VERITAS project

FP7 247765

User requirements: Benchmarking of existing tools

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BENCHMARKING OF EXISTING MODELS, STANDARDS AND PROBLEMS

MAIN ACTIVITY

- Identify initial framework regarding the **existing approaches towards the modeling** of the targeted beneficiaries:
  - older people
  - people with disabilities user groups
- Modeling of physical impairments:
  - Motor impairments
  - Visual impairments
  - Speech and hearing impairments
- Modeling of cognitive impairments
- Modeling of behavioral and psycological states

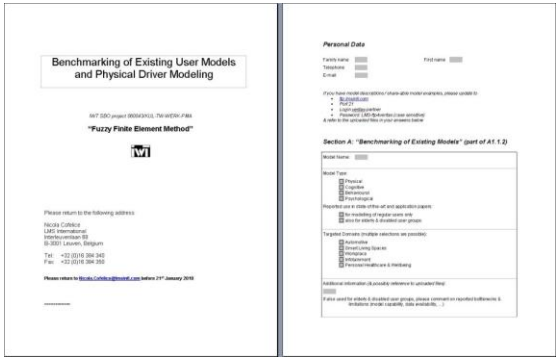
COLLECT INFORMATIONS

LMS PROPOSED A TEMPLATE (ACCEPTED BY INVOLVED PARTNERS)

- **A1.1.2**. Benchmark of *existing models, standards and problems*
- **A1.3.1**. Report on the study of the state of the art of *physical models*
- **A1.4.1**. Report on the study of the state of the art of *cognitive models*
- **A1.5.1**. Report on the study of the state of the art of *behav. and psyc. models*

STRUCTURE OF THE DOCUMENT

- General information about the model
  - (name, modeling methodology, experience of the reviewer with it, etc…)
- Description of the model for each targeted domain
  - (automotive, workplace, etc..)
- Reported use in state-of-the-art and application papers
  - (journal, user manual, thesis, etc…)
- Use of the model for elderly & disabled user groups
  - (strong points & bottleneck)
- Reference standard and simulation algorithm
- Principle for physical, cognitive, behavioral and psychological modeling



BENCHMARK OF EXISTING TOOLS FOR MOTOR & VISION IMPAIRMENTS

Motor and Vision Impairment

24 models analyzed

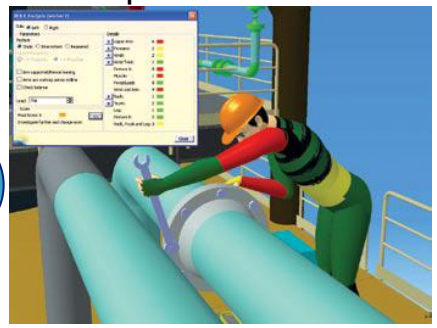
Almost 100 references analyzed

		Model name	Automotive	Smart Living Space	Workplace	Infotainment	Healthcare	Other
VR	Graphic render	ARGOSY					●	
		BLENDER				●		
		MAKE HUMAN				●		
	FK + IK	RAMSIS	●					
		DELMIA	●		●	●		●
		ENOVIA	●		●	●		●
		MAYA	●			●		●
		NX HUMAN	●	●	●			●
		JACK	●	●	●			●
VIDEO CAPTURE		MOTEK				●	●	
		CONTEMPLAS					●	
		VISUAL 3D					●	
		VICON	●	●		●	●	●
MBS	ID	ANYBODY	●		●		●	●
	FD + ID	OPENSIM				●	●	
		SIMM				●	●	
		MODEL from University CALIFORNIA				●	●	
		LIFE MODELER	●	●	●	●	●	●
	FD	MADYMO	●					●
		VL VIRTUAL DUMMY	●					
FE	FK + FD	ALTAIR	●					
		ABAQUS	●					
		LS-DYNA	●					
		PAM SAFE	●					

PHYSICAL MODELING APPROACHES FOR MOTOR IMPAIRMENT (1)

Virtual Reality

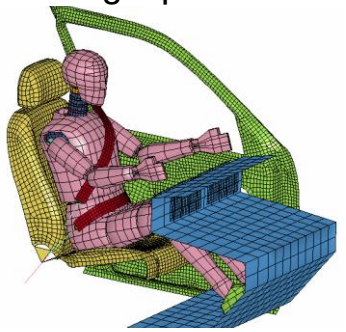
- Ergonomic studies & Posture prediction
  - Anthropometric database



3D

Finite Element Modeling (FEM)

- Crash test & comfort assessment
- Complete or single part human body model

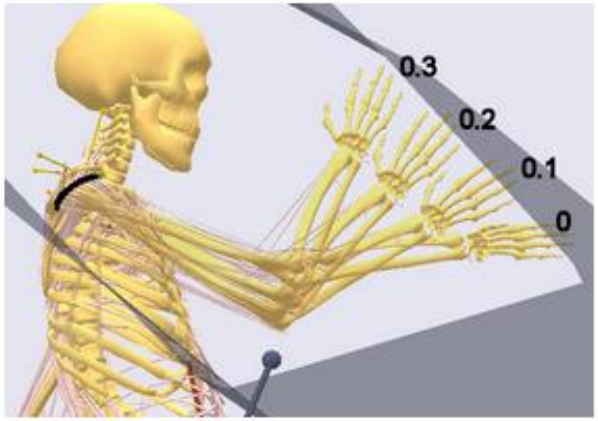


3D

4 Techniques

Multi-body Simulation (MBS)

- Forward/Inverse Kinematic/Dynamics Simulation



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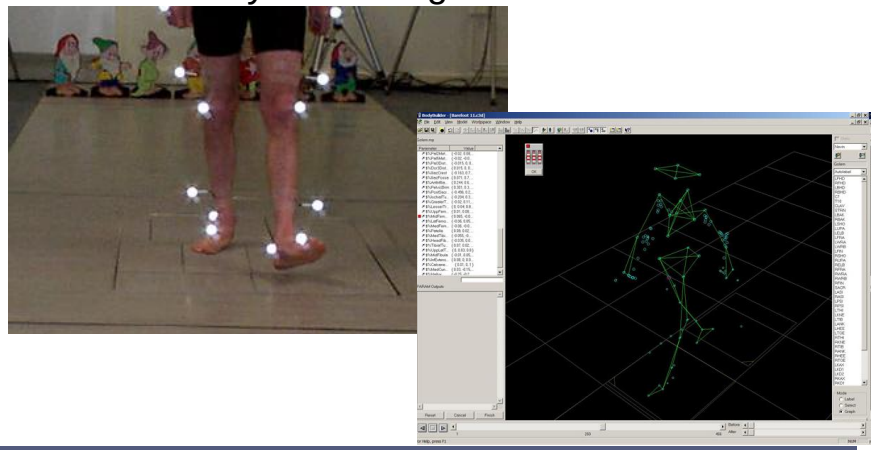
3D

Motion capture + post-process

- acquisition with cameras & kinematic and dynamic magnitude evaluation



PHYSICAL MODELING APPROACHES FOR MOTOR IMPAIRMENT (2)

Virtual reality models - IK/ID (i.e. RAMSIS)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
• The simulations are based on forward and inverse kinematics • Allows the user to create advanced, user–defined manikins using a number of advanced anthropometric tools	• No possibility of evaluation of muscle reaction forces • No elderly and disabled people database implemented • No possibility to perform forward and inverse dynamics analysis

Motion capture + post-processing (i.e. VICON)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
• Video capture system allows to analyse elder and disabled people gait • It is possible to perform inverse dynamics analysis	• There is not available a data base which contains anthropometrics information • Evaluation of kinematics and dynamics magnitudes are based on acquired data

PHYSICAL MODELING APPROACHES FOR MOTOR IMPAIRMENT (3)

Multibody models –FK / FD (i.e. VL Dummy)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
• The simulations are based on forward kinematics • It is possible to perform forward dynamics analysis • Allows the user to create advanced 3D manikins using an anthropometric database	• No elderly and disabled people database implemented • No possibility to perform inverse kinematics and inverse dynamics analysis

Multibody models - FK / FD & IK / ID (i.e. ANYBODY)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
• The simulations are based on forward and inverse kinematics • It is possible to perform forward and inverse dynamics analysis • Allows the user to create advanced 3D manikins using an anthropometric database	• Simulation and model data for elderly and disabled people are not available

PHYSICAL MODELING APPROACHES FOR MOTOR IMPAIRMENT (4)

Finite Element Models (i.e. PAM-safe)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
• Real experimental dummies are available in FE analyzed software. The models take into account kinematic magnitudes and biomechanical parameters (i.e. full and detailed model of the spine, internal organs, ribs) • The simulations are oriented to crash test and pedestrian impact test. It is possible to perform forward kinematics and dynamics analysis	• The dummies don't take into account elderly and disabled people • The simulations are very time consuming due to model and methodology complexity • It is not possible to perform inverse kinematics and inverse dynamics analysis

Virtual reality – only render (i.e. Argosy)

STRONG POINTS	BOTTLENECK AND LIMITATIONS
• Anthropometric database available	• Only for rendering (no possibilities of any simulation)

BENCHMARK OF EXISTING TOOLS FOR SPEECH AND HEARING IMPAIRMENTS

Speech and hearing impairment

12 models analyzed

15 references analyzed

Hearing loss simulators/models	Speech simulators/models
Inclusive Design toolkit simulator	sim.sagepub
HeLPS	Thomas & Hummel model
HearLoss	Robel & Rodet model
Inspire 2010.2, Starkey simulator	TRACE
Surround Town	
Cochlear Implant Simulator	
HELOS Hearing Loss Simulator	
NIOSH Hearing Loss Simulator	

CONCLUSIONS PHYSICAL TOOLS

- Review of 36 models for human physical modeling and more than 100 references analyzed
  - Virtual Reality + Video Motion Capture suitable to analyze kinematic quantitative metrics
  - Multibody Systems + Video Motion Capture suitable to analyze kinematic & dynamic quantitative metrics
  - FEM methodology not suitable
- Analysis of the interrelation with the cognitive, motor and perceptive tasks needed.

BENCHMARK OF EXISTING TOOLS FOR COGNITIVE IMPAIRMENTS

- 17 cognitive models have been studied and analysed until now

Modelling approach	Brief Descriptions	Primary Strengths	Primary Weakness

COGNITIVES MODELS ANALIZED
ACT-IF
ACT-R
ADAPT
AMBR
Artificial neural networks (ANNs)
COGENT
CoLiDeS
DOKGETT
DUAL
EPIC
GLEAN
IDA
MESA
MIDAS (CORE/AIR)
SNIF-ACT
SOAR
Task Network

CONCLUSIONS COGNITIVE TOOLS

- Analysis of 17 cognitive models
  - ACT-R
- Definition of 13 cognitive functions:
  - Functions considered as cognitive attributes
    - Independent attributes: reaction time
    - Dependent attributes: decision making
  - Functions considered as cognitive tasks
    - Primitive tasks: visual perception
    - Complex tasks: orientation
- Quantitative disability metrics can be extracted from the cognitive function analysis

BENCHMARK OF EXISTING TOOLS FOR BEHAVIORAL & PSYCOLOGICAL STATES

- 14 Behavioral & Psycological tools have been studied and analysed until now

Behav. & Psycol. MODELS
ACT-R
ACT-Simple
EPIC
ANN
Models based on Fuzzy Logic
GOMS
KLM-GOMS
GOMS & Markov Model
Models based on Markov Model
PUM
Motor-Behavior models
IPG driver
CORE
AVANTI

CONCLUSIONS BEHAVIORAL & PSYCOLOGICAL TOOLS

- Analysis of 14 Behavioral & psycological models
  - ACT-R
- From a behavioral point of view there are no impairments defined
  - Better to speak about **Psychological states**.
- Analysis of the **interconnection** of the P&B models, with the **Cognitive and Physical models** needed.

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Thank you for the attention!

For additional info, please feel free to contact:

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