A New Algorithm for Automated Aircraft Conflict Resolution

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ENAC

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Introduction

Air Traffic Management Requirements

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- Aircraft Separation,

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- Aircraft Separation,
- Staying close to the Business Trajectory.

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NextGen and SESAR Context

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NextGen and SESAR Context

- More automation $\Rightarrow$ Delegation of some spacing and separation tasks to aircraft,

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NextGen and SESAR Context

- More automation $\Rightarrow$ Delegation of some spacing and separation tasks to aircraft,
- There is need for automated conflict resolution, several methods exist among which Navigation Functions and Genetic Algorithm,
- The most important parameter to deal with is TIME .

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Automatic Resolution: Navigation Functions

How does it work ?

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- The Navigation Function produces a potential field which drives the aircraft toward the destination and away from obstacles,

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- Dipolar Navigation Function makes the resulting lines of potential field tangent to the desired orientation at the goal.

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Automatic Resolution: Navigation Functions

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- Absence of local minima,

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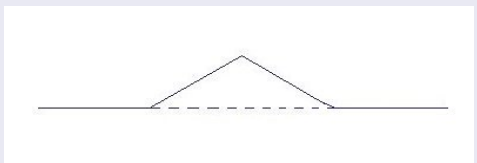
- The Turning point model:



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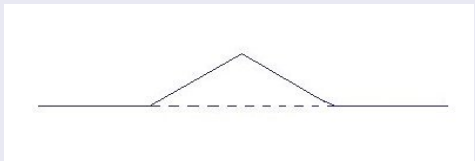
- The Turning point model: 
- The Offset model: 

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No proof of global convergence:

- A very good solution may eliminate worst solutions $\Rightarrow$ Prematurely convergence.

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Our method

We aim to find a method which combines the advantages of both previous methods:

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- Generating operationnal trajectories.

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Principles of the light propagation method

The light beams are launched from the starting point in the half sphere towards the point of arrival. The congested areas are represented by areas of high index. The first beam that reaches the point of arrival represent the optimal trajectory.

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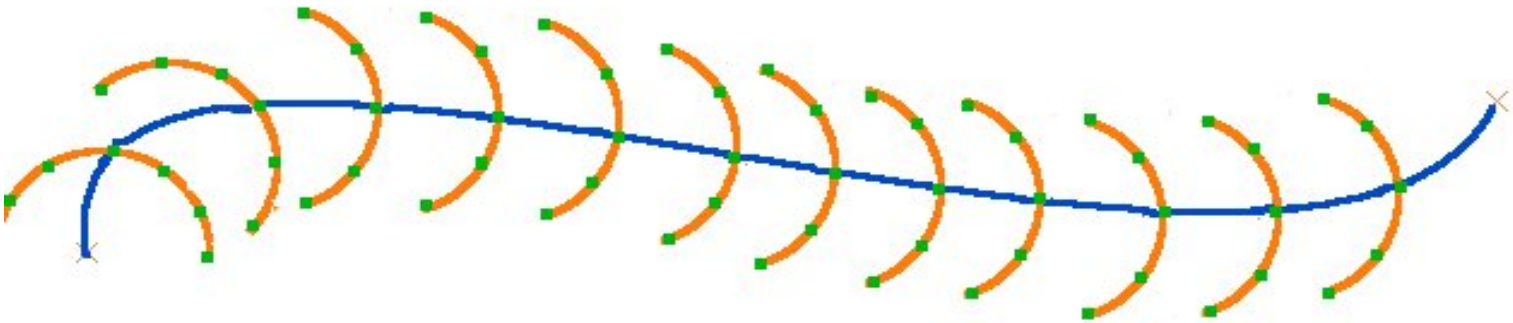
The light propagation algorithm

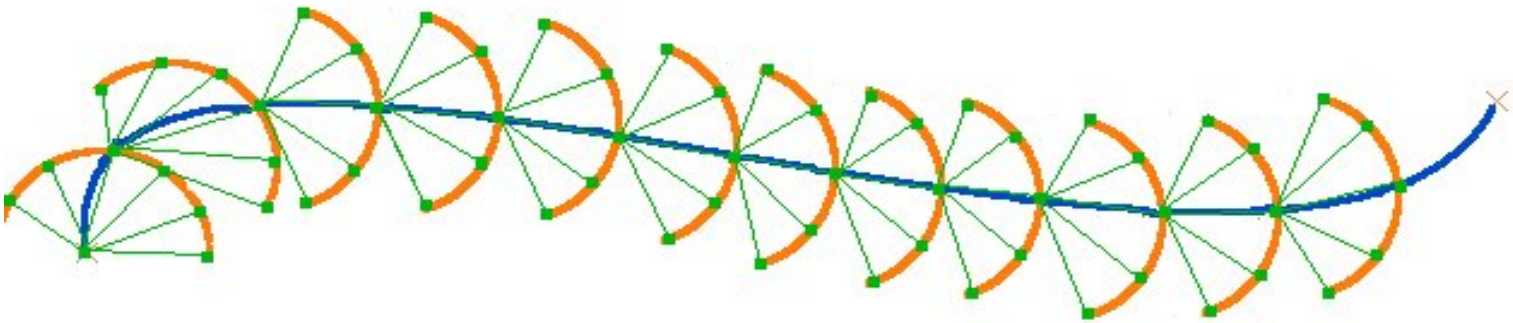
- Find the potential fields algorithm solution: the trajectory T $\Rightarrow$ UpperBound = time travel of T

The light propagation algorithm



- Sample T to build a tree, with half spheres with a radius dt, a curvilinear step ds and an angle dθ

The light propagation algorithm



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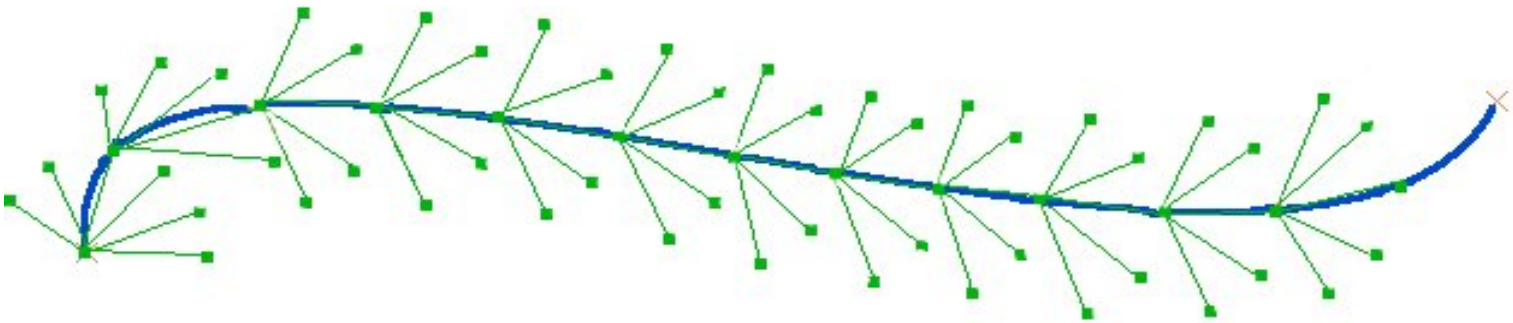

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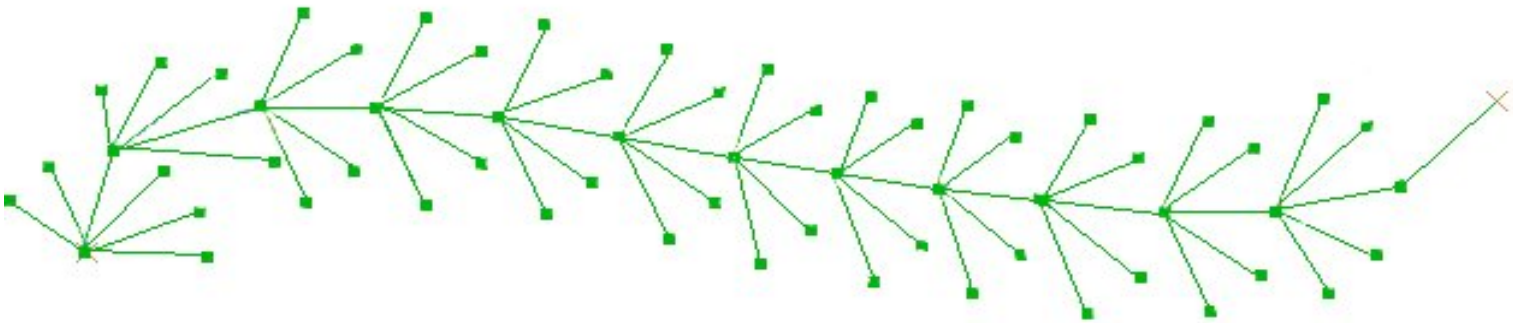

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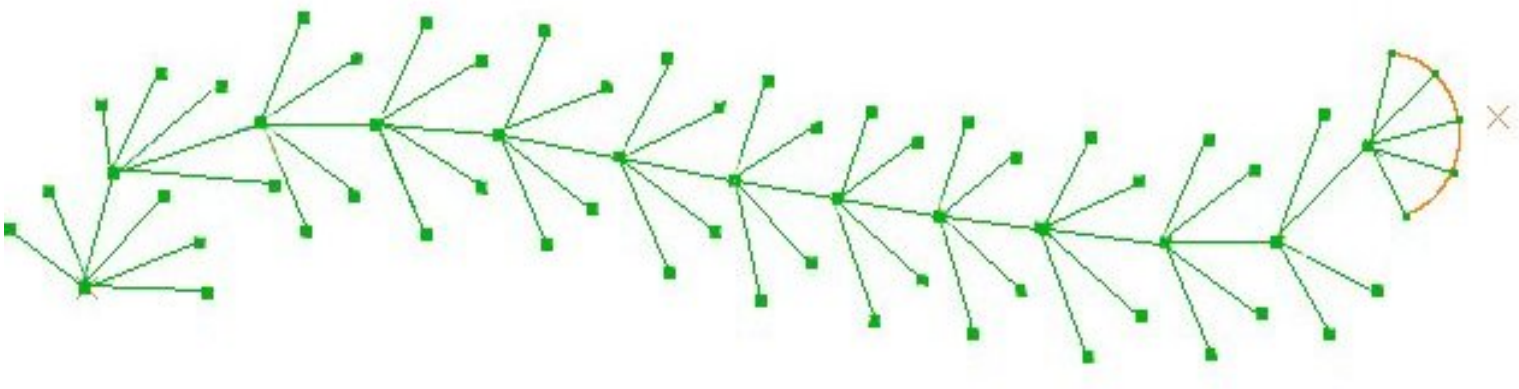

- While there is still unexplored nodes in the tree do
  - Choose a node N from the tree.
  - Update the environment index.
  - Relaunch rays from node N:
    For any light ray if the light beam initially in a media index n1, encounter an environment index n2 with a corner radius i1, it continues with a new angle i2 such that $n1 \sin i1 = n2 \sin i2$.

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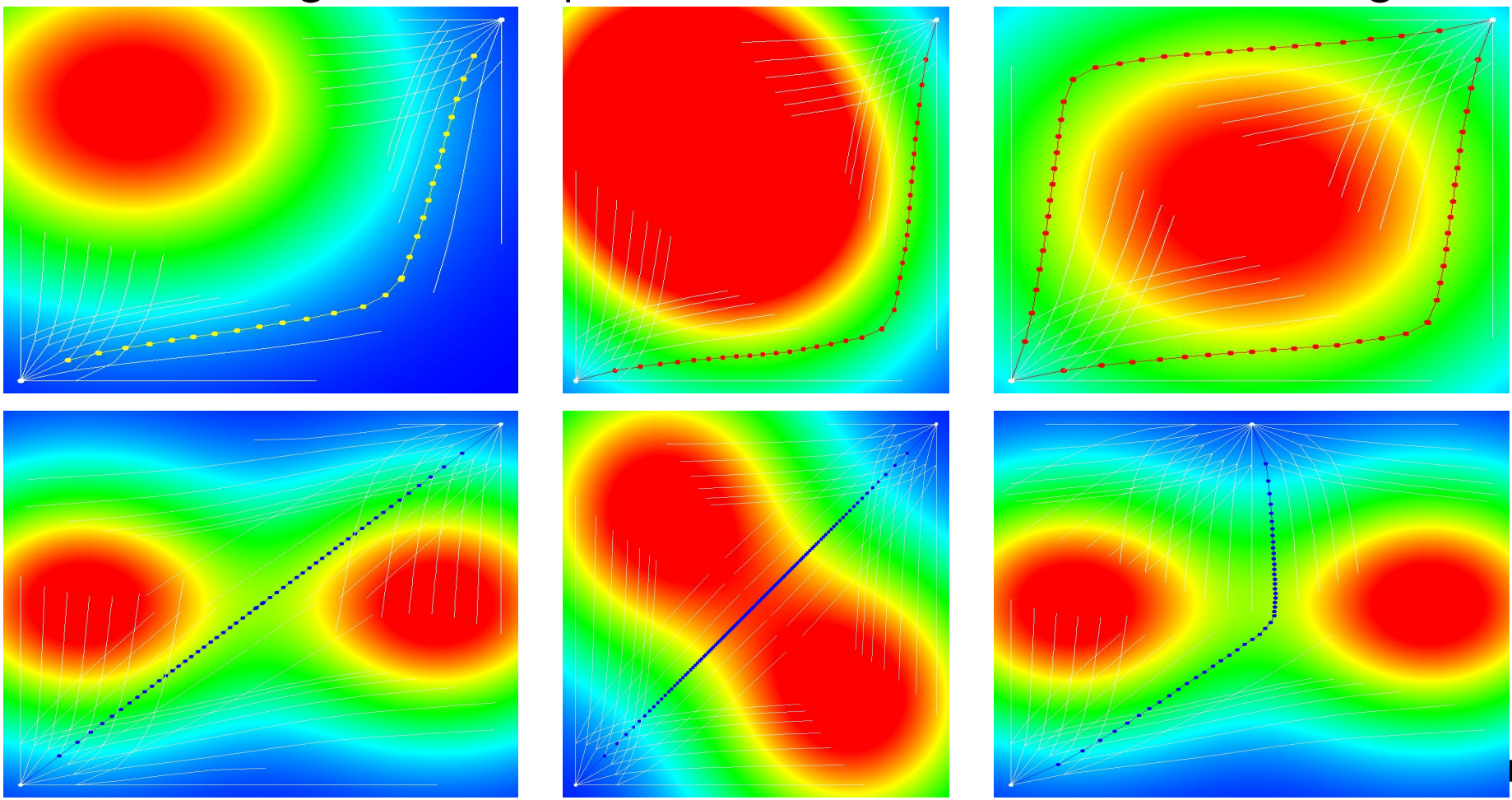
Experimental results

A simplified
version of the algorithm is implemented in 2D with static areas of congestion.



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work in progress (completing the implementation of the algorithm) but promising.

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- Find the value of index such that the corresponding area will act like a barrier $\Rightarrow$ use this index value to model other airplanes,

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- Find the value of index such that the corresponding area will act like a barrier $\Rightarrow$ use this index value to model other airplanes,
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- Find the value of index such that the corresponding area will act like a barrier $\Rightarrow$ use this index value to model other airplanes,
- Allow dynamic congested area,
- Convergence proof of the algorithm,

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Future work

- Find the value of index such that the corresponding area will act like a barrier $\Rightarrow$ use this index value to model other airplanes,
- Allow dynamic congested area,
- Convergence proof of the algorithm,
- Quantitative and qualitative comparison with other method.

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