

SPARR⁺OW

SGM 2/09



HIGHLIGHTS

- Flew drone for the first time...almost crashed into a tree
- Launched initial Pink Bagel campaigns on Google Ads, Reddit, Quora
- Started internal documents for drone onboarding, safety, and APIs
- Used Beam telepresence robot
- SAP + Walmart meeting
- RESEARCH! Drones, flight control, inventory





INDOOR FLIGHT: INERTIAL NAVIGATION

- Using **accelerometers** and **gyroscopes** to **continuously calculate the position**, orientation, and velocity of a moving object relative to a known starting point without GPS
- Used by deep sea submarines, and by some other aircrafts/vehicles but mostly as a supplement to GPS navigation
- 6 degrees of freedom: 3 orthogonal directions of (linear) acceleration, and 3 axes of rotation (angular velocity)
- **Strategy:** Using the starting position of the drone as the origin of our x, y, z space; specify several coordinates along desired path; based on current position and next point, determine the (3) velocities and (3) orientations necessary to reach the next point.



INVENTORY: PASSIVE RFIDs

- Passive RFID tags (transponders) activated by and respond to a radio signals from a transceiver. Range: about 3-20 feet, depending on frequency type.
- Already used in item-level tagging in retail stores, distribution centers, yard management
- Each tag has a **unique serial number** that can identify individual items/boxes
- **Advantages over barcodes:** does not need to be visible, does not require precise localization, more robust to environmental conditions than paper barcodes
- Cost: about 5-50 cents per tag, getting cheaper
- **Strategy:** Have warehouse employees tag each box as it comes off the truck; equip drone with RFID reader, fly near shelves to record type + number of items/boxes



SOFTWARE LIBRARIES

3DR | DRONEKIT

- Copter movement controlled either by **setting target position** or specifying velocity components
- **Velocity control** most useful: smoother when multiple updates
- Attitude class gives **yaw/pitch/roll**
- 3DR Solo can **run any Python** script/package
- Need to figure out if velocity/orientation are read/set via GPS/compass (bad) or accelerometer/gyroscope (good)



- DroneKit has a function that allows you to call any ArduPilot mission command
- Inertial navigation library to **read** directly from gyroscope/accelerometer sensors
- Position control library to **set** various velocity/acceleration components
- Extend ArduCopter control software with our own **custom flight mode**
- Low-level control guarantees that we are using gyro/accelerometer, not GPS



PINK BAGEL

Google AdWords

Drone inventory managing

sparrowsystems.herokuapp.com

Inventory errors cause lost sales.
Sparrow can help.

Indoor drone navigation

sparrowsystems.herokuapp.com

Navigating where other drones can't
Autonomous, safe, and precise

 **reddit** SMALLBUSINESS comments related

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! **How do you manage your inventory?** (self.smallbusiness)

submitted 9 days ago by [sparrow_eng](#)

My friends and I are researching inventory management pro

Quora

Those who have navigated drones indoors (could be a large indoor space)-- what modifications did you have to make to an off the shelf drone?

Remote-Controlled Vehicles • Unmanned Aerial Vehicles (UAV) • Technology • Edit Topics



Inventory management pain points:

- Time-consuming manual counts, with scanners and binoculars
- Losses are virtually untrackable in semi-annual inventory counts
- Difficult to balance forecasted needs, current inventory, and the timing of deliveries

Poor inventory practices:

- Losses due to theft or spoilage
- Inaccuracy in material conversions
- Inventory gets unorganized, due to daily movement of items

Could drones be a good solution?

- Existing solutions: RFID chips in shelves, robotic forklifts, control gates more efficient than quadcopters with 30-min flight times.

Experiences with flying drones indoors:

- Needed no modifications with the Phantom 3: uses sound and optical sensors
- Can't rely on GPS for position holding. Accelerometer and gyroscope together errors will compound over time
- AR Drone: programmable platform offering these two sensors, plus optical flow sensor
- Use propeller guards inside!



OUTDOOR TEST FLIGHT



Features

- Automatic take-off and “return to home,” with GPS
- Two joysticks, controlling: altitude, horizontal rotation, pitch, and roll

Issues

- Loss of GPS mid-flight! (Even on automatic mode)
- Potential obscuring of camera lense



QUESTIONS

- It makes sense how we would do rapid prototyping if we were making something like an app; for a drone-based solution, how should we approach rapid prototyping?
- Rapid prototyping seems to focus on gauging user experience. The goal of our navigation technology, however, is to remove the human from the flight control of a drone. Should we still try to rapid prototype anything to learn about user experience?
- We've gotten some Reddit and Quora answers and some clicks on Google Ads, but not too much. Many of the responses we have received are in the form of short answers (more along the lines of needfinding?). Does this align with the intended purpose of the Pink Bagel activity?
- For a non-consumer product, what insights should we attempt to derive from Pink Bagel? We are not sure how click numbers from Google Ads necessarily will provide insights for an enterprise drone solution? Should we use clicks to identify which indoor domain is most compelling, even though we have already narrowed in on warehousing?