Gameplay experience based on a gaze tracking system

M. Perreira Da Silva – V. Courboulay – A.Prigent

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Who are we ?

- **L3i – University of La Rochelle**
  - Computer science, Image and Interaction Laboratory (70 persons)

- 3 Teams : ImagIN, IMeDoc, Sido

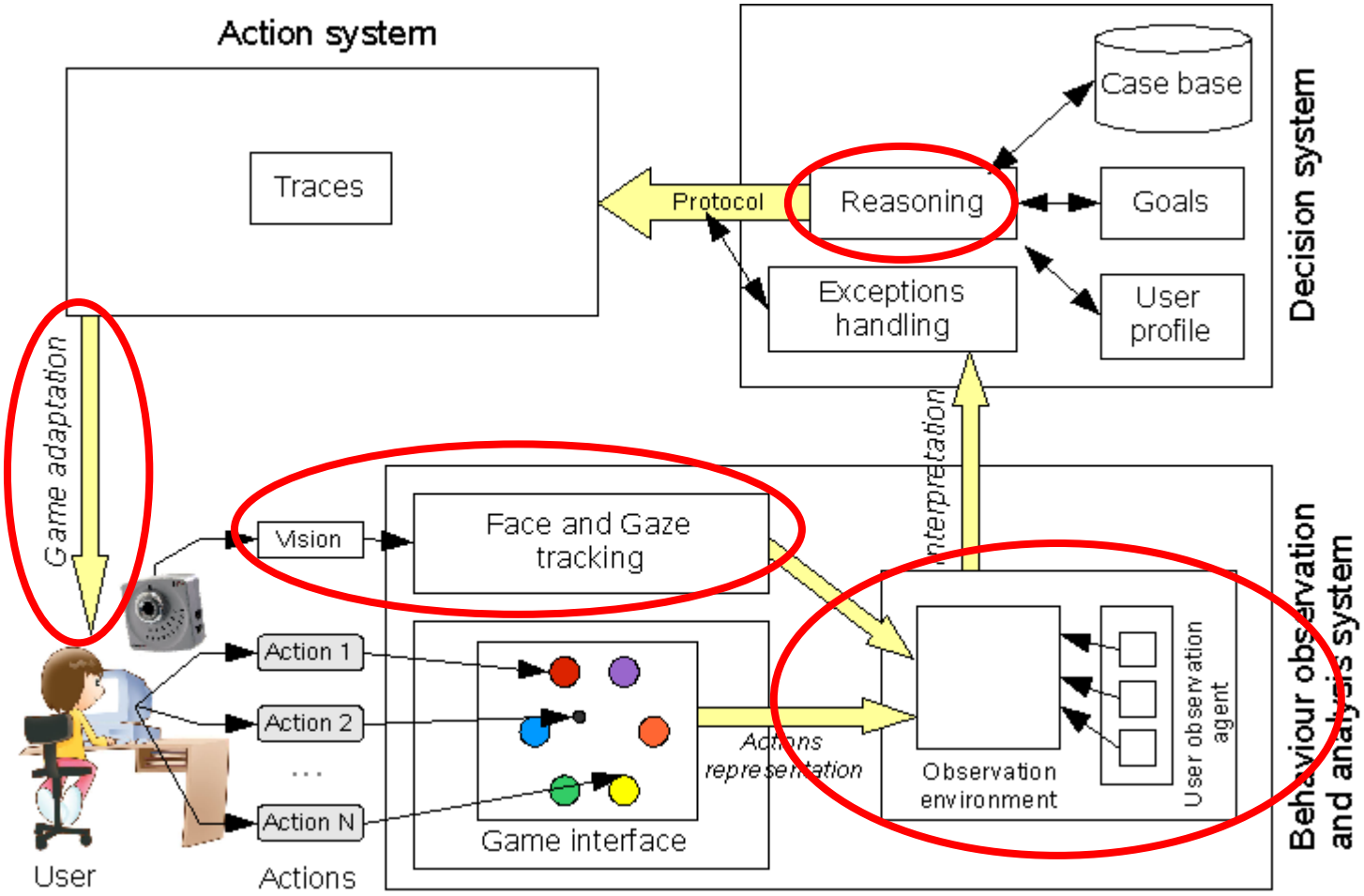
- ImagIN: Image and Digital Interaction Team (25 persons)
  - Conception and Adaptive execution of Interactive Application
    - Image and video analysis (***features extraction, tracking***)
    - Implicit or explicit behaviour analysis (ontology, ***models***)
    - Software engineering for interactive systems (authoring systems, ***interactive application execution control***, narrative quality control)
  - Sub-project : ***Game and Interactivity***

Outline

- General context
  - An interactive application framework
  - Applications
  - *L3i Life*
- A new gameplay
  - What is a gameplay ?
  - Description
- Our solution
  - Interactive storytelling
  - Low cost gaze tracking system
  - Temporal and spacial
- Results
- Perspectives
- Conclusion

General context

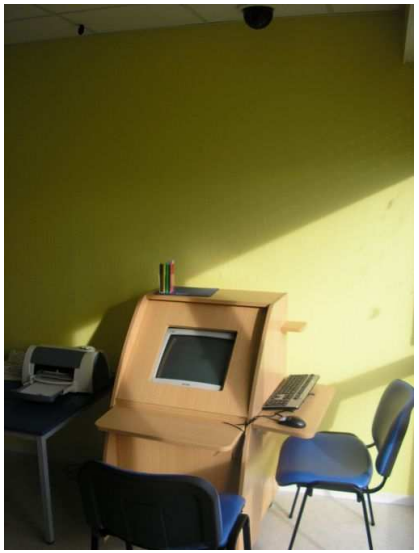
An interactive application framework



General context
Applications

- Games
  - *L3i Life* :
    - 3D adaptive adventure game
    - Evolve in the L3i laboratory

- Assistive technologies
  - *AutiSTIC* project
    - Adaptive educational games for autistic children
  - *RobAutiSTIC* projects
    - Autistic children interaction with an adaptive robot



General context
L3i Life

- The player is a student who must hand his homework in.

- Goals
  - Find his homework CD
  - Print it
  - Give it to the teacher

- Competition against 2 Non-Player Characters
  - The evil student
    - tries to catch the player
  - The little pest
    - tries to steal the player's work
    - tries to give her work before the player

A new gameplay
What is a gameplay ?

- **Definition** (from Wikipedia) : **Gameplay** includes **all player experiences during the interaction with game systems**, especially formal (rule-based) games. Proper use is coupled with reference to "*what the player does*".

- Player-game interaction
  - Non immersive:
    - Keyboard, mouse, joystick, gamepad.
  - Immersive:
    - Gyroscopic devices (Wiimote)
    - Body motion capture (Eyetoys)
    - Head motion capture
      - Control the player's movements
      - **Observe the player's behaviour**

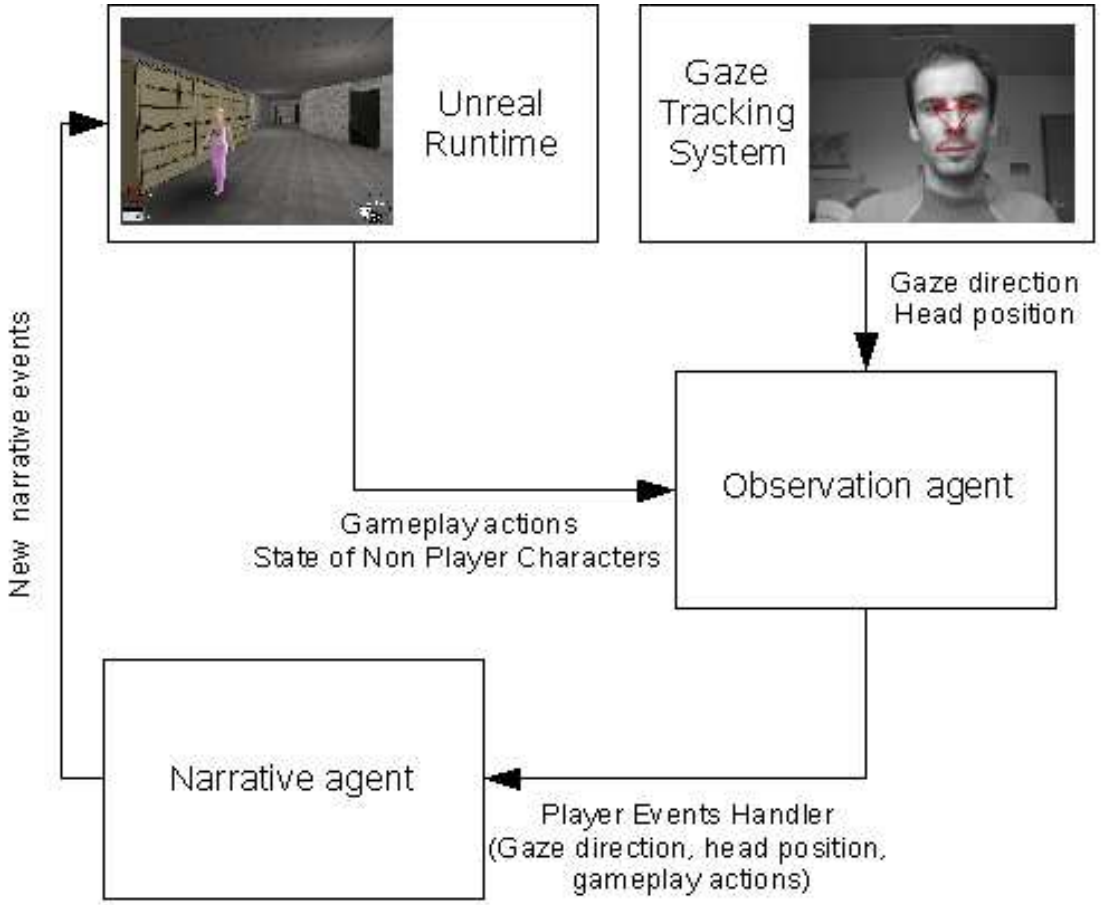
A new gameplay
Description

- Use gaze for human computer interaction
- Does not replace but complements usual input devices (mouse, joypad)
  - Do not use gaze for player's movements
- Improve player's immersion
- Detect implicit and explicit behaviour
  - Explicit: look down, look up, …
  - Implicit: stress, attention, …
- Adapt game unfolding to player's behaviour

Our solution

Interactive storytelling driven by gaze tracking

- Observation agent
  - Captures the player's behaviour
    - Mouse and keyboard inputs
    - Gaze tracking
  - Translate behaviour into player's actions
- Narrative agent
  - Receives players actions from observation agent
  - Controls the game unfolding
  - Controls the parameters of the observation agent



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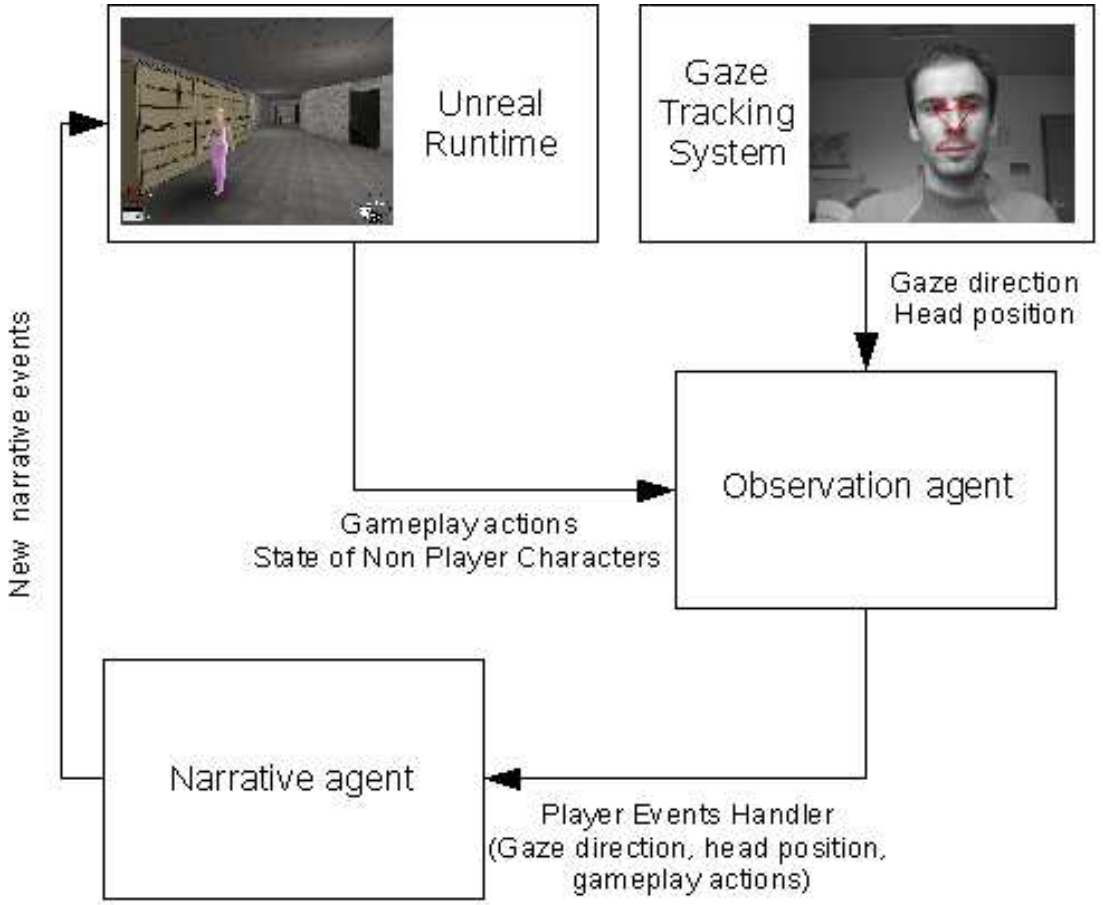
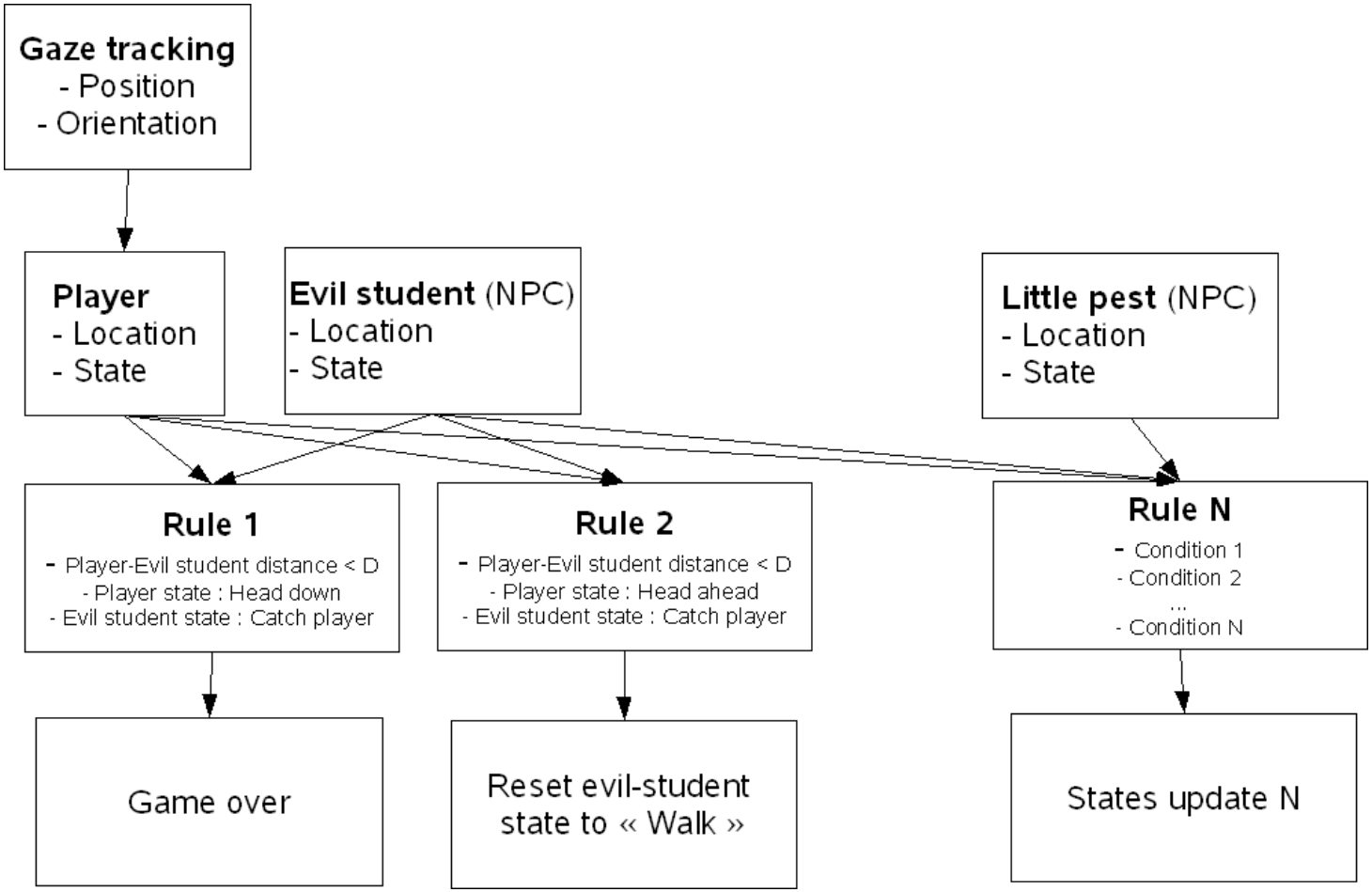


Scenario control

Temporal and spatial context adaptation



Our solution
Low cost gaze tracking

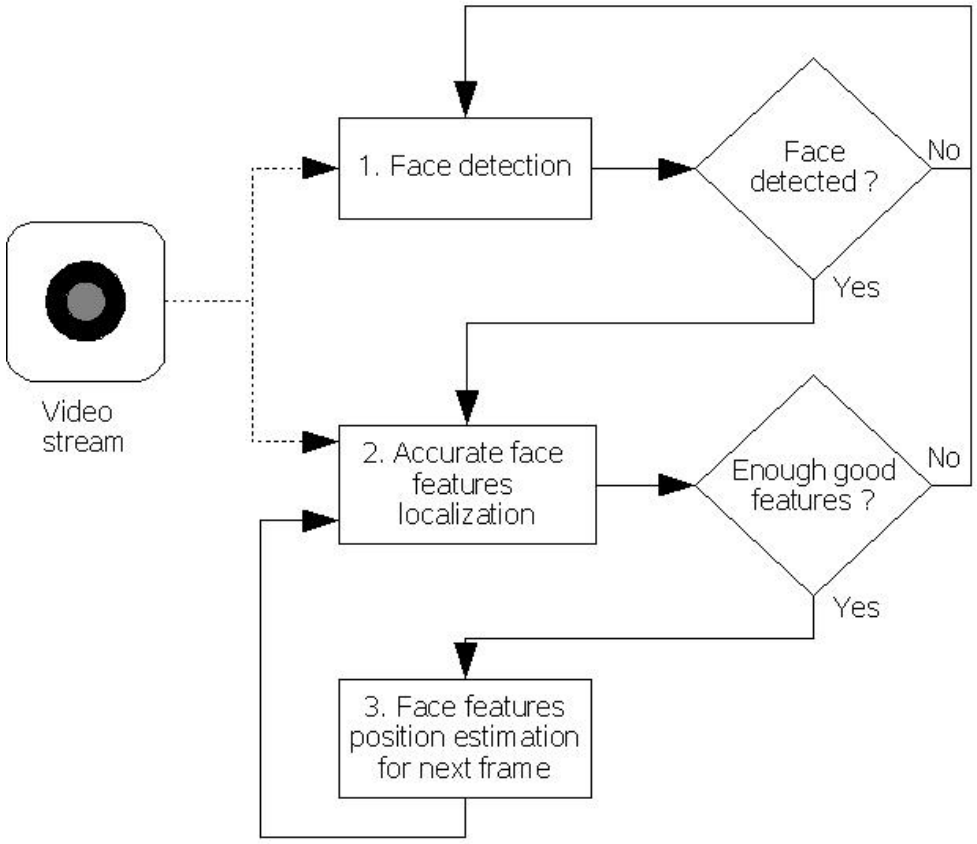
- First experiments done with *Facelab*^{tm}
  - Accurate and robust
  - But expensive

- Development of a low cost face/gaze tracking system
  - Webcam based, no IR lightning
  - Robust
  - Low CPU usage: can run Game and Gaze Tracking in parallel at 30fps on a single PC

Our solution

Low cost gaze tracking architecture

- Face detection
  - Check if a face is present
  - Raw estimate of 2D face and features position
- Face features localization
  - Precise 2D position of features
  - 3D position and orientation of face and gaze
- Position estimation
  - Kalman filtering on 3D positions and orientations
  - Back project to 2D camera plane.



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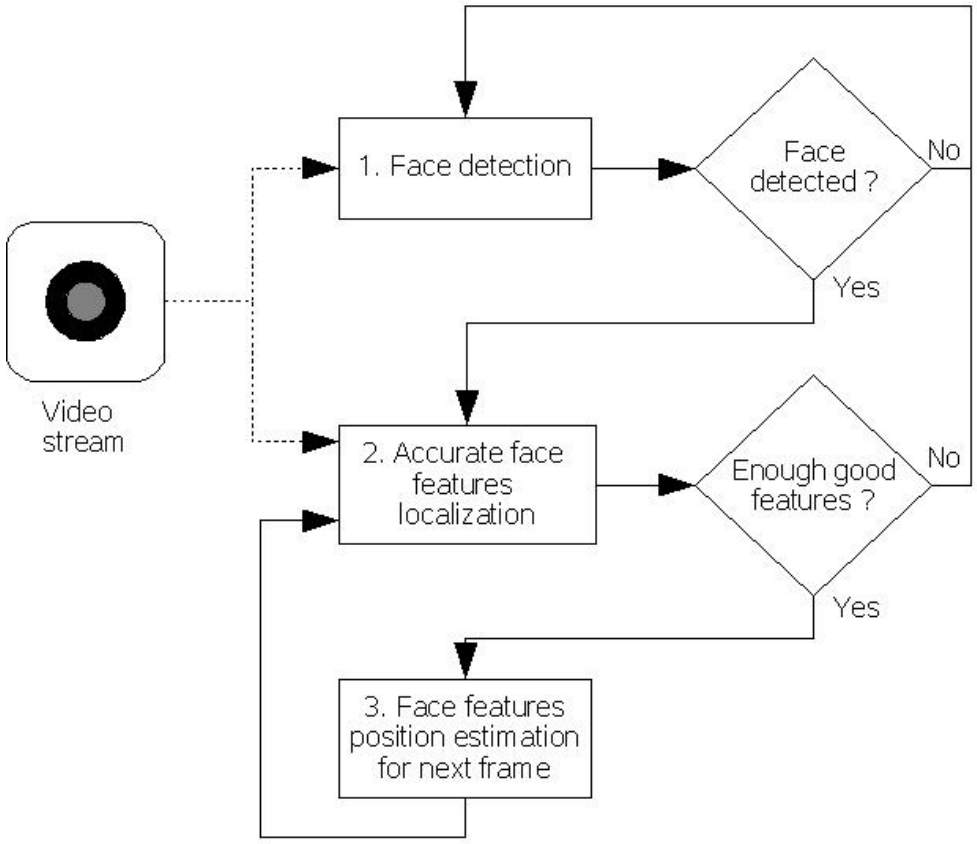

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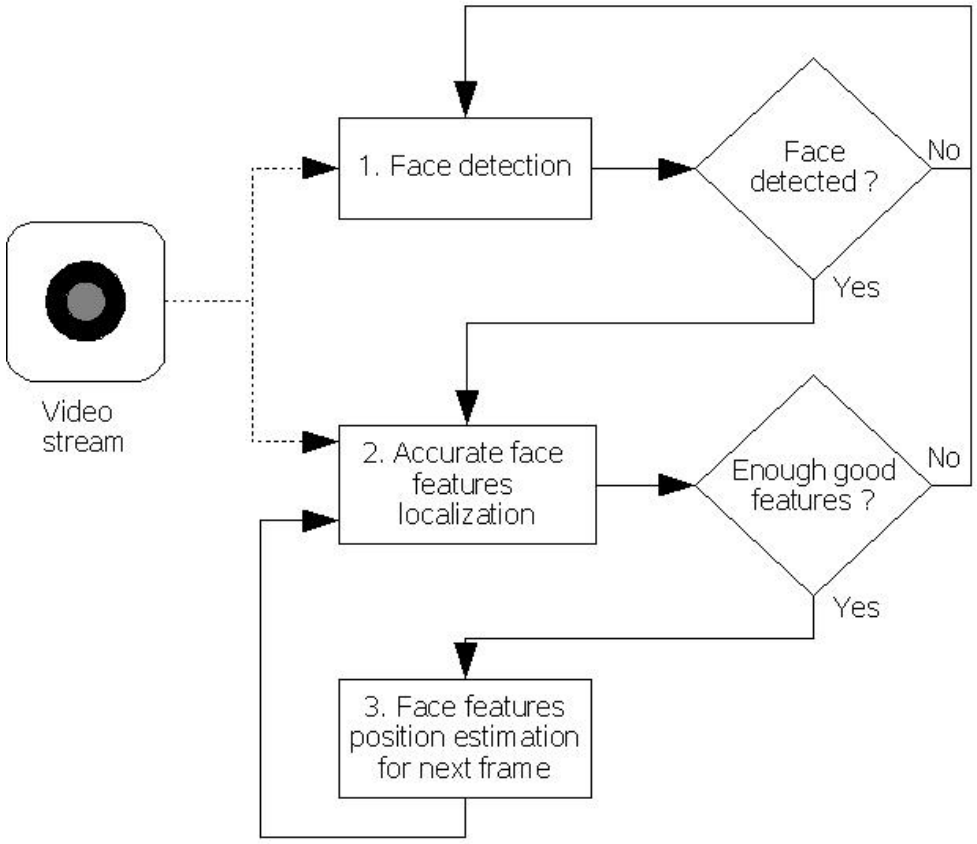
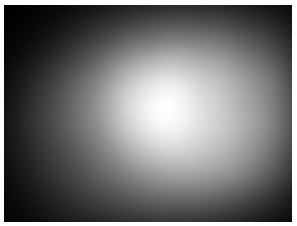


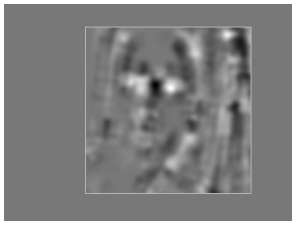
Our solution

Spotlight on real time face detection

- Pre-processing
  - Simple retinal processing



- Large radial symmetry detection
  - multi-radius Hough transform



- Small black radial symmetry detection
  - Optimized Loy & Zelinsky detector
  - Face candidate from eye detection

- DoG and model based face detection
  - Face candidate validation

Results

The evil student tries to catch the player

The evil student is about to catch the player

The player gaze down in order to show his submissiveness

The evil student does not catch the player: Game is not over !

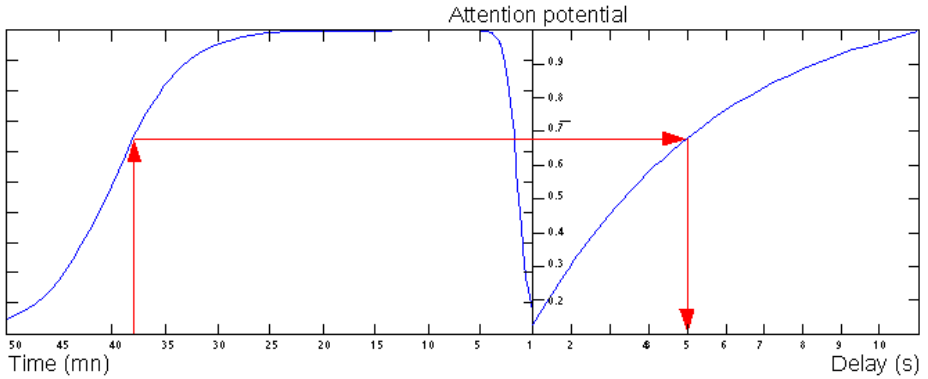
Perspectives

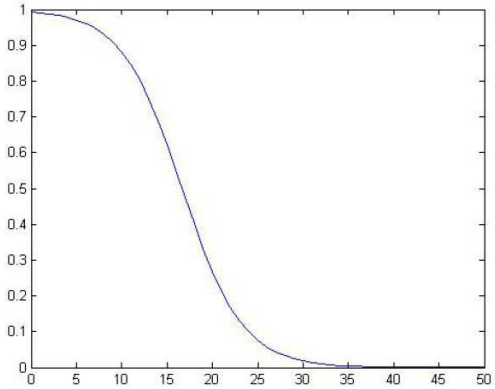
- Improve robustness and accuracy of face/gaze tracking system
- Use more explicit behaviours to improve game immersion
  - answer to “yes/no” questions with head shaking
- Develop models to detect implicit behaviours
  - Stress
  - Attention
    - Simple Model : developed for autistic children attention modeling in the AutiSTIC Project)

Perspectives
A simple model of attention

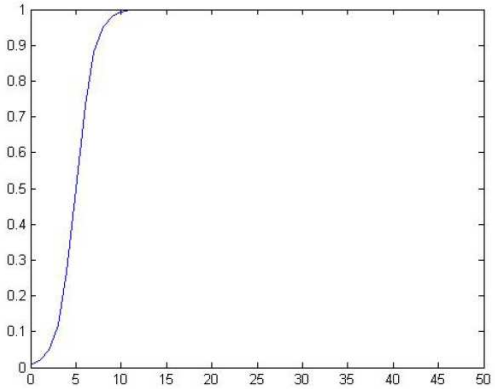
- Time after which attention is lost if user stops looking at the screen:

$$D_{game} = exp^{\gamma(t)*P_{attention}}$$

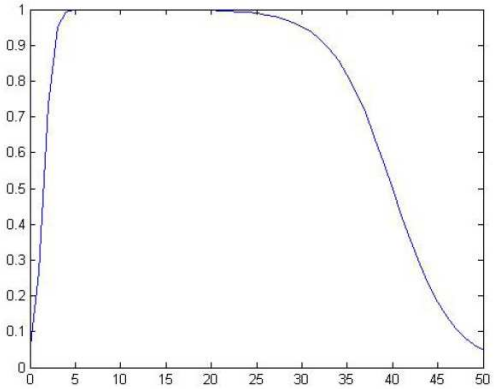




$$P_{tireness} = \frac{\exp^{-\rho_1 t+\rho_2}}{1+\exp^{-\beta_1 t+\beta_2}}$$



$$P_{interest} = \frac{1}{1+\exp^{-\alpha_1 t+\alpha_2}}$$



$$P_{attention} = P_{interest} * P_{tireness}$$

Conclusion

- Game which reacts dynamically thanks to the observation of the player's behaviour
  - Information gathered according to temporal and spatial context
- New kind of interaction improves the player's immersion
- The gameplay is richer, the game is:
  - more interesting
  - more fun to play
- Need to include implicit behaviour for deeper immersion and more adaptive game unfolding