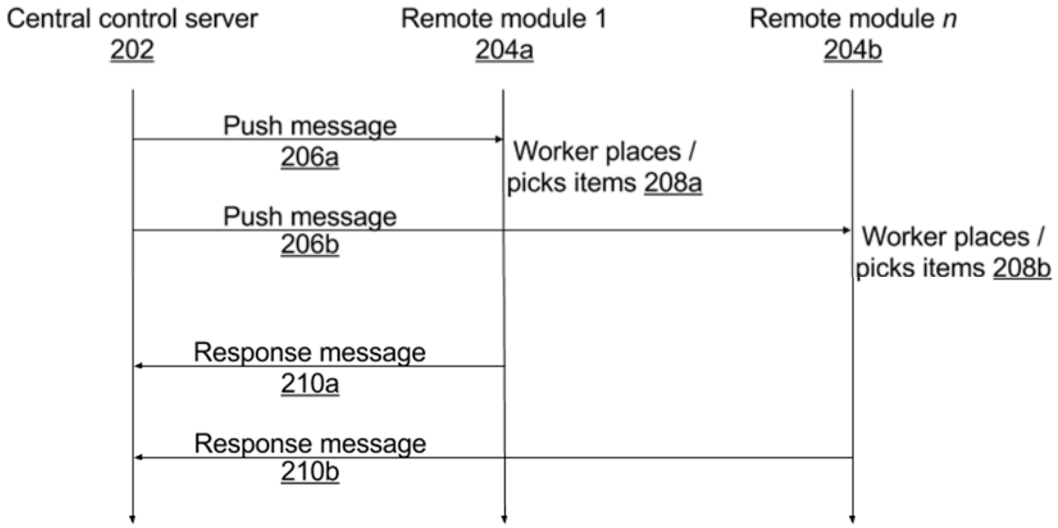

Fig. 2: Communication between central control server and remote modules

Fig. 2 illustrates communication between a central control server (202) and *n* remote modules (204a, 204b). The control server pushes outbound messages (206a, 206b) to respective remote modules. These push messages include, for example, a quantity of components to pick or place, color of lights to activate for visual identification, etc. Upon receipt of the messages, the display of the remote modules show the message content in a manner that enables a worker

to pick an accurate number of items from the correct container or place the number of items into the container (208a, 208b).

The remote module detects the number of items picked out by the worker using, e.g., RFID or bar-code scans, physical contact switches, button-pushes by the worker, etc. The remote modules send back response messages (210a, 210b) to the central control server. The response message includes details such as quantities placed or picked, out-of-stock indication, serial numbers of placed-in or picked-out componentry, etc. The central server in turn updates databases, e.g., cloud-based databases relating to real-time inventory levels. In some implementations, portions of the central server functionality can be implemented in a cloud-based server.

Wi-Fi connectivity between server and module enables flexible placement of the modules in a facility. The server-module communication is IP-based, encrypted, and uses well-known protocols. These features enable a cloud-based solution to the parts-management problem. Internet-of-things (IoT) modules are placed in facilities where no server infrastructure is deployed. The LED displays are addressable, e.g., extendable to support multiple simultaneous visual indications for multiple workers in same area. The remote modules are packaged using various technologies, e.g., PCBs, 3D printed enclosures, etc.

Example use-case: assembly line manufacture of computers

A customer orders a customized computer server. The order is sent to an assembly line, where workers assemble the custom server from a base configuration. The base-configuration server moves down the assembly line to an assembly workstation. Based on customer order, the LEDs light of the corresponding remote modules lights up with quantities to be selected. The assembly worker picks the parts and indicates that the part was picked by interacting with the

remote module, e.g., via button push, barcode scan to track serialized inventory, etc. The remote module communicates inventory information, e.g., number of parts picked, serial numbers of parts picked, out-of-stock indication if applicable, etc., to the central server.

The techniques of this disclosure can be utilized in various contexts, e.g., manufacturing, warehousing, parts/spares management, repairs, assembly, supply-chain, logistics or distribution, etc. More generally, the techniques apply in any situation that involves human selection from an inventory of items is selected by humans, e.g., for a package, a parts/tool kit, a custom assembly step, etc. Due to flexibility of the modules and the use of standard components, a remote module is quickly customizable for other potential applications, e.g. microkitchens, technical support stations, workshop/lab spaces, etc.

CONCLUSION

This disclosure describes a cloud-based warehousing framework and inventory location/retrieval system for use in manufacturing, assembly, logistics, distribution, and other situations. Small, low-cost remote modules are co-located and associated with containers that store components or other items. The remote modules are wirelessly linked to a central server. The central server issues commands, e.g., number of items to be picked or placed into the container. The actions to be performed, e.g., items to be picked or placed, are displayed on the modules, e.g., via an LED display. The remote modules update the quantities, serial numbers, etc., of items in the container and communicate the status back to the central server.