



Drone Delivery System for Restaurant Orders

Team 127



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KFUPM Design Expo

Background

The project aims to develop a system to deliver restaurant orders in cities with high population density, and address problems such as delivery delays and cold meals. The system will provide high efficiency, lower costs and increased accuracy compared to traditional delivery methods. The novelty of this idea lies in the use of drones specially designed for restaurant delivery. While drone delivery systems have been explored in many industries, the focus on restaurant orders is relatively new. By targeting this area, the project can address the unique challenges and requirements of delivering food quickly and efficiently.

Introduction

- Problem Statement

Today's food delivery process faces challenges with long delivery times, traffic congestion in densely populated cities, and human errors. A drone-based solution is needed to improve delivery efficiency, reduce costs, and enhance customer satisfaction.

- Constraints

- ❖ Restricted Operational Distance
- ❖ Limits on Weight and Cargo
- ❖ Requirements for Landing and Delivery Locations
- ❖ Dependency on Weather Conditions

- Target Specifications

- ❖ Delivery Speed (From 30-40)
- ❖ Lead Time Order (Less than 30 min)
- ❖ Payload (Up to 2.5 kg of the order weight)

- Project Impact

The project has Impacts in many fields such as: Public Health, Safety, Global, Welfare, Cultural, Social, Environmental, Economic.

Product Design

The System Consists of:

- Drone
- Container
- The Web Site (Called NAZEL)

The Detailed Specifications

Metric	unit	acceptable value	ideal value
Weight	kg	(15-20)	16
airspeed	km/h	40-60	70
operating temperature	Celsius	-10 to 40	0 to 40
vertical speed	m/s	(3-6)	7
Lead time	Min	<50	<30
charging time	min	(60-90)	50
maximum payload	kg	(1-5)	6
maximum weight to take off	kg	24	27
camera resolution	pixel	(2-50)	50
altitude	m	200	250
flight time	min	(22-28)	35
range	km^2	(5-9)	10

Prototype Design



Testing / Validation

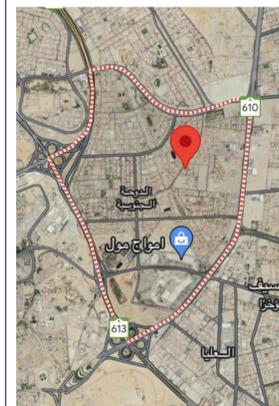
General Model Weight: 7000 g, # of Rotors: 4, Frame Size: 1100 mm, FCU Tilt Limit: no limit, Field Elevation: 500 m ASL, Air Temperature: 25 °C, Pressure (QNH): 1013 hPa, Battery Cell: LFP 2200mAh-25.55C, Configuration: 8 S 1 P, Cell Capacity: 22000 mAh, max. discharge: 85%, Resistance: 0.001 Ohm, Voltage: 3.7 V, C-Rate: 25, C cont: 542 g, Controller: Type: max 80A, Current: 80 A cont, Resistance: 0.0035 Ohm, Weight: 105 g, Accessories: Current drain: 0 A, Motor: Manufacturer - Type (KV) - Cooling: T-Motor MNS007H-320 (320), KV (info torque): 320, no-load Current: 1 A @ 10 V, Limit (up to 15s): 1040 W, Resistance: 0.0475 Ohm, Case Length: 28 mm, # mag. Poles: 28, Weight: 180 g, Propeller: Type - yoke twist: T-Motor CF, Diameter: 18 inch, Pitch: 6.6 inch, # Blades: 2, PConst / Tconst: 1.15 / 1.0, Gear Ratio: 1 : -1, Weight: 6.3 oz

Remarks:

Battery		Motor @ Optimum Efficiency		Motor @ Maximum		Motor @ Hover		Total Drive		Multicopter	
Load:	9.80 C	Current:	27.19 A	Current:	35.94 A	Current:	6.98 A	Drive Weight:	5458 g	All-up Weight:	7000 g
Voltage:	20.91 V	Voltage:	21.13 V	Voltage:	20.78 V	Voltage:	21.92 V	Drive Weight:	192.5 oz	All-up Weight:	246.9 oz
Rated Voltage:	22.20 V	Revolutions*:	6311 rpm	Revolutions*:	6057 rpm	Revolutions*:	3179 rpm	Thrust-Weight:	2.9 : 1	add. Payload:	10229 g
Energy:	488.4 Wh	electric Power:	574.5 W	electric Power:	748.8 W	electric Power:	33 W	Current @ Hover:	41.87 A	max. Payload:	360.8 oz
Total Capacity:	22000 mAh	mech. Power:	502.4 W	mech. Power:	648.1 W	Throttle (log):	49 %	PI(n) @ Hover:	929.4 W	max. Tilt:	66 °
Used Capacity:	16700 mAh	Efficiency:	87.4 %	Power-Weight:	640.1 W/kg	electric Power:	153.0 W	PI(n) @ Hover:	794.7 W	max. Speed:	69 km/h
min. Flight Time:	5.2 min			electric Power:	290.3 W/kg	mech. Power:	132.8 W	Efficiency @ Hover:	85.5 %	est. Range:	42.9 mph
Mixed Flight Time:	20.4 min			Efficiency:	86.9 %	Power-Weight:	132.8 W/kg	Current @ max:	215.62 A	est. Range:	6023 m
Hover Flight Time:	26.8 min			est. Temperature:	53 °C	mech. Power:	60.2 W/kg	PI(n) @ max:	4786.9 W	est. Rate of climb:	3.74 m/s
Weight:	3252 g			est. Temperature:	127 °F	Efficiency:	86.6 %	PI(n) @ max:	3894.5 W	est. rate of climb:	6.8 m/s
	114.7 oz			Wattmeter readings:		est. Temperature:	31 °C	Efficiency @ max:	81.4 %	Total Disc Area:	98.50 dm²
				Current:	215.64 A	specific Thrust:	7.63 g/W			with Rotor tail:	1526.75 m²
				Voltage:	20.91 V						
				Power:	4509 W						

Controller Gravity Location Model

$$TC = \sum_{n=1}^k d_n D_n F_n$$



X_n, Y_n : Coordinates of either customer or restaurant location n

F_n : cost of shipping one order for one KM

D_n : Num. of orders to be shipped between restaurant and customer per month

$$d_n = \sqrt{(x-x_n)^2 + (y-y_n)^2}$$

Controller Location

x =	0.5
y =	0.5

Objective

Cost =	\$	35
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System Architecture

Ultrasonic Sensor



Arduino Uno



T- Motor



Controller



Battery



Camera



Conclusion

In conclusion, the combination of drone and a connected website for meal delivery presents a compelling solution with multiple benefits. It not only contributes to environmental sustainability by reducing emissions and traffic congestion but also enhances convenience, efficiency, and customer satisfaction. By embracing this innovative approach, we can pave the way for a more sustainable and technologically advanced future.