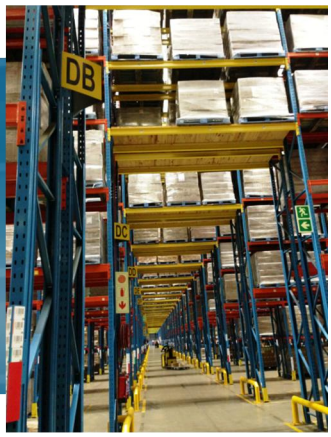
DRONE READINESS WHITEPAPER

Drone Ready?



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Inside This Article

Is your warehouse drone ready?

Drones seem to be everywhere at the moment, from doing military duty in the skies to bouncing around the local toy store.

One place we haven't seen them is in warehouses. Airborne drones probably won't have the capability to pick and place, however there are some repetitive warehouse operations that are well suited to a robotic device. Physical inventory, stock counting and cycle counting could all be done by a drone, and soon will be.

What can we expect from the drones and how could we prepare for them?

Warehouses have a built in navigation system. No extra setup required.

Why drones?

When it comes to repetitive barcode scanning operations out of reach of a human, drones can be 100 times faster and 100 times more energy efficient than using a reach truck to lift a 0.8kg barcode scanner held by an 80kg human in a 100kg man-cage up to each item to scan it.

An 800g drone can lift an 80g barcode scanner to do the same thing.

A drone operator can count as much stock in a warehouse in two days as a team of 80 people with handheld scanners and reach trucks can count in 3 days.

The time and labour saving benefits are especially evident in stock counting of large, uniform warehouses containing tens of thousands of handling units above head height.

There are also energy savings to be made since reach trucks don't need to be used for barcode scanning.

There are inherent safety risks in lifting a human up to high racking to scan barcodes, in this regard the drone is far safer.

Uniformly positioned and labeled pallets, one per location, are ideally suited to early drone scanning versions

How they work

Drones are a stable, lightweight, maneuverable, battery powered flying platform. They can have multiple propellers (e.g. multi-rotors, quad copters, tri copter or hexa copters) or a single propeller (e.g. a helicopter). They are capable of carrying a small payload proportional to their size.

In the last few years, microchip gyros have meant that a tiny on-board computer can keep the UAV stable in the air. Recent advances in sensor and image processing technology coupled with many hours of software development have meant that they are now capable of robotic type motion.

Drone stock counting services will be on-call with local service providers available in your area

There are many videos of drones performing highly precise robotic movements indoors, however these drones rely on a navigation system made up of many cameras mounted in fixed positions a few feet apart. This is cost prohibitive to set up in a warehouse.

Outdoors, drones can do amazing things like delivering your theoretical parcel right to your front garden. This is because they have access to GPS which an absolute postioning system of 1m Accuracy. If the drone delivering your parcel is a few feet left or right of the landing zone, you wouldn't really notice. However if a drone was inspecting stock in your warehouse and it got out of position by a foot it would likely crash into the racking.

Indoors, drones don't have reliable access to GPS, and even if they did, the space in a warehouse is limited, and the navigational accuracy needs to be down to a few inches not a few metres. These challenges are the main reason that we haven't seen drones in our warehouses. ***Yet***!

Warehouse enabled drones are still in prototype stages with all of their wires visible, held together by cable-ties, they frequently crash. Warehouse testing should commence by second quarter 2015 with real work being done third quarter 2015

The Future

Drones are being designed and built specifically for warehouse use. They are being integrated directly into WMS systems and will work with little operator input.

Drone stock counting services will be on-call. They will come in with their equipment on a weekend, download your warehouse layout, scan all the items in your warehouse and give you a report on the Monday morning for doing your stock adjustments.

New job descriptions will appear like "drone operator", "drone service technician" and "drone integrator".

Drones will eventually do other tasks like continuous inventory, searching for items, and once found, hover there or mark them with an inking device.

The navigation solution

It took a computer programmer with warehouse experience and a drone building hobby to realise that warehouses have an intrinsic absolute navigation system, both in horizontal movement and vertical movement:

- warehouse racks are uniformly spaced and laid out for horizontal positioning in one dimension ,
- every bin location is labeled with a barcode for horizontal positioning in another direction,
- every shelf is at a known height for vertical posititon information.

Patent Application:PCT/ZA2014/000029 AIRBORNE SCANNING SYSTEM AND METHOD

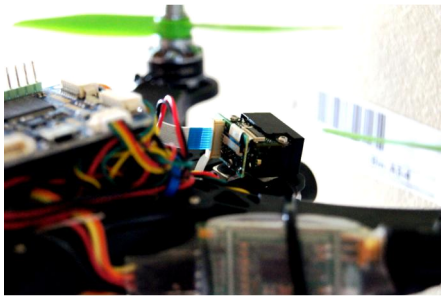
In palletized warehouses, the items on the shelves have barcodes in consistent places providing a fixed area in which to find the item barcode.

This means that no additional infrastructure is needed to provide an absolute positioning system for the drone to navigate along.

An application for a patent using this navigational method was made under: Patent Application:PCT/ZA2014/000029 AIRBORNE SCANNING SYSTEM AND METHOD

The scanning solution

A scanning system has been developed that makes use of a database of bin locations to determine the drone's absolute position from scanned data and figure out, in real-time what the drone must do next.



Miniaturized barcode scanning engines are suitable payloads for scanning drones

The scanning system has been designed to integrate into both vision processing systems and simple on-board sensor systems. None of these navigation systems rely on fixed infrastructure e.g. beacons, fixed cameras or indoor GPS systems, they rely on the drone being aware of, and responsible for avoiding, its immediate surroundings and a database to provide contextual information to direct it into performing its robotic tasks.

The scanning solution is designed as "BYOD"- bring your own drone, not locked into any one drone or navigation platform nor into any one ERP or WMS. This makes it flexible for adaptation to new drone and navigation technologies as they become available

Drone Highway

An understanding of how the drone scans items in the warehouse will assist in planning for its arrival and minimize setup time.

Early versions of the system require a supervisor to place the drone in front of the racking and to tell it to start flying, future models will be fully automatic, taking off from a charging station themselves.

Once started, the drone navigation system takes over and makes the drone fly up to the first known shelf level, say 1.8m high.

The drone then advances forwards towards the racking (by using onboard avoidance sensors) until it is within scanning range of the racking (approx. 50cm away).

While maintaining its height and distance, it flies left along the shelf until it scans a barcode.

The drone pauses while it asks the server what to do next. The server recognizes the scanned barcode as a bin location barcode and immediately has an absolute position for the drone.

It then tells the drone to fly up to the typical location of a pallet barcode and fly around within the area of a pallet until it finds the barcode.

If the drone scans a barcode, it pauses until the server confirms the barcode is correct, saves it as scanned in the stock count, records the current location, and gives the drone further instructions: to drop down to the shelf level and look for the next bin location.

When the drone reaches the end of the shelf (the database knows how many bin locations in each shelf), it moves up to the next shelf level, say 3.6m and then travels right along the shelf looking for bin location barcodes.

This is repeated until the entire rack level has been navigated and the drone lands.

In early versions, the operator moves the drone to the next rack, optionally changes the battery, and restarts it, more advanced versions will automatically fly to the nest rack level.

The system automatically detects void spaces, both to prevent flying forwards and under the shelves, and to store a blank in the database stock count for that location.

Readiness checklist

If designing a warehouse, or re-organizing an existing one, taking care of some small changes might mean that your space needs little preparation when the first drones hit your shelves (not literally!).

Layout changes to suit drones should not be at the expense of efficiency in normal warehouse operations. The drone can be adapted to different layouts with a change in its software, however the reach-truck doing 20% more mileage cannot easily be fixed.

Large, uniform warehouses are naturally going to be the most drone friendly. The least interruptions in the repetitive, robotic behavior of the drone the better.

Obstacles : If possible, recess the roof support pillars inside the shelving so that nothing protrudes in front of the shelves for the drone to strike.

Shelves: ensure the shelves are at a uniform and known height. Don't randomly change the height of shelves, especially in one length of racking.

Data: Ensure that the height of all bin locations is stored in your warehouse system or saved in a spreadsheet for easy importing into the drone controller software. Early versions of the systems will have their own databases for looking up bin location positions and item information. A direct link into SAP R3 is being developed by integrating ScanMan WMS software, the developers of DroneScan. ScanMan WMS is drone ready and can be run standalone or integrated to other ERP systems. Drones can also inspect items and take photos of them, e.g. damaged goods or visual verification. Your WMS should be able to link images to items for later reporting and enquiry.

Barcodes: Reduce barcode clutter. Every barcode scanned needs to be processed, the drone pauses while waiting for a verdict from the server. In order to speed up processing and minimize scanning of irrelevant barcodes, keep the barcode symbologies of your bin and item barcodes separate from other irrelevant barcodes. E.g. most packaging barcodes are EAN13, if you make your bin and item barcodes code 128 or code 3of9, the scanner can be configured to completely ignore EAN13 barcodes, thus saving time.

Safety: If investing in PPE, consider hard-hats with visor mounts. Drones have propellers that spin at 10 000 rpm and frequently break when striking objects. Splinters of plastic could damage an eye.

Wireless: Drones are wireless devices operating on their own frequencies, try and keep your wireless transmissions uncluttered and at low power to avoid swamping the drone's signals.

Handling units: Early versions of drones will only be able to handle one pallet per bin location. Ensure that each pallet has a unique handling unit number a.k.a. "Serial Number" in a large barcode in a consistent location in the middle of each pallet. Ensure labels are stuck on straight with the barcodes horizontal.

Housekeeping: Drones will entangle in any dangling wires, straps or loose packaging. The downdraught from their propellers creates turbulence which will cause loose barcode labels to flap and become un-readable. Ensure shelf barcodes are placed consistently in the center of the bin location, and center of the shelf structure, that they are stuck on firmly, are printed in large, easily scannable barcode fonts, horizontally aligned.