



# University of Twente

Dance Movement Patterns Recognition  
(Part II)

Jesús Sánchez Morales



**University of Twente**  
The Netherlands

# Contents

- Goals
- HMM
- Recognizing Simple Steps
- Recognizing Complex Patterns
- Auto Generation of Complex Patterns Graphs
- Test Bench
- Conclusions

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- **Goals**
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# Goals

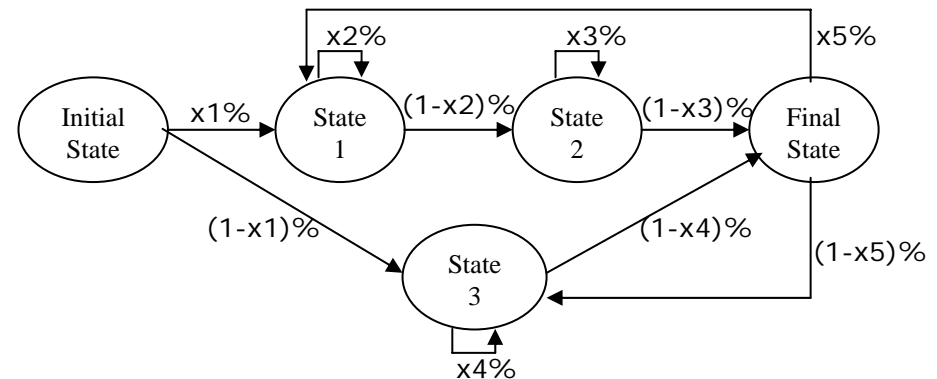
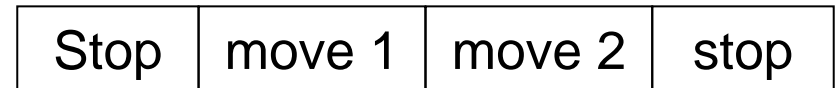
- Recognizing simple user's movements
- Recognizing complex patterns
- Auto generation of reference patterns
- Pattern searching during the dance without any reference

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# Hidden Markov Model (HMM)

- Highly used in Speech Recognition
- We adapted it for our problem
- Data sequences to analyze
- HMM graphs for each recognition
- Viterbi's algorithm



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# Recognizing Simple Steps

- What we understand as being a simple step?
  - Right, left, down, up, jump and twister
- How we divided these recognitions
  - Horizontal
  - Vertical
  - Twister



# Recognizing simple steps (Horizontal)

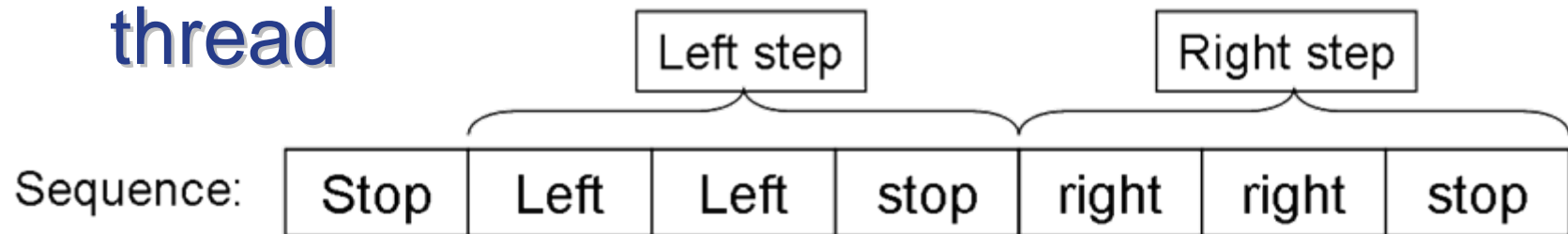
- Recognized steps
  - Left step
  - Right step



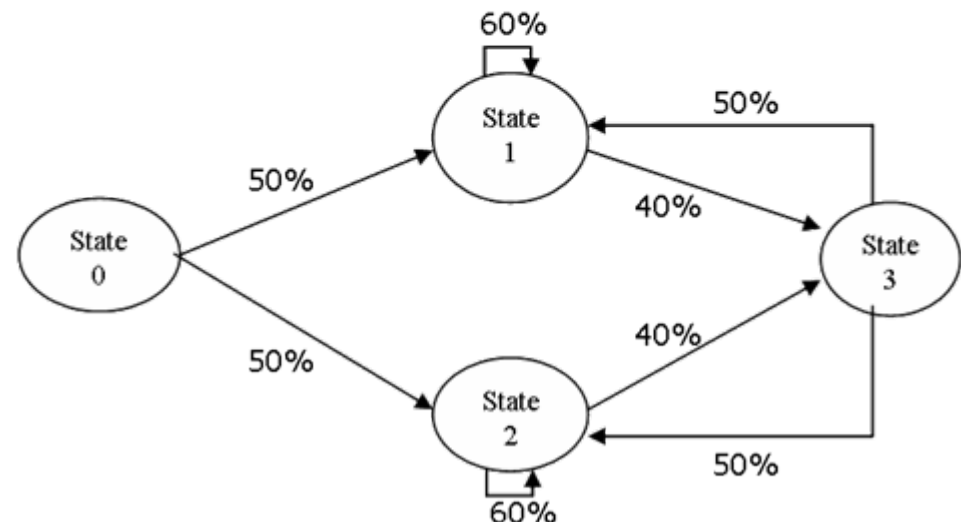
- Used data
  - Horizontal variation of the centre of mass between frames
  - User radius

# Recognizing simple steps (Horizontal)

- Building a sequence and launching a thread



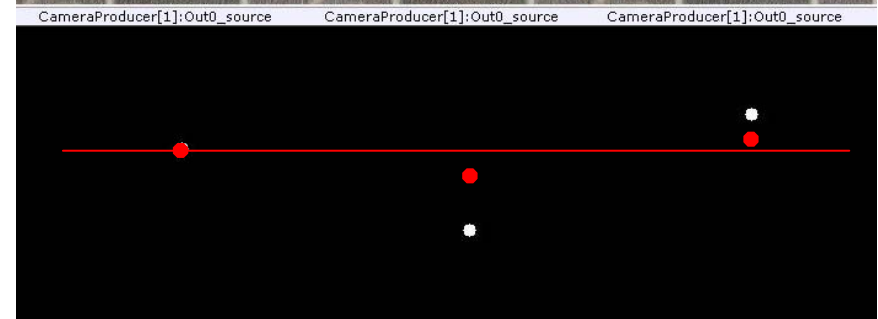
- Markov graph



# Recognizing simple steps (Vertical)

- Recognized steps

- Up
- Down
- Jump



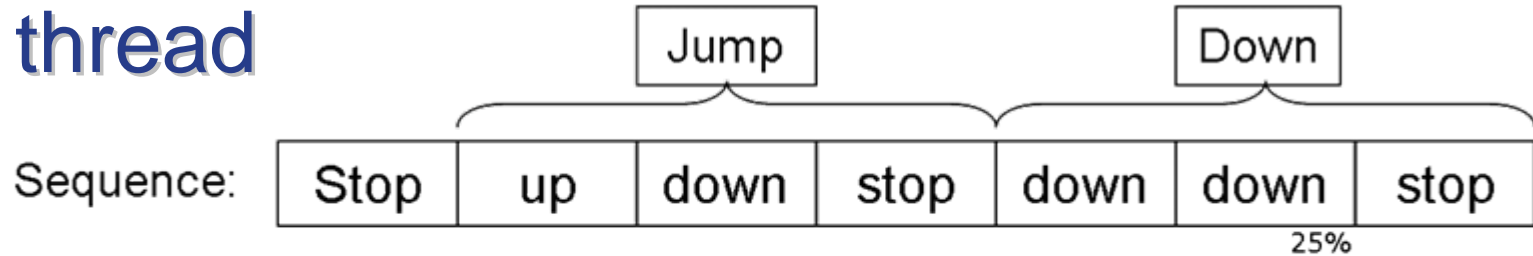
ulateCenterOfMass[4]:Out0\_center-of-mulateCenterOfMass[4]:Out0\_center-of-mulateCenterOfMass[4]:Out0\_center-of-m

- Used data

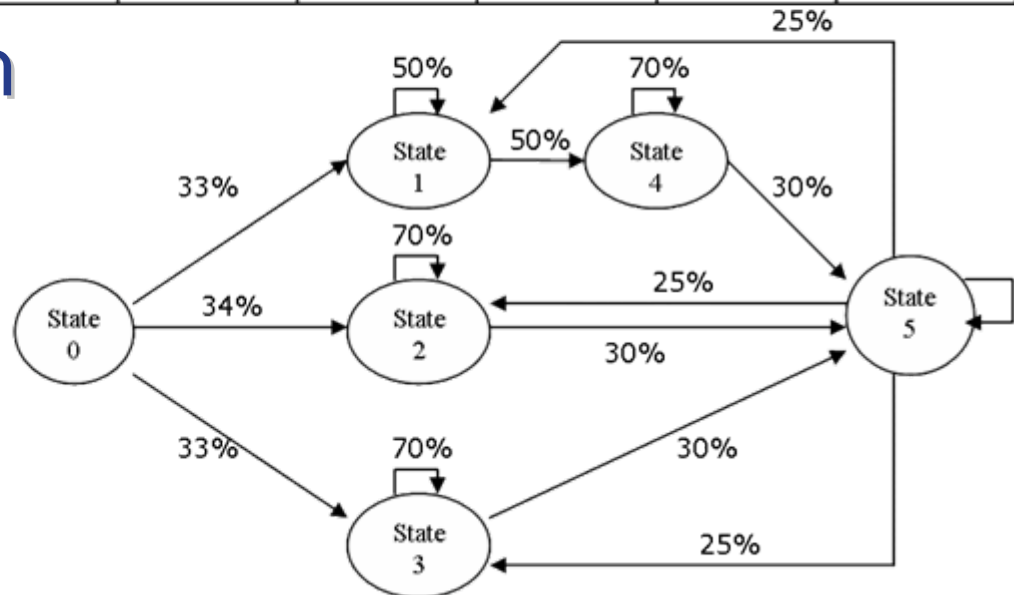
- Vertical position of the centre of mass
- Vertical average position of the centre of mass
- User radius

# Recognizing simple steps (Vertical)

- Building a sequence and launching a thread

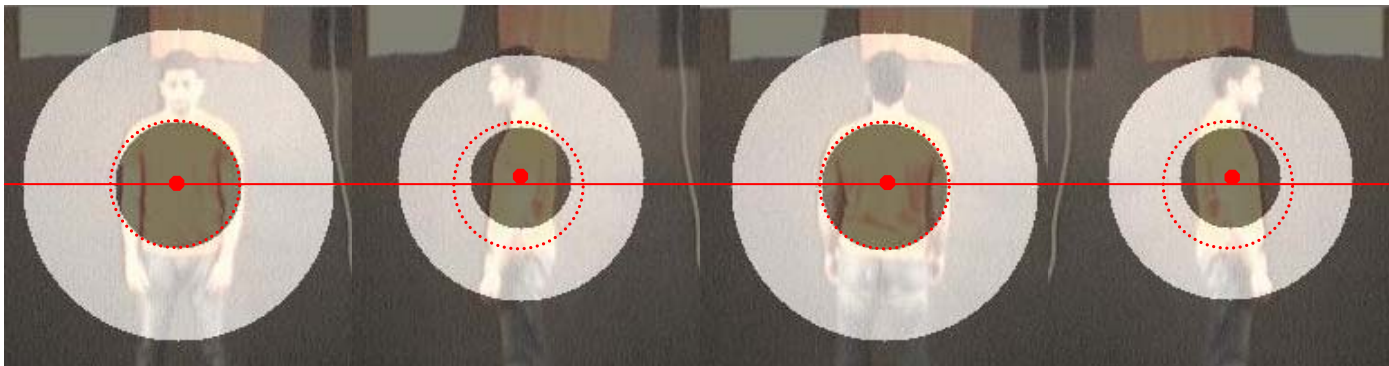


- Markov graph



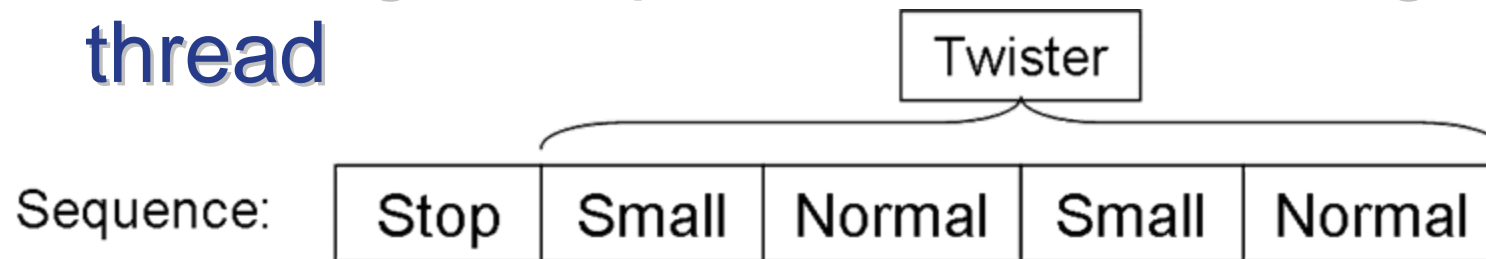
# Recognizing simple steps (Twister)

- Recognized steps
  - Twister
- Used data
  - User radius
  - Average radius
  - Horizontal and vertical position of the centre of mass

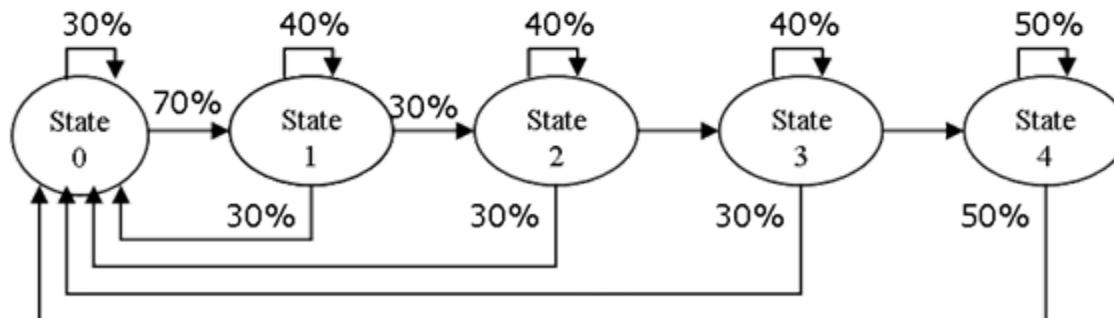


# Recognizing simple steps (Twister)

- Building a sequence and launching a thread



- Markov graph



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# Recognizing Complex Patterns

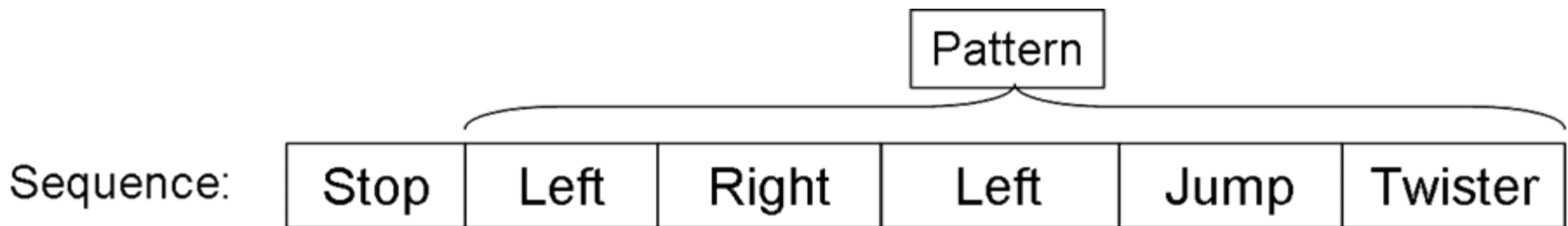
- What we understand as being complex pattern?
  - Combinations of simple steps  
Left Step + Right Step + Left Step + Jump + Twister + ...
- What we receive from the simple step recognition
  - Step code
  - Duration
  - Step time

Left Step
Code: 11
Duration: 3 frames
Time: second 54

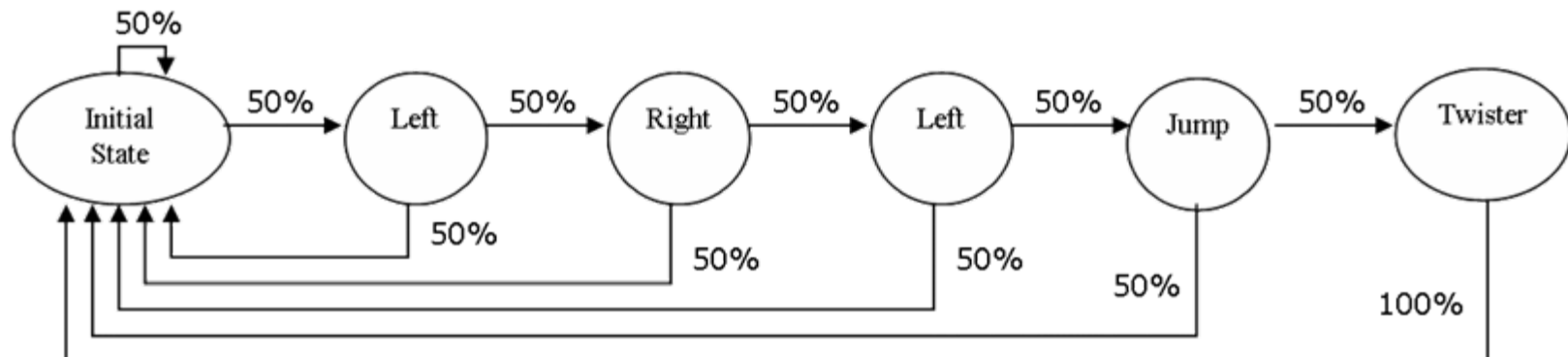


# Recognizing Complex Patterns

- Building a sequence and launching a thread



- Markov Graph



# Contents

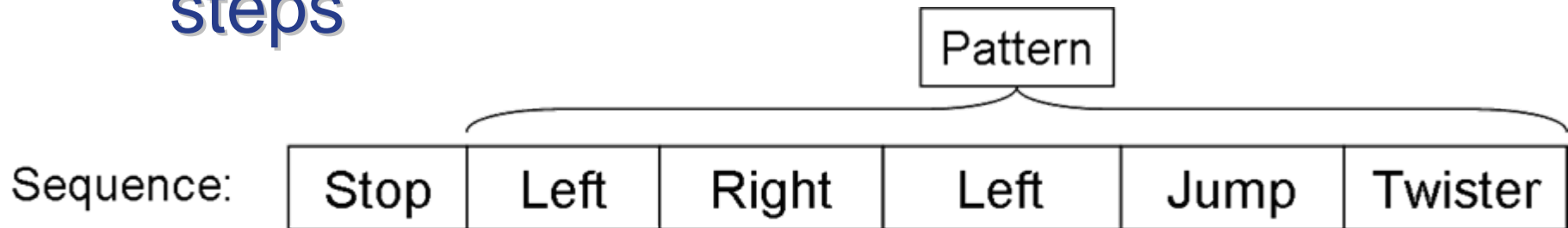
- Goals
- HMM
- To Recognize Simple Steps
- To Recognize Complex Patterns
- **Auto Generation of Complex Patterns Graphs**
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# Auto Generation of Complex Patterns Graphs

- Easy way of building graphs for complex patterns recognition
- Included in the pattern recognition
- Saved as a text file

# Auto Generation of Complex Patterns Graphs

- We receive the sequence of simple steps



- We build the graph for the recognition

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# Test Bench

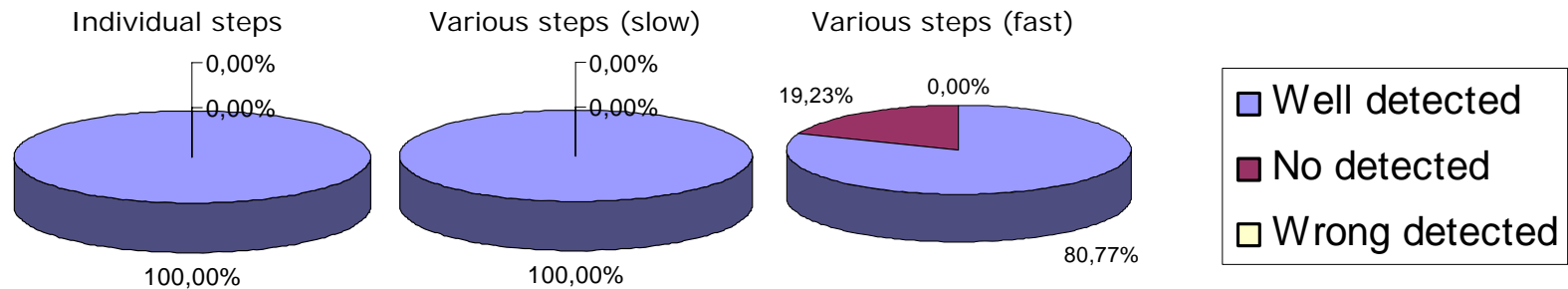
- Test setup
  - Good external conditions
  - Real time tests - 210 steps
  - Possible results for each test
    - Well detected
    - Wrong detected
    - Not detected

# Test Bench

- Test organization
  - Horizontal recognition
  - Vertical recognition
  - Twister recognition
  - Complex pattern recognition

# Test Bench (Horizontal recognition)

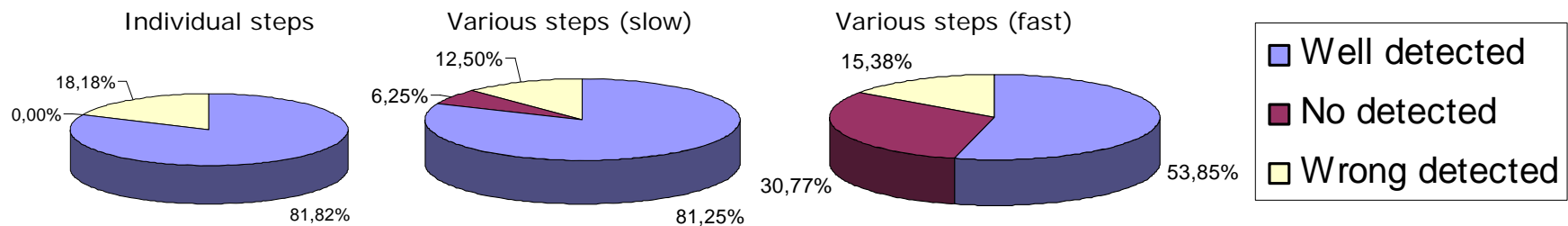
- High success rate
- No wrong detections
- In case of fast dance some steps get lost





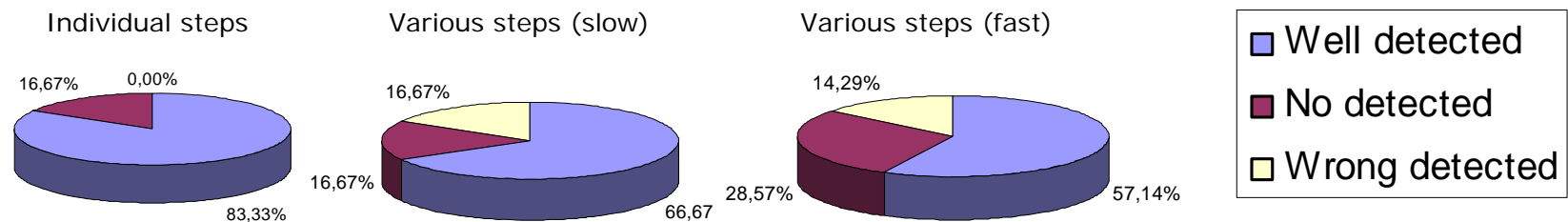
# Test Bench (Vertical recognition)

- Very good individual step recognition
- Slow dance tests: some recognition problems
- Fast dance tests: recognition performance decreases



# Test Bench (Twister recognition)

- High recognition performance for steps separately taken
- Slow dance tests: start having major detection problems
- Fast dance tests: many steps are mixed



# Test Bench (Complex pattern)

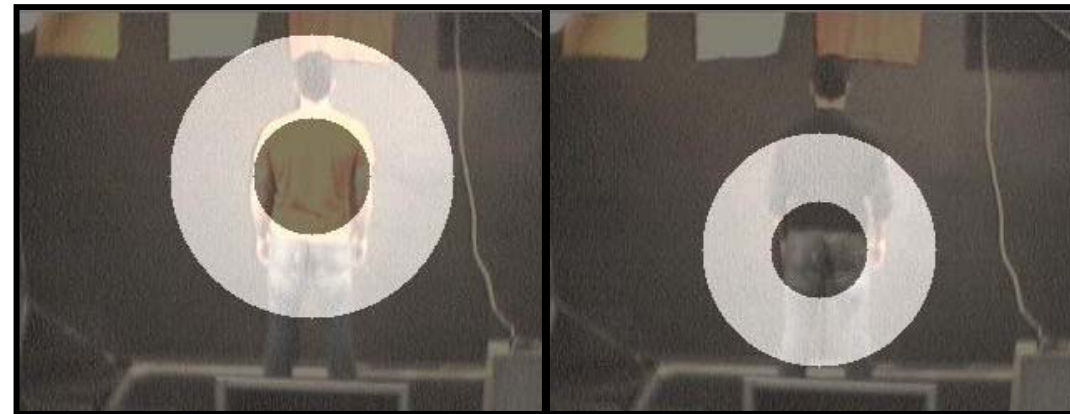
- Perfect recognition performance for steps separately taken
- No concrete pattern to analyze
- Inherit problems
  - Wrong simple step recognition
  - Too slow simple step recognition
  - Wrong received order

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# Conclusions (Difficulties encountered)

- Clothe variations
- Unknown frame rate
- Similarities in the vertical movements
- User radius variation due to arms movements
- Failed complex pattern recognition due to wrong order in simple movements recognition



# Conclusions (Possible improvements)

- Visual detection
- Use of the data from the “dance dance revolution pad”
- Relating the beat detector with the user recognized steps
- Detection of other simple movements
- Development of a learning algorithm to improve the HMM graphs

# Conclusions (Reached goals)

- We have found a good technique to recognize body movements
- In some cases the results have not been as good as we hoped but we think that can be improved
- This technique is also valid to detect more complex patterns
- We easily generate complex pattern graphs
- It has not been possible to search patterns without reference



**Thank you very much !**