Arrangement for DroneGo

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Abstract

After the worst hurricane to ever hit Puerto Rico, lots of people were injured. Highways were blocked and damagedby the flood. We establish a model to both meet the needs of medicine delivery and road reconnaissance with rotor wing drones. Our model takes into account the following factors : the number of cargo containers, the type and the number of drones, the number of medicines, the associated packing configuration of each cargo, the exact locations of cargo containers.

First, by thresholding the aerial image, morphological dilate and feature point recognition, the image is transformed into a Occupancy Grid Map with passable area (road) and obstacle area (non-road area) and extract the ROI (city) in the same time.

Second, we determined the geographic distribution of each container and the arrangement of drones based on the spatial distance between Puerto Rico's every hospital and the demand for medicines, which included the classification of two functions of drone , one is transportation Medicine drones, the other is the terrain survey drones: A single F drone that cannot survey the terrain but can carry more medicines is used to transport medicines to two hospitals that are closer to each other,which are located farther away Of hospitals were selected to use 4 fast drones B to transport medicines.Then the remaining 45 B-type UAVs surveyed the surrounding terrain with each city as the base point, which not only ensured the drug demand of each hospital, but also greatly improved the effectiveness of the reconnaissance.

In the process of container loading, under the premise of using the **hybrid genetic simulated annealing** algorithm, medicines and drones are placed on the bottom of the container, and stability and safety can be guaranteed to the greatest extent when transporting. On the premise of ensuring a one-month drug demand for each hospital and a sufficient number of survey drones, the container volume utilization rate is optimized, and the space utilization rate of the three containers is 18.08 %, 20.56 %, 21.68 %.

Third, since there are not too many cargo esthest per shipment, the payload configuration of the drone is simply designed. For A Containers: Drone B mounts a MEDIC1. For B Containers: Drone F mounts three MEDIC1s, two MEDIC2s, two MEDIC3s. For C containers: Drone B is loaded with two MEDIC1s or one MEDIC3 or one MEDIC1 and one MEDIC3.

Fourth, because the Occupancy Grid Map has already contains the obstacle information, we determine to use **RRT-connect** instead of **A*** or **dijiskra** algorithm to plan the dilvery path and roads between cities.

At last, the result we got is we can sustain a month of medicine supply, 100% road reconnaissance coverage within the flight radius and 100% road reconnaissance between cities.

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1 Model Establishment

1.1 ROI Extract And Map Established

1.1.1 The ratio of the image between the real world

Through calculation we can got the ratio R of the physical distance corresponding to each pixel. This is of great significance for our future flight radius calculation and path planning. We extract two points $A(x_A,\, y_A)$ and $B(x_B,\, y_B)$ in the image, calculate euclidean distance between A and B (unit : $pixel$), measure their physical distance S_{real} using Google Map.

$$R = \frac{S_{real}}{\sqrt{(x_A-x_B)^2+(y_A-y_B)^2}} = \frac{69.61km}{615.11pixels} = 113.1m/pixel$$

1.1.2 Threshold The Image

Load the original image and convert it into the threshold image so we can extract the road data from the orignal image. It makes us possible to reconnaissance along the road.The range is from$(50, 50, 20)$ to $(150, 90, 50)$

```
cv::Scalar lower_range = { 50,  50, 20 };
cv::Scalar upper_range = { 150,  90, 50 };
cv::inRange(src, lower_range, upper_range, out);
```

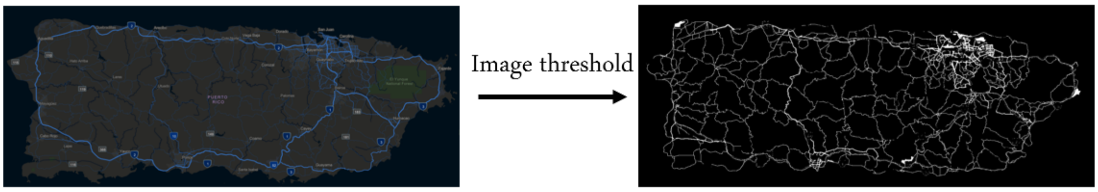

Figure 1: Shows the result after threshold.

1.1.3 Dilated The Image

We dialte the image (using $8 * 8$ Convolution kernel).On the one hand, the new white area represents the area that our drone can detect, on the other hand, this can be our better plan for the reconnaissance trajectory and delivery route of the medicine.

$$\text{Convolution Kernel} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

```
cv::Mat element = cv::getStructuringElement(cv::MORPH_RECT, cv::Size(8, 8));
cv::dilate(out, out_dilated, element);
```

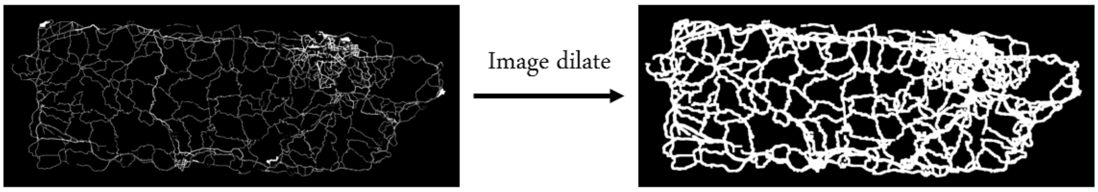

Figure 2: Shows the result after dilated.

1.1.4 Detct And Extract The Cities Location

By performing image feature detection and circle fitting, we can extract the locations of various cities for later road reconnaissance.

```
medianBlur(src, cimg, 5);
GaussianBlur(cimg, cimg, Size(9, 9), 2, 2);
Canny(cimg, cimg, 10, 250, 5);
vector<vector<Point>>cnts;
findContours(cimg, cnts, RETR_EXTERNAL, CHAIN_APPROX_NONE);
for (int i = 0; i < cnts.size(); i++)
{
    vector<Point> cnts_single = cnts[i];
    if (cnts_single.size() > 0)
    {
        vector<Point> approx;
        string shape = detect(cnts_single, approx);
        Moments M = moments(cnts_single);
```

```
        int cX, cY;
        if (M.m10 != 0)
        {
            cX = int((M.m10 / M.m00));
            cY = int((M.m01 / M.m00));
        }
        putText(cimg, IntToStr(cX) + ", " + IntToStr(cY), Point(cX, cY),
         FONT_HERSHEY_SIMPLEX, 0.5, Scalar(255, 0, 255), 1);
    }
}
```

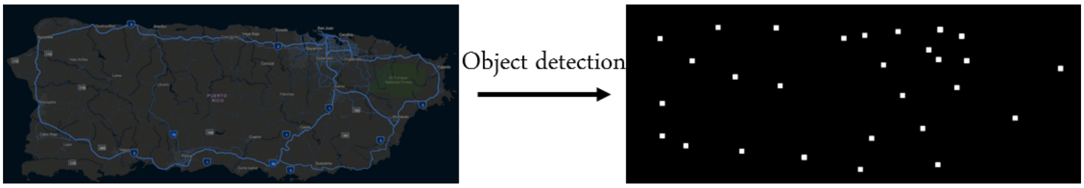

Figure 3: Shows the result after object detection.

2 Drone Flight Plan

2.1 Path Planning