e-Yantra Robotics Competition - 2017

Theme and Implementation Analysis – Chaser Drone

1712

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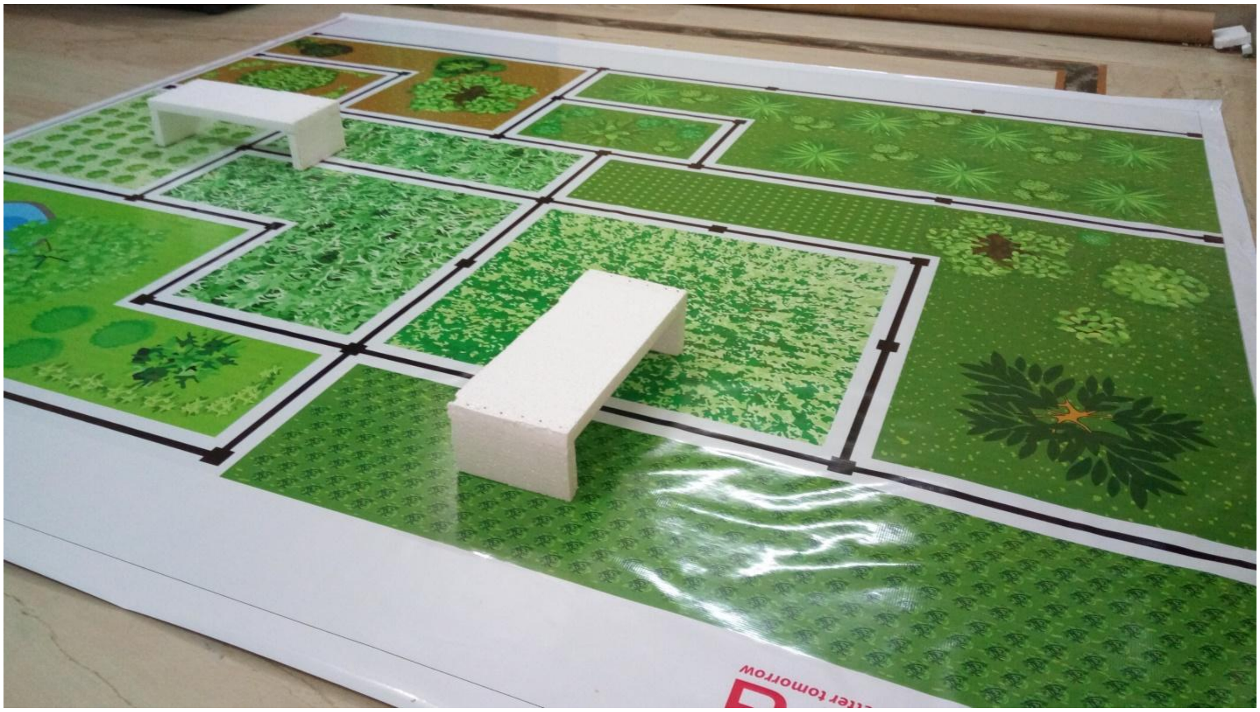
Date	12/01/2018

Scope and Preparing the Arena

Q1 a. State the scope of the theme assigned to you. (5)

The chaser drone must protect the crops from damage due to intruding wild animals, like elephants, tigers, and rodents etc., which run over the field and destroy them. A drone is made to hover over the field and to wait for any intruding animal. When it encounters one, it lands on it or chases it (like a scarecrow) preventing its entry into the field. As an improvisation, one can make the drone inject tranquilizer to the animal caught. This theme helps in finding a solution to avoid crop damage by animals and increasing total yield for farmers.

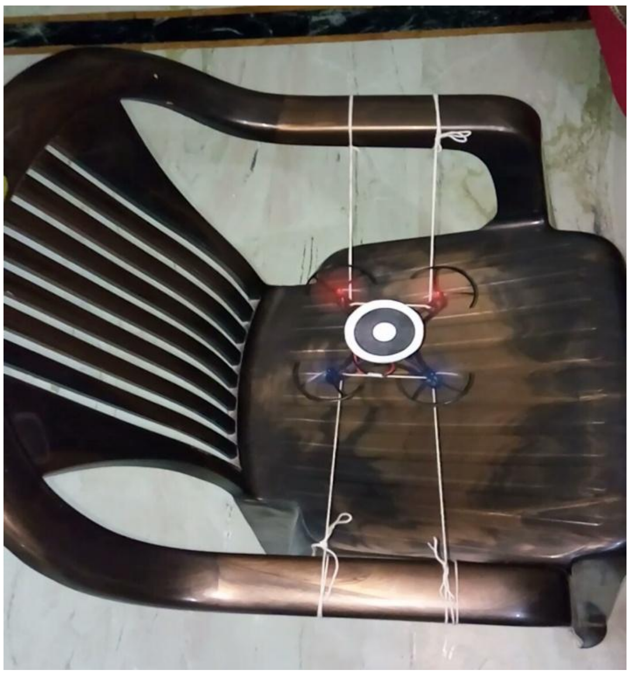
b. Attach the Final Arena Images. (5)



Testing your knowledge (theme analysis and rulebook-related)

Q2. How will you ensure that while tuning the PID value, Drone will not crash? (5)

By tying string to the drone, it is possible to keep it from flying away and also tune the drone to obtain required response. The drone is kept closer to the hold position in x, y, z coordinates and in yaw position. For roll and pitch tuning, the drone is tied to a chair with string on both ends perpendicular to the axis to be tuned (left image). For e.g., for roll tuning, the drone is tied to chair on its front and back. For yaw tuning, the drone is tied to balance on its center of gravity through a single string, and PID tuning is done (right image).



The PID constant values are modified in the run time through a code. The following is a sample code which obtains the key pressed from key_command.py node and modifies the kp value for roll. This code is implemented for all the axis and all the PID constants. The modified constant value is published to a topic which is subscribed by the node which controls the motion of the drone and changes its PID constant value according to the subscribed value. For e.g., here the published kp_roll value is subscribed by drone motion control node and uses this value for PID control of drone.

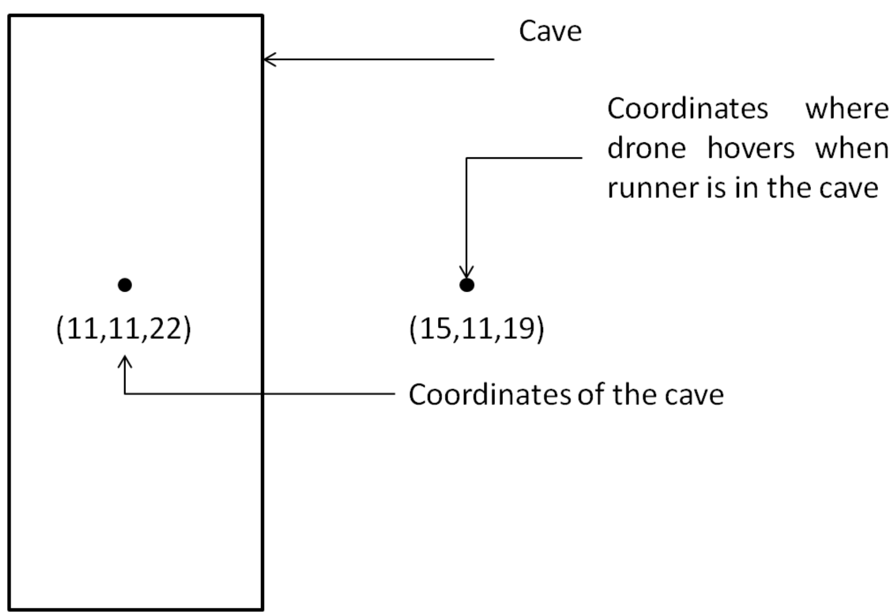
Since the drone is attached to string, it is possible to tune the PID values for each axis separately without crashing. Moreover, by tuning the PID values in runtime, the response of the drone to any change in PID constant values can be easily observed and modified accordingly. For e.g., when oscillations are more, kd value can be tuned runtime.

The sample code for controlling kp value for roll is:

```
class roll_kp_set():

    def __init__(self):
        rospy.init_node('drone_server')
        self.kp_pub = rospy.Publisher('/pub_roll_kp', Int16, queue_size=1)
        rospy.Subscriber('/input_key', Int16, self.identify_key )
        self.key_value =0
        self.kp_roll = 28.0
         self.roll_rate = 0.01
        self.kp_roll = Int16()

    def increase_kp_roll(self):
        self.kp_roll +=self.roll_rate

    def decrease_kp_roll(self):
        self.kp_roll -=self.roll_rate

    def identify_key(self, msg):
        self.key_value = msg.data

    def control_drone(self):
        while True:
            if self.key_value > 20:    #if any other key is pressed
                 continue
                if self.key_value == 10:   #if 'i' is pressed
                self.increase_kp_roll()
            if self.key_value == 20:   #if 'd' is pressed
                self.decrease_kp_roll()
            self.kp_roll = kp
            self.kp_pub.publish(self.kp_roll)
```

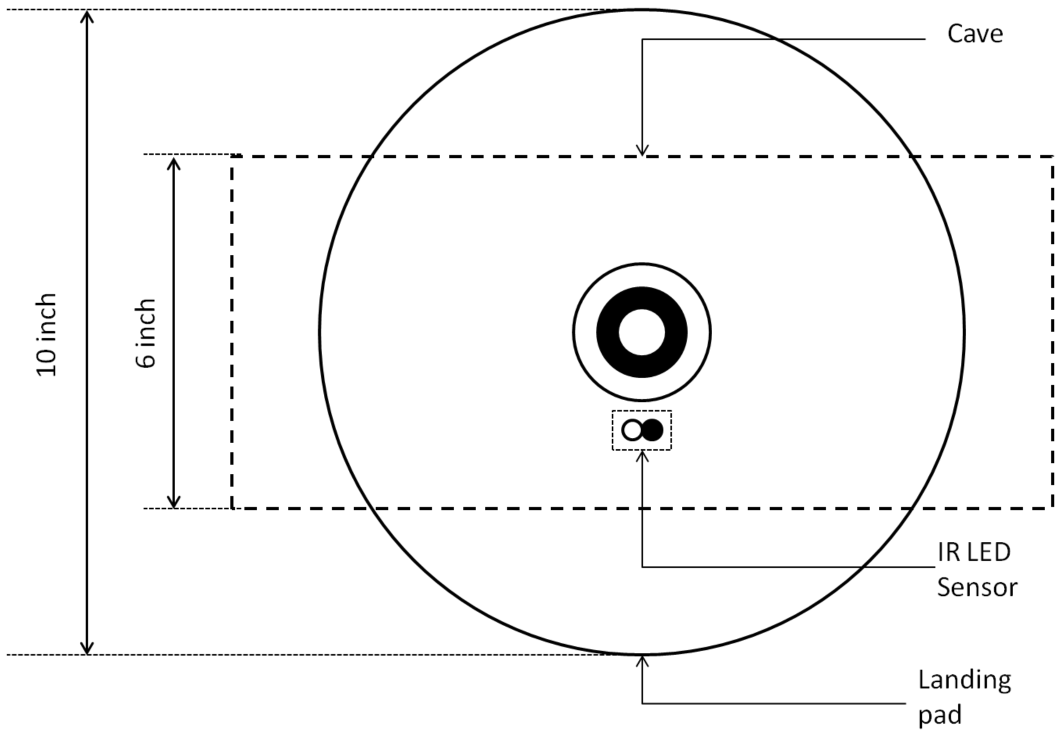
Q3. How Chaser will detect that Runner has entered into the cave? What will be the action taken by the Chaser while Runner hides inside the Cave? (5)

The number of targets for Whycon node will be set as 2. **When the runner hides inside the cave, the camera cannot detect both the Whycon markers** and as a result the drone node cannot access the coordinates of both runner and catcher. This condition may also arise, when the drone blocks the view of the runner's marker while landing. These two situations can be easily distinguished by determining the last known marker coordinate. So, when the difference between coordinates of runner and chaser are very close (within a predetermined value), it indicates that the chaser is about to land on the runner. **When the difference between last read coordinates of the runner and coordinates of the cave is very low, chaser identifies that runner has entered into the cave.** Moreover, when the both the markers go undetected more than a specific time, the Whycon node service is reset using '/whycon/reset' and setting number of targets as 1. Now, the catcher is made to hover at coordinates slightly ahead of the coordinates of the cave (as given in figure). By this way, when the runner comes out of the cave, the catcher can immediately land on the runner.



Q4. How you will interface and place the IR sensor on Runner to detect the successful landing of Chaser on the Runner. (5)

The IR sensor is placed few cms (2 cm) in front of the Whycon marker of the landing pad of the runner as in figure. The IR sensor is connected to the sensor expansion slot of the runner such that the transmitter and receiver LEDs face the ceiling or top by piercing them through the landing pad. When the drone lands on the runner, the IR sensor will give the output to the runner such that it stops for the drone to land. The IR sensor gives high output on detecting white colour and low output on black colour (depends on sensitivity). The sensitivity of the sensor is adjusted such that the IR sensor detects only the drone (which is not white in colour) and does not detect the cave as it is white in colour (made of thermacoal).



Q5. Let us consider a scenario: (5)

Runner is on first node and Chaser tried to land on Runner, but instead Chaser has landed on the Arena.

What will happen according to your algorithm (Considering theme rules specified in the rule book)?

When chaser lands on the runner, it can determine a successful land by identifying the Whycon z coordinate and laser sensor's altitude value. That is, when the z coordinates value of the chaser is close to the ground and sensor's altitude value is near zero, it indicates that the chaser has landed on the arena instead of runner indicating unsuccessful run. In such case, the chaser takes off again and starts chasing the runner repeating the whole process.

Q6. What will be your strategy to earn maximum points in a run? (5)

1. Fine tune the PID such that stability at a coordinate can be immediately achieved.

2. This also allows the chaser to fly over the specified 2 waypoints without overshooting from the arena which holds a very high weightage in scoring.

3. For any entry node, the drone will be made to reach the 1^{st} decision point just before the runner reaches it.

4. In case it misses it, catching the runner near the cave is easier as the drone can easily stabilize during the wait time. Once the runner comes out of the cave, the chaser is closer to the runner than other points and can easily land on it.

5. The drone is made to hover only slightly above the ground to reduce battery usage and also achieve immediate landing of the drone.

6. The IR sensor on the runner will be tuned to sensitivity such that the runner immediately detects the landing of drone and stops moving and thereby increasing the bonus marks.

7. The algorithm together with proper PID tuning will be such that the drone catches the runner as early as it could so that NT as well as T is minimised(increasing TN-NT).

8. Proper landing and avoiding repositions increase LB and decrease P respectively, thereby ultimately increasing the Total Score.

Challenges

Q15. What are the major challenges that you can anticipate in addressing this theme and how do you propose to tackle them? (5)

1. One problem might result when a drone cannot distinguish an intruding animal and farmers themselves. So, it is necessary to identify between an animal and a human using image processing technique, such that the drone does not attack humans mistaking them as animals.

2. Fixture of camera for an agricultural land becomes difficult. It requires complex mechanical structure. A better approach would be to use multiple cameras fixed on poles rather than a single one.

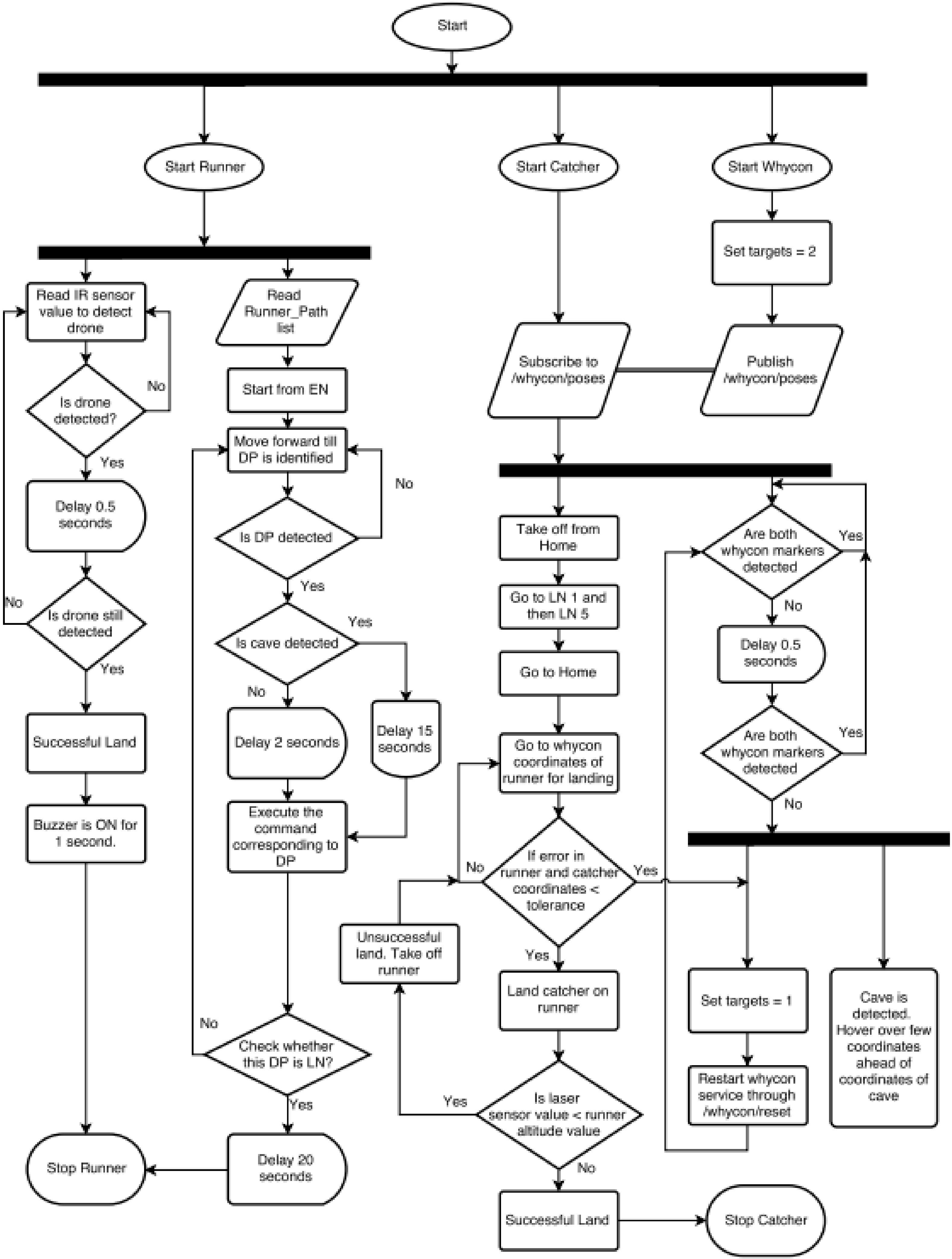
3. Predicting a real life animal's movement is far more difficult than a robot. So, a case study of common animals that might intrude a farm is required. Moreover, any object which attracts the animal can be kept in farm, so that the drone can at most expect the animal to reach that object.

4. Once the drone identifies and tries to chase away the animal, it should do so such that it drives the animal further away from the farm which is difficult due to its unpredictability. Solution in 3 can again resolve this.

5. Wind can greatly affect the performance of drone. So, a proper PID tuned drone which also takes wind speed into account can resolve the issue.

Algorithm Analysis

Q5. Draw a flowchart illustrating the algorithm you propose to use for theme implementation. (10)



Start
Start Runner
Start Catcher
Start Whycon
Set targets = 2
Read IR sensor value to detect drone
Read Runner_Path list
Subscribe to /whycon/poses
Publish /whycon/poses
Is drone detected?
No
Start from EN
Move forward till DP is identified
Yes
Delay 0.5 seconds
No
Is DP detected
Take off from Home
Are both whycon markers detected
Yes
Yes
No
Is drone still detected
Yes
Is cave detected
Go to LN 1 and then LN 5
No
Delay 0.5 seconds
Go to Home
No
Successful Land
Delay 2 seconds
Delay 15 seconds
Go to whycon coordinates of runner for landing
Are both whycon markers detected
Yes
No
Buzzer is ON for 1 second.
Execute the command corresponding to DP
No
If error in runner and catcher coordinates < tolerance
Yes
Unsuccessful land. Take off runner
Yes
Land catcher on runner
Set targets = 1
Cave is detected. Hover over few coordinates ahead of coordinates of cave
No
Check whether this DP is LN?
Yes
Is laser sensor value < runner altitude value
Restart whycon service through /whycon/reset
Yes
No
Stop Runner
Delay 20 seconds
Successful Land
Stop Catcher