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The Ultrasonic Polar Scan as a novel non-destructive material characterization technique

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Introduction

Technological advances in materials engineering
→ New and innovative materials such as carbon fiber reinforced polymers (CFRP)

- CFRP's combine high strength with low weight
- Little deformation under temperature loading
- No corrosion (no rust formation)

These properties make CFRP's excellent for usage in industrial environment(Figure 1).

- Aeronautical industry (CFRP's make up to 50% of an airplane)
- Sporting goods (cycling bikes, baseball bats, . . .)
- Automotive industry (structural components of cars)

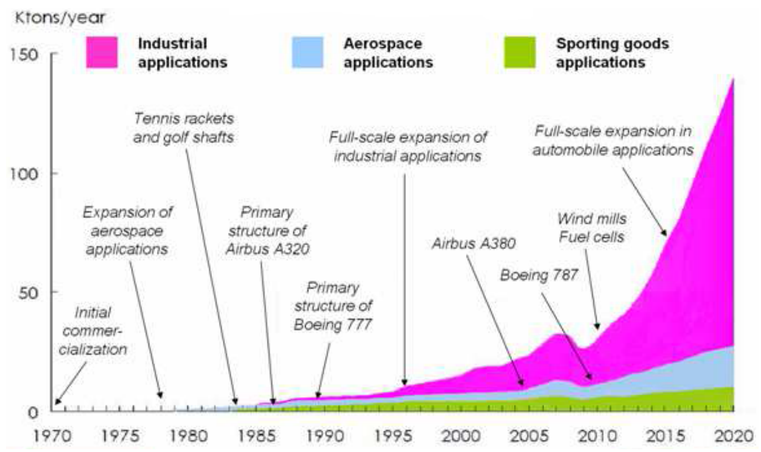


Figure 1: *History and potential evolution of the carbon fiber market [1]*

CFRP's are constructed out of repeating layers 'glued' together. This specific geometry can pose some severe risks and potentially limit their industrial use.

- High degree of material complexity
  → Difficult characterization of material parameters
- Defects invisible to the naked eye
  e.g. individual layers becoming detached, . . .

⇒ Need for efficient non-destructive (NDT) characterization and defect detection techniques

⇒ Novel NDT technique:

The Ultrasonic Polar Scan (UPS)

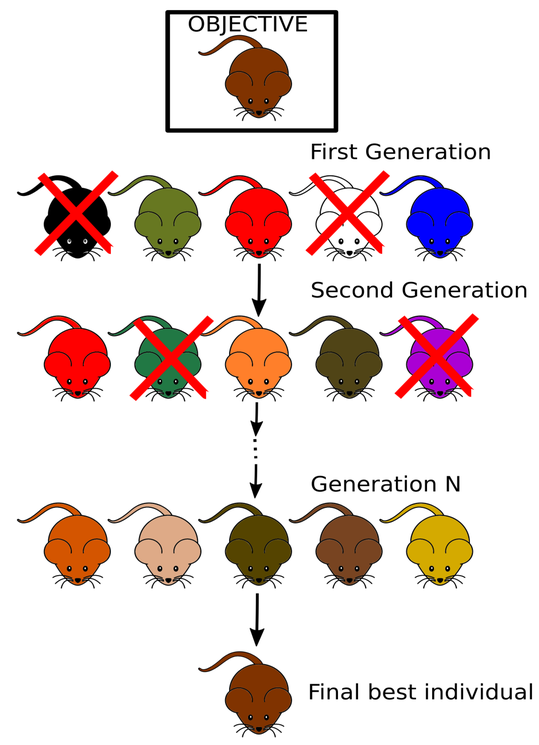
The Ultrasonic Polar Scan: Material Characterization

MATERIAL CHARACTERIZATION ?

FIND: $C_{ij}^{*} = C_{ij}^{R} + iC_{ij}^{I}$

$$(C_{ij}^{*}) = \begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{22} & C_{23} & 0 & 0 & 0 \\ C_{13} & C_{23} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{pmatrix}$$

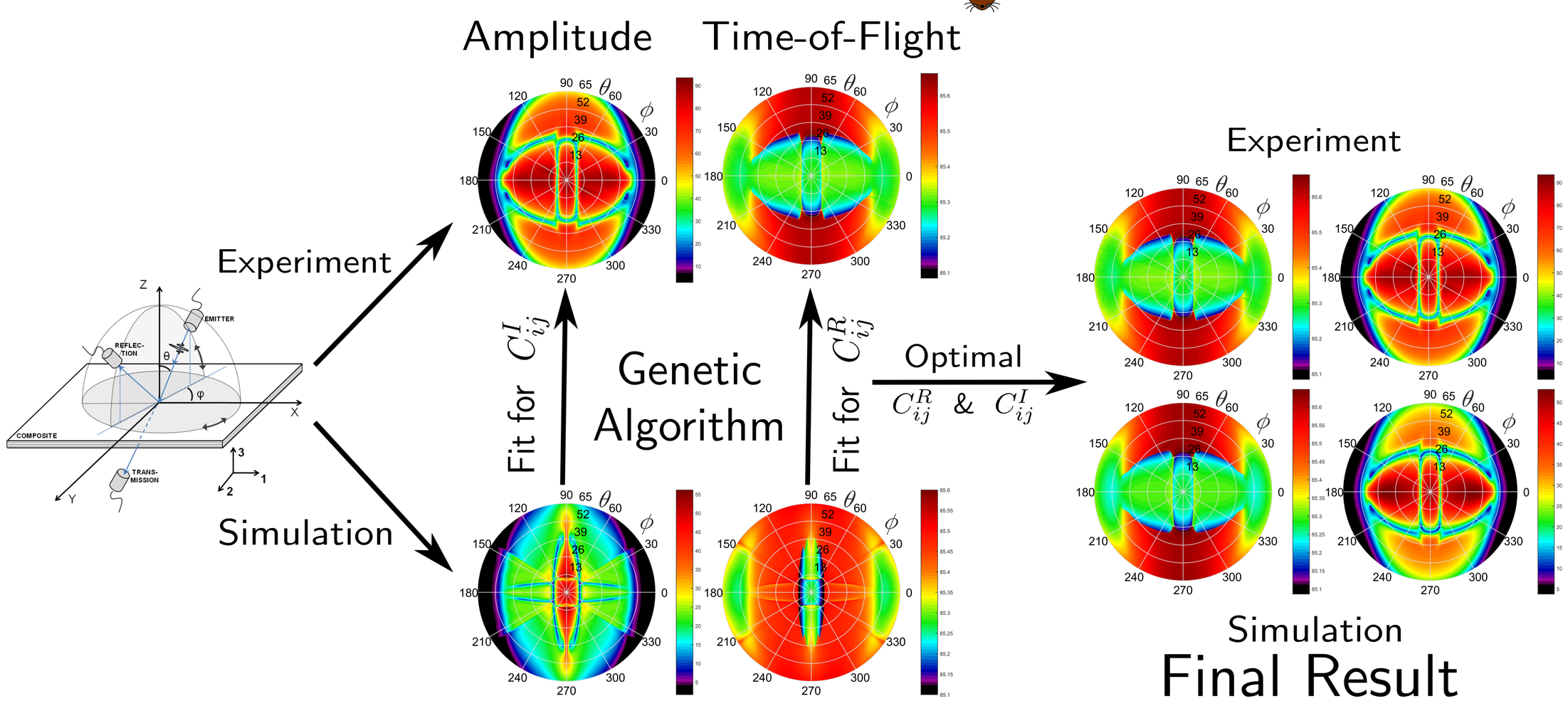
GENETIC ALGORITHM



HOW TO FIT?

- C_{ij}^{*} values → Colors of mice
- Dark brown colored mouse is the objective

1. First generation of mice with random variation of colors → From these select the mice having the most brown-like shades → Parents of second generation
2. Parents reproduce to make a second generation of browner colored mice
3. After several generations most mice have a brownish color
4. In the end, the intended colored mouse is found



[1] SEII European Society for Engineers and Industrialists. International colloquium on composite materials, 2015.

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