

AirPizza Project

Great Pizza Delivered. . .
Anywhere!



Project Details

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CSSC372

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Overview

The AirPizza project is all about supporting a business around delivering the best pizza in a region at low cost (no restaurant or wait staff). Customers would order a pizza from wherever they are and get the pizza delivered via a drone. The overall service structure would be much like Uber with orders mostly via an app (and via Web) where a credit card is given up-front. The vision for AirPizza includes the ability to automate the whole process of making and delivery of the pizzas where the focus is on quality pizzas delivered cheaply. In the future, there are plans to generalize the drone fleet to also provide point-to-point delivery services of anything else it can safely carry.

Goals and objectives

The primary goal of the company and system is to have cost-effective delivery of pizzas. Some specific goals of the system are:

- Will be cost effective and be price-competitive with high-quality pizzas.
- Will be efficient for consumers to use and interact with, being less hassle than other delivery services or picking up from a restaurant.
- Will be able to deliver from oven to a location in 15 minutes.
- Is focused on the Terre Haute city limits but could be replicated in other regions of a similar size.

Statement of scope

The project will include not only the software components but also the set-up of the initial hardware and servers. So, it will include deciding on the particular drones, server location (likely cloud-based), testing of the system, prototypes of the system, and deployment of the system to full use. The scope of the software components are any software needed on the drones, ordering and purchasing system, maintenance of customer accounts, and tracking and monitoring of drones in flight. The system is not expected to cover other aspects of running the business such as payroll, personnel management, inventory, accounts payable, or ordering.

The additional scope for teams or 4 is to include the ability to delivery any package that is less than 10 pounds to any other point in the service region.

System Context

The system will interact with end-consumers for ordering, status, and tracking of their delivery (much like Uber). The interaction with the customer should include some confirmation of delivery to the specified location. The system will depend on having GPS available and usable by the drones as well as the ability to give a particular Lat-Long location for delivery (such as uploading a current location). The server side will interact with other services, such as a payment system to process payments.

Constraints

There are several known constraints to the project:

1. Delivery region. While the intent is to cover the entirety of the Terre Haute region, there may be practical difficulties in doing so. These include some

regions being off-limits (like the airport or near the airport) or others that will not allow delivery (like university campuses). There may also be distance limitations for the drones that depend on the weight of the delivery.

2. The drones are expected to have a limit of 10 pounds, thus restricting the delivery to 2 large pizzas at most. Other food items may eventually be added to the system such as side orders and drinks but are not part of the initial system.
3. Deliveries need to be completed in 15 minutes from take-off.
4. The system may not be able to operate in heavy rain, sleet, or snow. There may be times that deliveries cannot be done.
5. Drones will have to re-charge regularly and may limit the number of deliveries during peak periods.
6. An initial fleet of 20 drones is planned but the system should be able to scale to more drones and more originating locations to serve a busy or larger areas.
7. Budget is \$300,000 for the project for all costs with an expected delivery in 3 months.

Success Criteria

The system will be considered a success if it is able to successfully deliver and charge for 10 pizzas per hour at random locations in the service area.

Other success criteria include the ability for customers to quickly order a pizza.

Customers should be able to order a predefined pizza at their current location in less than a minute using the mobile phone app.

Known Risks

The system has a number of known risks at this time (but, there may be others):

1. The system depends on getting approval from the FAA and Terre Haute to fly. There may be other approvals needed as well to operate in specific regions.
2. The drone capabilities are critical to be reliable, able to not drop a pizza, and have consistent battery life.
3. It is unknown how customers will treat the drones and they may damage the drones.
4. In order to beat any competition, we'd like the service to be fully operational in 3 months.
5. Precise locations may be difficult to specify for customers with GPS or address alone. For example, if I give the address of a building how will we know what door to deliver the pizza to? This increases the risk of missed deliveries or dropping the pizza in the wrong place.
6. There is expected to be a risk of interference for the drones' communication and/or dead spots to be avoided.

System Features

The system has a number of initial features:

1. Pizza ordering:
 - a. A user can order a pizza(s) for a particular place at the current time or a future time (no longer than a week into the future).

- b. A user can create pre-defined orders such as from previous orders.
 - c. A user can set up payment methods and must specify a payment method before placing an order.
 - d. A user can set up an account and save their details for easy future ordering include preferred locations. Accounts should be secured with a password with optional multifactor authentication using SMS to a phone.
 - e. Menus should be set up for customers to order from as well as customers can request special requests using the ingredients available (such as double mushrooms or both jalapenos and giardiniera peppers). Menus should be updatable and keep existing future orders intact that were based on older menus.
 - f. The system should allow the use of coupon codes, gift cards, and normal payment methods (debit and credit).
- 2. Drone monitoring:
 - a. Drone locations should be monitorable by order and by identification of a particular fleet of drones.
 - b. Customers should be able to monitor the location of their drone delivery and direct it to the final drop point.
 - c. Drones should be monitored for battery status (and other issues) and taken out of service to be charged or repaired. It should be quick to indicate a drone is again ready for service.
- 3. Customer analysis:
 - a. The system should keep track of all orders by all customers in a particular delivery area and produce a report of usage and trends in ordering. This information will be used to adjust/add locations or to change the menus.
 - b. The system should analyze prior orders to predict future orders for a particular customer (such as they always order a pizza of a particular type on Saturday at 5PM) so that coupons/discounts can be offered.
- 4. Mobile App and Web customer interfaces
 - a. The system should support both iOS and Android OS devices that are 2 years old or newer.
 - b. The mobile app and interfaces should both provide all the user functionality.
- 5. Drone features:
 - a. The drone should be secured from wireless attacks.
 - b. The drone should mitigate against denial of service attacks or threats (such as bombarding it with RF).
 - c. The drone should be capable of detecting when it is out of contact with the servers and fly back to home base or until it is in contact with home base.
 - d. The drone should be able to respond to commands on where to fly.
 - e. The drone should be able to transmit video from its location to both the home base and to the particular customer.
 - f. The drone should require minimal control from the home base (i.e. it should be able to self-navigate to be close to the delivery point most of the time).

Overall System Architecture and Technologies

The system is expected to have four major components:

- **User interfaces:** iOS and Android mobile apps as well as a Web interface that supports all major browsers (Safari, Edge, Firefox, and Chrome). The interfaces should be as consistent as possible so that a user could switch from one to another and have a similar experience.
- **Server:** that supports the storage of the menus, availability of items, user profiles and orders as well as interfaces to external systems (such as the payment system). The server should also support the monitoring and management of the drone fleet and any reporting needs.
- **Drone:** The drones should support the needed functionality which may require adding software to the drone itself, depending on the drones chosen.
- **Management interface:** A Web interface should be developed for the server with the focus providing the ability to manage the business.

The mobile apps and web server should be developed using Flutter and Dart with the server system being developed on a Microsoft platform including .Net and SQL Server on a cloud-based Azure server. The drones should use 4G/5G cellular data services to communicate to the server. Any features needed on the drone itself will depend on the drone chosen.

The user interfaces should not store any transient or changeable data locally and pull items such as customer orders, menus, availability, and drone status from the server. The user interfaces should only communicate with the server directly. The server will then manage all communication with the drone including any directions from the user to rendezvous with the drone. The management interface will communicate with the server only. Figure 1 also suggests that it may make sense to have a separate component for the Drone Monitoring and Control as that has real-time requirements.

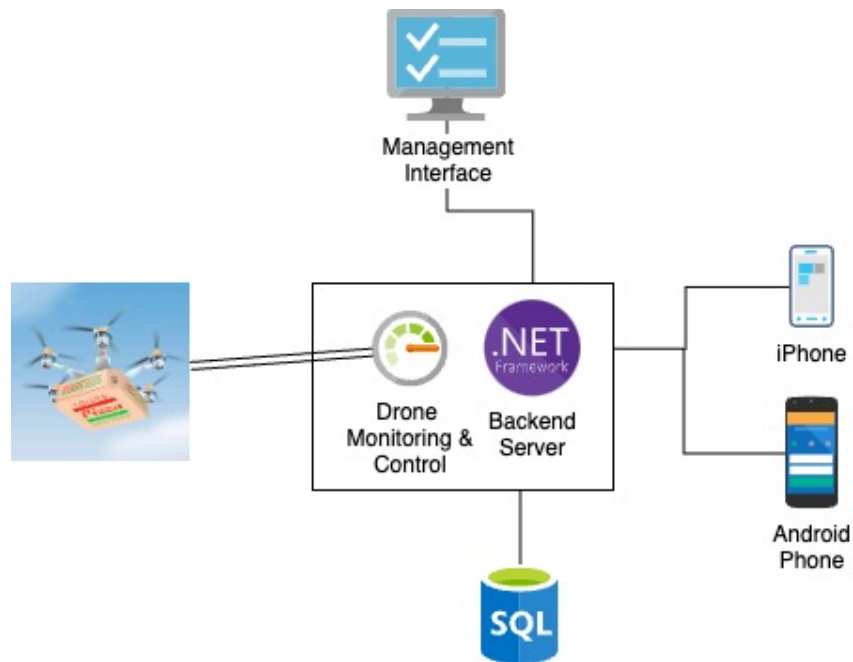


Figure 1. AirPizza overall architecture.