Phase 3 Presentation

COEN / ELEC 490

A Tool for Global Motion Estimation and Compensation for Video Processing.

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Contents

- Introduction to video processing and to GME.
- Modeling.
- Description of three approaches.
- Simulation.
- Comparison between the three approaches.
- Encountered problems.
- Conclusion.

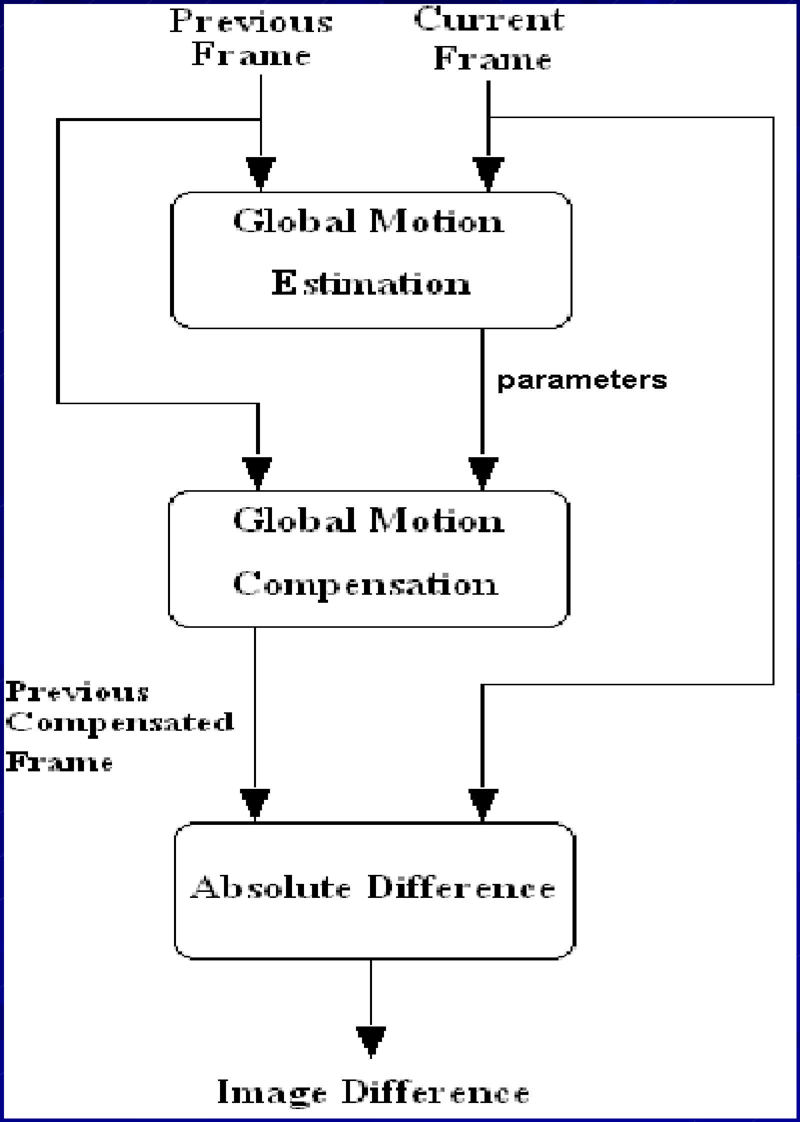
Introduction

- An important research field among multimedia types.
- Large number of applications.
- Consists of manipulation and analysis of visual data.

Recall the objectives

- Realize a tool for global motion estimation and compensation.
- Implement three algorithms of Global Motion Estimation.
- Implement an algorithm of compensation.

Design of our tool



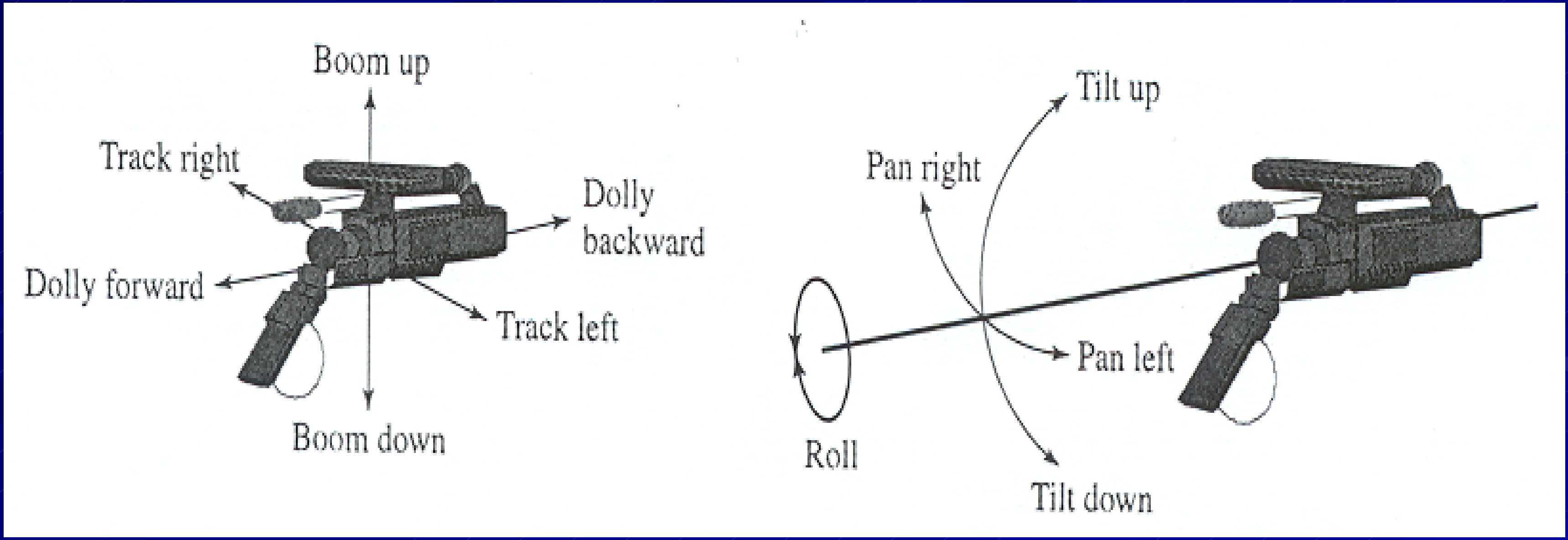
Motion Types

- Local motion:
- Due to individual object motion.

- Global motion:
- Mainly constituted by a camera motion.
- In the presentation, global motion refers to camera motion.

Camera motions

- Track
- Boom
- Dolly
- Pan
- Roll
- Zoom



Introduction to GME (1)

- There are two main global motion estimation approaches.

  - Minimizing the prediction error

  - Finding pixel motion vectors

Introduction to GME (2)

- Difficulties with global motion estimation
  - Global/Local motion
  - Local changes
  - Global changes

Applications

- Compression
- Video surveillance
- Video retrieval and database

Modeling (1)

- The affine motion model is defined by six parameters as follows:

$$x' = a_0 + a_1 x + a_2 y$$
$$y' = a_3 + a_4 x + a_5 y$$

a_0, a_3: translation

a_1, a_2, a_4, a_5: rotation and zooming

Modeling (2)

- To get the parameters:
  - Minimize the sum of square differences (SSD).

$$\sum_{x,y\in R}(I(x,y)-I'(x',y'))^2$$

I: current frame.

I': motion compensated previous frame.

  - Minimize the sum of absolute differences (SAD).

$$\sum_{x,y\in R}\left|I(x,y)-I'(x',y')\right|$$

Solution Approaches

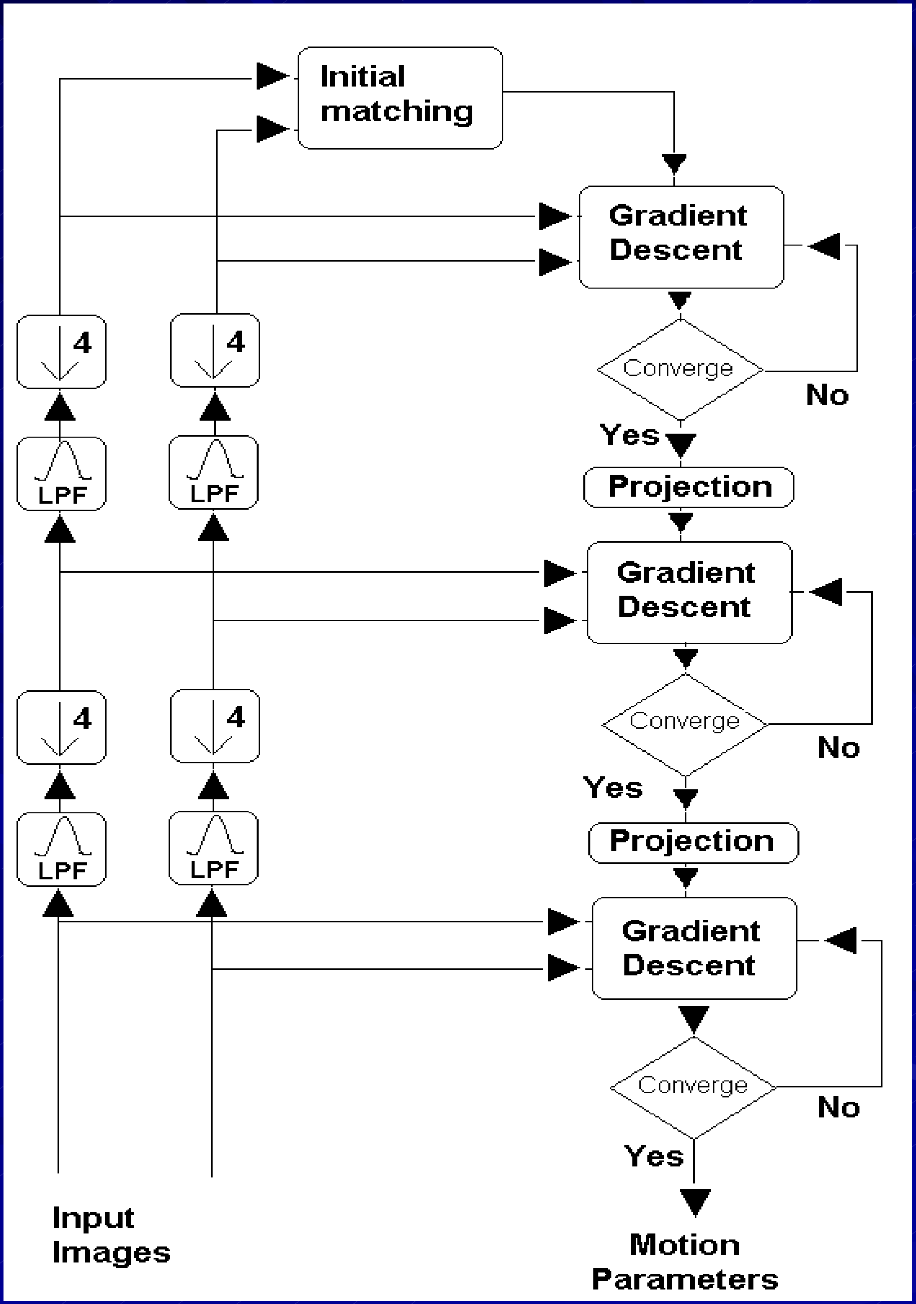
- GME technique using a three-level hierarchical implementation.
- Improved GME using prediction.
- Real time GME using feature tracking.

GME using hierarchical implementation and gradient descent

- The technique is designed to minimize the sum of square differences.
- Three-level hierarchical implementation.
- The algorithm consists of three stages.

Block diagram of the technique

- Input images.
- Low-pass image pyramid.
- Initial matching.
- Gradient descent.
- Motion parameters.

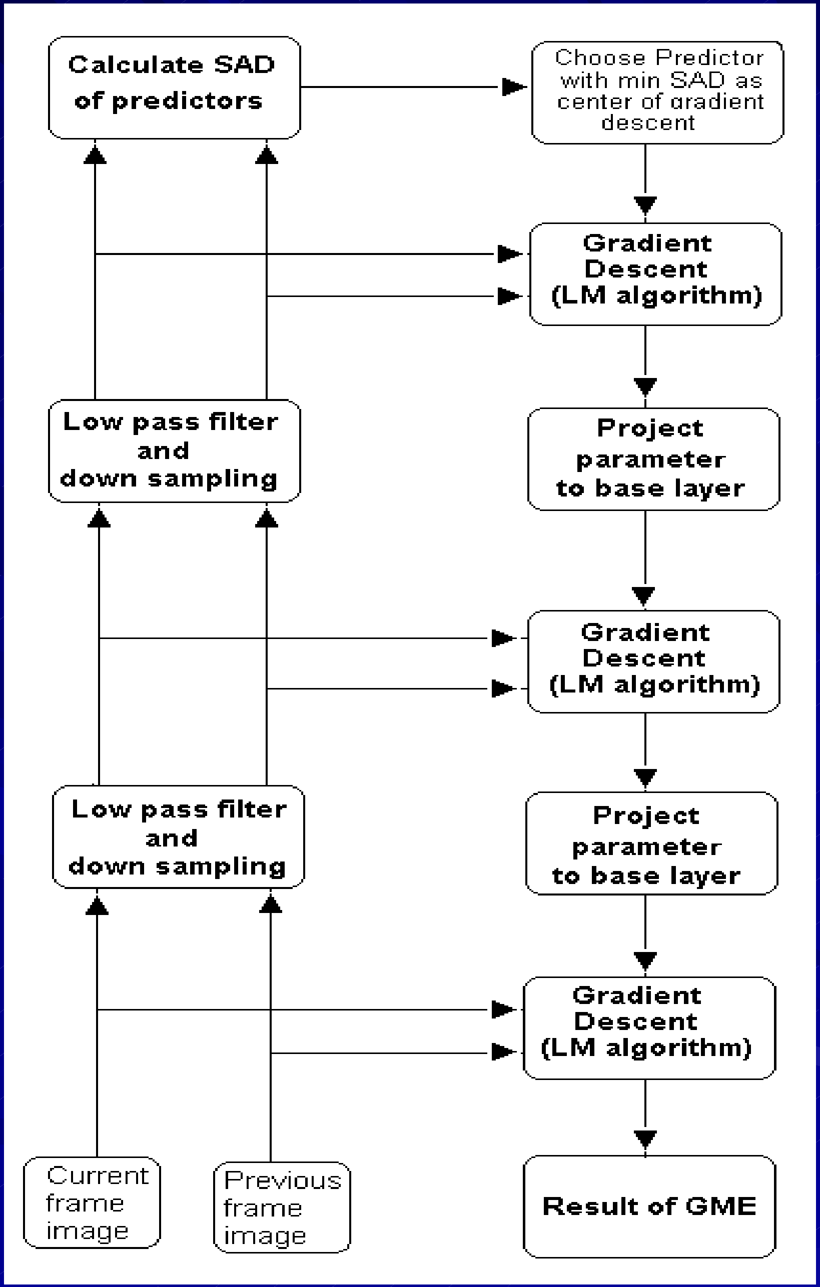


Improved GME using prediction

- Based on the first algorithm
- Uses prediction and early termination.
- The goal is to minimize the sum of square error

Block diagram of the technique

- Input images.
- Low-pass image pyramid.
- Predictors.
- Gradient descent.
- Motion parameters.



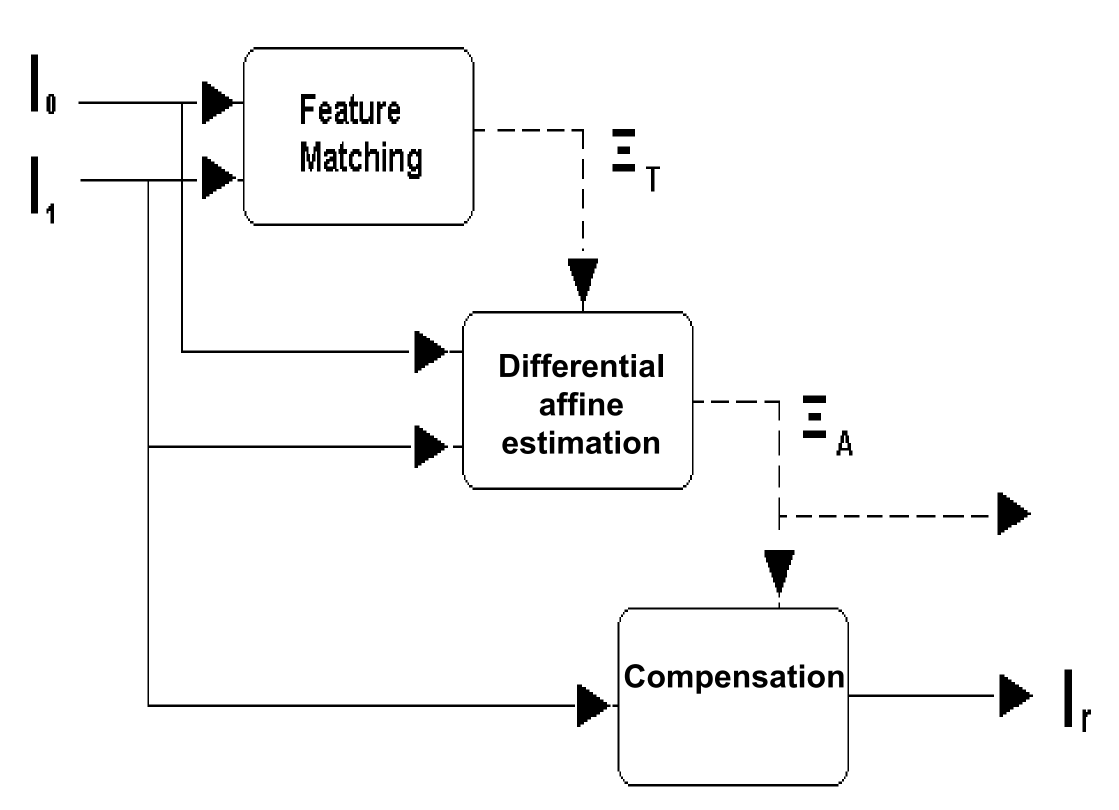
Real time GME using feature tracking (1)

I_0: current image.

I_1: reference image.

E_T, E_A: motion parameters (translation, affine).

I_P: compensated image.



Real time GME using feature tracking (2)

- Feature matching:
  - Feature selection.
  - Feature tracking.
  - Use of a robust M-estimator to get the global translation parameters

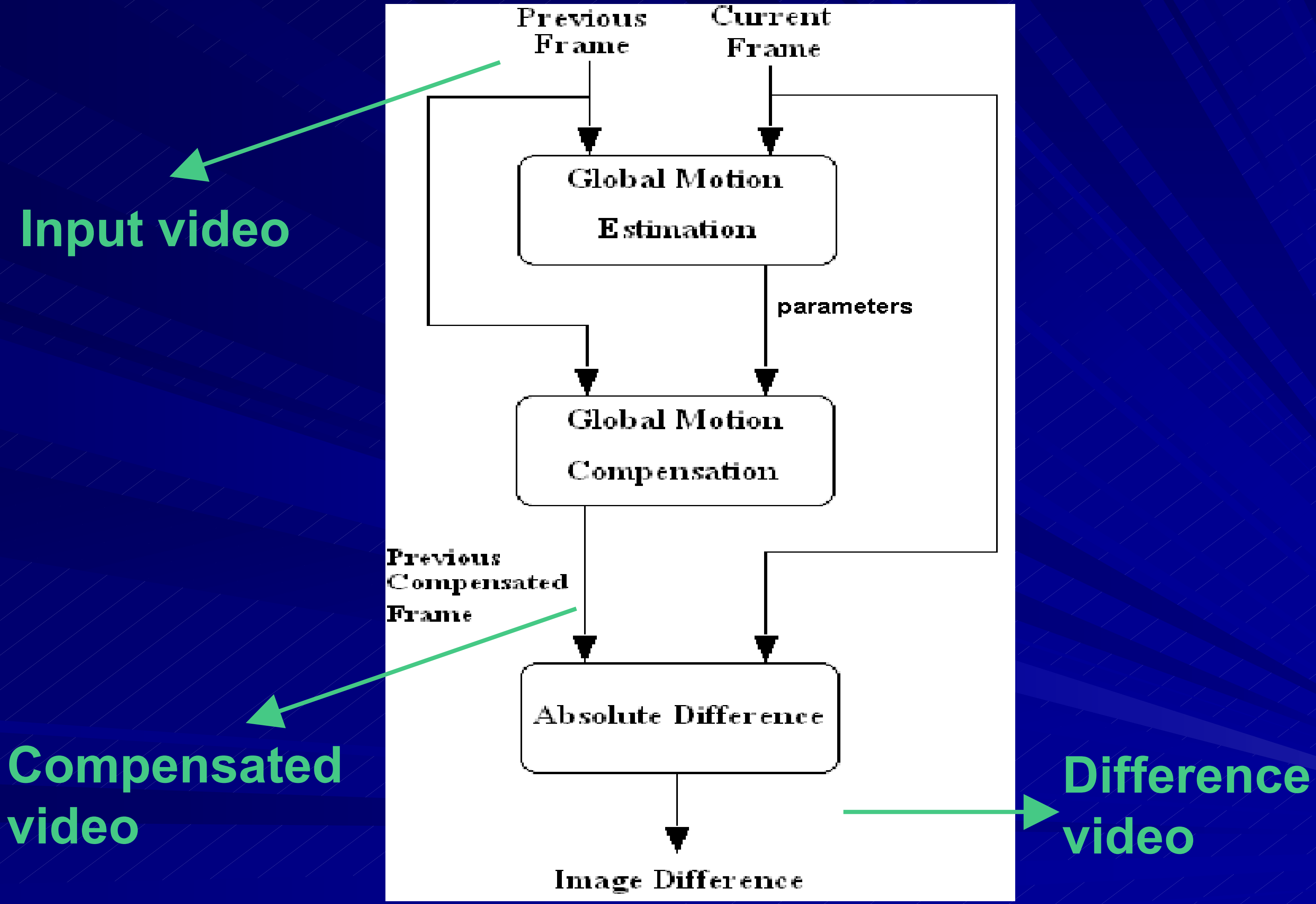
Real time GME using feature tracking (3)

- Differential affine estimation:
  - Use of a robust M-Estimator to minimize the difference:

$$I_1(x, y) - I_0(x', y')$$

  - Iterative Gauss-Newton minimization of the difference.

Design of our tool



Simulation

Comparison: *MAE*

MAE	Car	PrIcar	Tennis	Atp
1st algo	10.9	15.2	7.6	10.12
2nd algo	10.9	15.3	8.7	10.2
3rd algo	11.4	15.4	X	10.6

Comparison: *Speed*

Speed (s/im)	**Car**	**Prlcar**	**Tennis**	**Atp**
1st algo	9.9	6.5	6.9	5.1
2nd algo	3.6	2.2	3	1.9
3rd algo	2.4	2.5	X	2.2

Robustness

- Definition.
- Our algorithms seem to be robust.
- More investigation are needed.

Conclusion

- The second algorithm is fast.
- The feature tracking seems to be a good initial step.
- Future work.

Problems encountered

- Video handling software understanding.
- Linking the software to our code.
- Mathematical implementation.
- Administrative problems (disk quota).

Thank you