Gathering Atmospheric Data
Using an Unmanned Air Vehicle

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March 6, 2014

Abstract

This report looks at three dimensional energy based path planning for unmanned air vehicles in a predetermined area, with particular consideration to quality of data produced.

Contents

1 Introduction

The following section outline the process in which a minimum cost route through a sample space can be obtained that provides the best data collection quality

2 Plane Properties

Name	Wingspan	height
Plane 1	20m	5m
Plane 3	40m	6m

Table 1: Table of Plane Properties

To considere th minimum cost of circumnavigating a particular route the specifications of a plane must be considered in table 1 the properties of differnt planes is shown

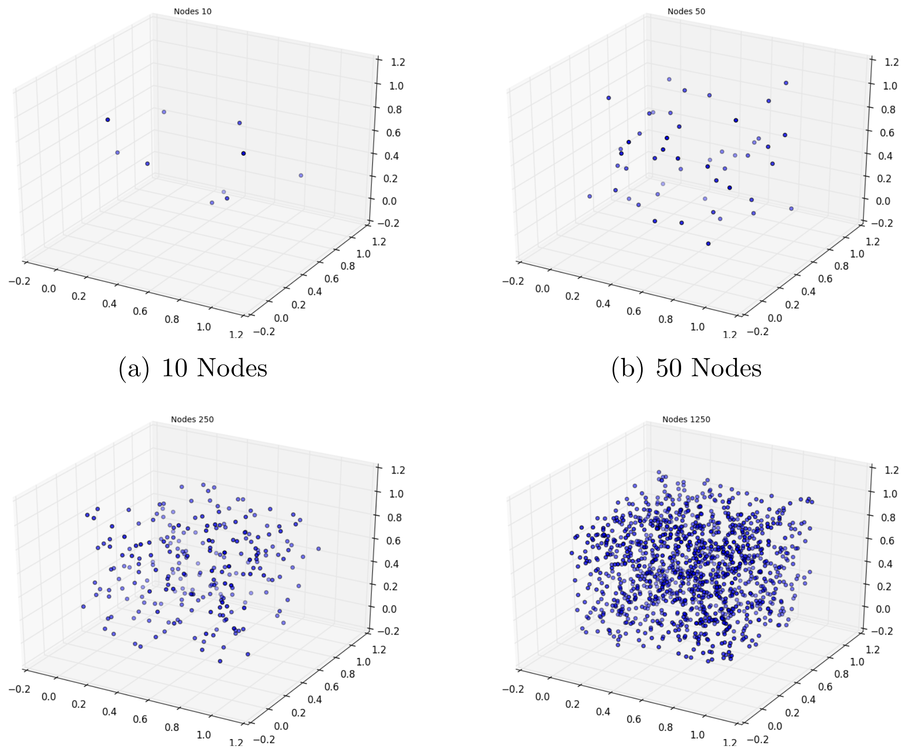
3 Energy Model

$$E = \alpha D + \beta H \tag{1}$$

From these plane properties the following energy model has been definened in equation 1 where α and β are coeficients that are determined by the plane. For the current plane shown in table 1 α and β take values of 10 and 6 respectively.

4 Latin Hypercubes

Latin hypercubes are sampling pland that provide the best space fillingness while limiting the total number of sampling points required. This is generally applied to testing of computer similations where the collection of each point is expensive. In this situation however the travel bertween the points the expensive component.



(a) 10 Nodes (b) 50 Nodes (c) 250 Nodes (d) 1250 Nodes

Figure 1: Latin Hypercubes with Varying Numbers of Nodes

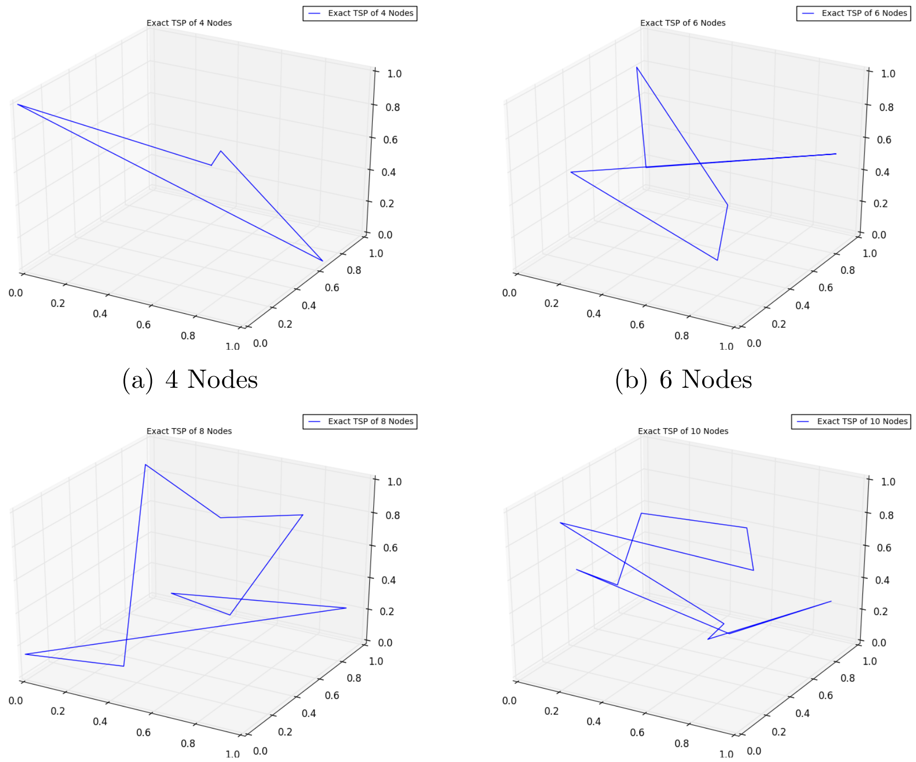
Figure 1 shows a number of latin hypercubes with differnt numbers of nodes. All the Latin Hypercubes are within a unit cube. For collection of data in a required area these cubes can be stretched to fill the desired space. This does not provide an even spacing in each direction however means that eeach vertex of data collection is equally considered.

For this project the idea is to follow this logic to utilise Latin Hypercubes:

1. Specifiy area of interest to researcher
2. Estimate number of nodes able to be circumnavigated given the UAV total energy and the area of sample space
3. Fit Latin Hypercube of given nodes to sample area
4. Calcualte least energy route through the sample space
5. After first flight asses areas of encertainty to plan route through for next flight

5 Path Planning

Given a set of points within a sample space the next stage of the proceedings is to compute the least cost path through these points. This problem presents itself in the forn of the travelling salesman problem. The travelling salesman problem is the problem of finding the least cost path through a set of points. There is lots of work done on the elicidean travelling salesman problem and introducing heroustics to improe the time taken to compute. This is due to the problem being an NP hard problem (the computing time required increases exponentially with the number of points in the route)



(a) 4 Nodes

(b) 6 Nodes

(c) 8 Nodes

(d) 10 Nodes

Figure 2: Exact routes calculated by travelling salesman

Figure 2 shows the optimal routes for diffrent numbers of nodes

Number of points	4	6	8	10
Number of possible routes	24	720	40320	3628800
Computation time (ms)	0.0	5.0	634.0	33670.0
Best route cost (J)	110.38	106.71	106.72	108.76

Table 2: Comparison of route calculation

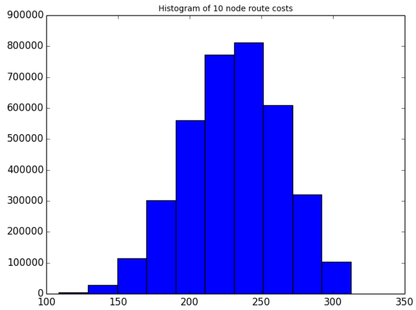


Figure 3: Histogram of 10 node route costs

Figure 3 shows a histogram of differnt route costs for a 10 node latin hypercube