End-to-end Digital Integration based on Modular Simulation of Natural Human Motions

ITEA 3 – 17028

Work package 2

Technical requirements and concept for modular simulation framework

Deliverable 2.1

Deduction and definition of required atomic MMUs

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Executive Summary

The content described in this document is part of MOSIM output for deliverable D2.1 “Deduction and definition of required atomic MMUs” from WP2. The aim of this document is;

- To structure the use-case dependent human activities from D1.1 and to furthermore determine clusters.
- To define a decomposition concept for each group by means of identifying recurrent patterns and common motions.
- To derive a list of atomic motions from this concept, which allows to model complex human motion by means of aggregation.

The document is structured as follows:

Section 1 Introduction: This section describes an overview of the document, including its scope and methodology.

Section 2 Overview use-case specific motions: This section gives an overview of the different cluster and the targeted human activities.

Section 3 Definition of atomic MMUs for each group: Here, suitable motion decomposition concepts are initially discussed. Building upon and extending the Methods-Time Measurement methodology - especially MTM1 – a list of 19 atomic motions is defined.

Section 4 Exemplary motion decomposition: To underline the genericity and applicability of the defined atomic MMUs, this section maps the tasks being defined in D 1.1 to the atomic motion list.

Section 5 Summary and Conclusions: This section briefly summarizes the overall conclusions in terms of defined atomic motions.

Appendix: This section summaries the definitions of use-case dependent activities, being defined in D1.1.

The primary conclusion includes the following:

- The motions in the MOSIM project are divided into three main groups: common, manufacturing and entertainment-related activities.
- MTM1 is ideally suited to cover a large extent of the atomic motions within the domains of common and manufacturing-related activities. Those basic operations are furthermore supplemented by additional motions such as jump, position foot, walk and gesture.
- The defined list of atomic motions is generic and allows to simulate all activities being defined in D1.1 - and beyond MOSIM.

Contents

1 Introduction

The MOSIM project aims at realistically simulating complex human motion in the context of different use-cases. This particularly includes various environments such as industrial assembly lines, roads as well as sidewalks. Apart from those well-defined use-cases, the portfolio of the MOSIM consortium (e.g., MIMIC or SignTime) furthermore comprises entertainment-related scenarios. The heterogeneity of scenes coupled with different scopes entail a wide range of human actions and motions, which all need to be covered by the Motion Model Unit (MMU) concept.

Deliverable 1.1 already provided an exhaustive list of approx. 60 human activities (see Table 3), originating from the different use-cases. Please note that the predominant proportion is ambiguous and therefore comprises a wide range of different execution-variants. For instance, the operation “fasten” groups activities ranging from one-handed to two-handed fastening, to the usage of corded, manual and electric screwdrivers. It is apparent that the concrete posture of a digital human model (DHM) varies vastly for each variant.

This circumstance significantly increases the number of necessary MMUs, encapsulating the respective motion models. This, in turn, inevitably affects the implementation efforts of MMU developer and the scalability of the approach. To counteract this problem by means of limiting the total number of Motion Model Units, Task 2.1 aims at defining a list of atomic activities, which form the basis of all tasks being identified in Deliverable 1.1. In particular, less than 20 reusable sub-motions (such as “grasp”, “reach” and “point”) are identified, which allow the simulation of high-level task by means of recombination. For instance, the activity “pick up” can be molded by means of co-simulating the fine-grained atomic MMUs “reach”, “grasp”, “gaze” and “move”. In order to allow a usage beyond MOSIM, special care has been given to genericity so that the findings can be applied to a wide range of domains beyond well-defined use-cases.

To implement the aforementioned aspects, this document is structured as follows: Section 2 clusters the plain list of high-level actives, being defined in Deliverable 1.1 according to the groups “manufacturing-”, “common-” and “entertainment-related-actives”. Next, Section 3 identifies atomic sub-motions within each generic cluster. Section 4 subsequently merges the three independent decomposition approaches to a unified concept, ultimately enabling the simulation of complex motion using less than 20 MMUs. Section 5 briefly summarizes the overall conclusions in terms of required motions in this project.

2 Overview use-case specific motions

To enable the definition of atomic Motion Model Units, which can be used to simulate realistic human motion regardless of the respective use-case, three generic cluster are initially defined. Those overarching groups cover the vast majority of use-cases and fields of application. It is thus ensured that the motion decomposition concept presented hereinafter, can also be used beyond the MOSIM project.

The following gives a brief overview of the different cluster and the targeted human activities.

2.1 Common activities

A fist cluster for human motion synthesis and DHMs is the simulation of situations, which might occur in everyday-life. This exemplarily includes scenarios such as pedestrian (see the TWT use-case) or crowd simulation. At the same time this category also includes customer simulation for product operations. One concrete example is the interaction of an end-customer with a truck and its driver's cab. Figure 1 gives a representative overview of applications in this field.

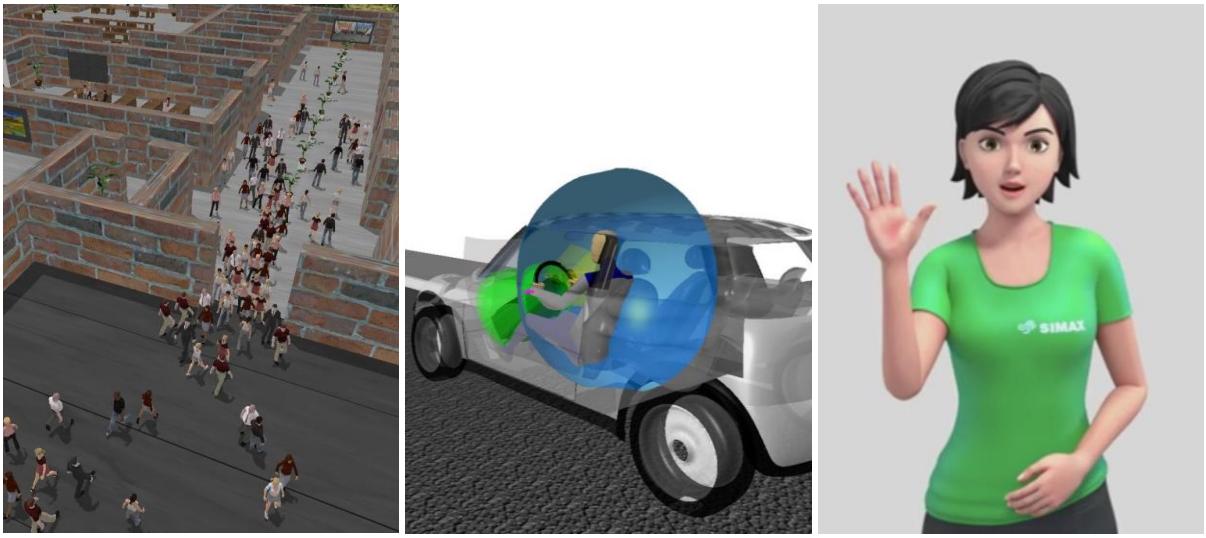

Figure 1: Example of common motions: pedestrian (left; source: www.uu.nl/en/), customer simulation (mid) for product operations and sign language translation (right).

Activities in this field usually point out following aspects:

- Upper- and lower-body motions
- Simple interaction with environment (i.e., press button, turn steering wheel) in seated postures
- Complex interaction with environment (i.e. entering a car or truck)
- Motion of DHM is self-determined
- Motions are energy-optimal
- Non-repetitive motions
- Interaction between multiple persons
- Motion activities are subjected to customer variations (age, gender, size)

2.2 Manufacturing activities

The manufacturing sector represents one prominent field of application of digital human models. Such simulations are utilized for planning, analyzing, visualizing and optimizing manual assembly processes within final assembly lines, which comprise a predominant proportion of manual tasks. Furthermore, this group also covers training of staff and ergonomic assessment. Figure 2 depicts a typical scenario of a final assembly line of Mercedes Benz Cars.

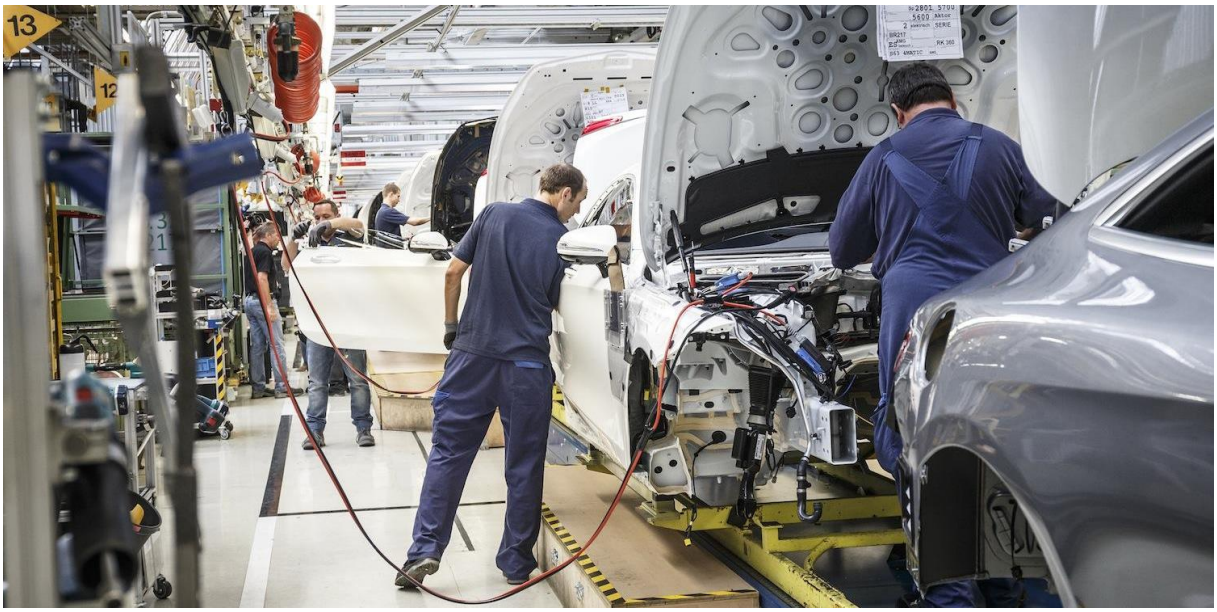

Figure 2: Example of a final assembly line of Mercedes Benz Cars.

Activities in this field usually point out following aspects:

- Mostly upper-body motions
- Mostly sophisticated hand/finger motions
- Complex interaction with environment (i.e., parts)
- Motion of DHM is restricted by installation path
- Goal-oriented motions
- Motions are time-optimal (time pressure by assembly cycle)
- Repetitive motions (low cycle times)
- Potentially strenuous postures (e.g. assembly in engine bay)
- High training level required
- High-precision / low fault tolerance
- Collision-afflicted, narrow spaces
- Highly specialized environments (e.g., handling tools, racks, products, conveyor belts)

2.3 Entertainment-related activities

The third groups being identified by the MOSIM consortium represents the domain of entertainment. This predominantly covers gaming, animation movies as well as advertisement. Motions in this field are specialized, sometimes exaggerated and usually do not occur in everyday-life (e.g., kicking, jumping, shooting).

Figure 3: Example of entertainment-related activities.

Activities in this field usually point out following aspects:

- Upper- and lower-body motions
- Simple interaction with environment (i.e., press button, turn steering wheel)
- Specialized, uncommon motion (e.g., kick, jump, flip or shoot)
- Motion of DHM follows is self-determined
- Motions are appealing to spectators / naturalness
- Non-repetitive motions
- Specialized environments

2.4 Allocation of motions to groups

Having defined the overarching groups, next, the concrete list of MOSIM activities (see D 1.1) is allocated to the different clusters. Building up on this mapping, the next section will present tailored motion decomposition concepts.

Table 1: The common activity list in the MOSIM project contains definitions and examples (see D 1.1)

Activities	Common	Manufacturing	Entertainment-related
Bend and Raise		X	
Close		X	X
Connect cables		X	
Connect hose		X	
Cut		X	
Document/Write		X	X
Enter	X	X	X
Exit	X	X	X

Activities	Common	Manufacturing	Entertainment-related
Fasten		X	
Fit		X	
Get and Place		X	X
Glue		X	
Grab	X	X	X
Hammer		X	
Hold	X	X	X
In and out a Cab	X	X	
Insert		X	
Jog	X		X
Jump	X		X
Lay		X	X
Look (left/right/up/down)	X	X	X
Lubricate		X	
Move/tilt (joystick)		X	
Open		X	X
Place/Insert part		X	X
Plug in (electrically)/ Connect cables		X	
Position		X	
Press (button)	X	X	X
Press in		X	
Press pedal		X	
Pull		X	X
Pull off		X	
Push		X	X
Put		X	X
Read		X	X
Remove		X	X
Return part		X	

Activities	Common	Manufacturing	Entertainment-related
Run	X		X
Scanning		X	
Sit (down)	X	X	X
Slide on		X	
Squat		X	X
Stagger	X		X
Stamp		X	
Stand up	X	X	X
Take/Pick part		X	X
Technical tightening time		X	
Tighten		X	
Test		X	
Thread		X	
Tie		X	
Unfasten		X	
Use device		X	X
Use lifting tool		X	
Use trolley		X	
(Visually) Inspect		X	
Walk	X	X	X
Wave	X		X

3 Definition of atomic MMUs for each group

In general, the heterogeneity of use-cases in combination with the wide range of different motions impedes the direct definition of a universal decomposition concept. Therefore it is necessary to firstly identify recurrent sub-motions and patterns within each of the three clusters. For instance in the context of manufacturing-related motions, MTM-1 allows to trace back an arbitrary motion to a limited set of atomic activities. Same applies for the two remaining groups. With this intermediate step, it is possible to ultimately derive a universal decomposition concept, which unifies the three sub-groups. The following presents the cluster-specific approaches.

3.1 Overview and related concepts

The decomposition and formal description of human motions has been subject to research for several decades. In manufacturing environments, methods to a priori assess the time needed for a certain assembly task are of great interest. The Methods-Time Measurement (MTM) has been developed to serve this demand (see Deutsche MTM-Vereinigung e. V.). By decomposing human body movements into basic motions, time estimations for complex shop floor operations could be derived. First a comprehensive set of basic motions was defined, from which all complex movements can be composed of. Through collection of empirical data, time estimates for those basic motions were provided and catalogued. Now the time needed to perform a complex movement can be calculated, by adding up the time estimates of the basic motions it comprises of. Certain multiplying factors can be used, to take the length and difficulty of the task and the proficiency of the conductor into account.

The MTM motion decomposition system (without time assessment) forms the basis to define the list of atomic Motion Model Units. The following gives a brief introduction into Methods-Time Measurement.

The MTM system knows five basic motions for finger, hand and arm movements. They are reach, grasp, move, position and release and provide the framework to perform all pick and place activities (see Figure 4). In addition, there are basic motions to apply pressure on an object, to turn something around or to disengage two connected items (see Figure 5). Eye movement is segmented into eye travel, when turning ones gaze onto another object, and eye focus, when taking a look at something more carefully. Figure 6 depicts those basic activities.

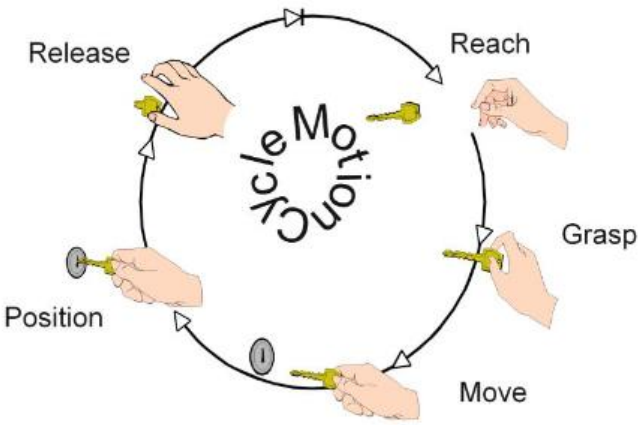

Figure 4: MTM-1 basic cycle (source: Deutsche MTM-Vereinigung e.V.).

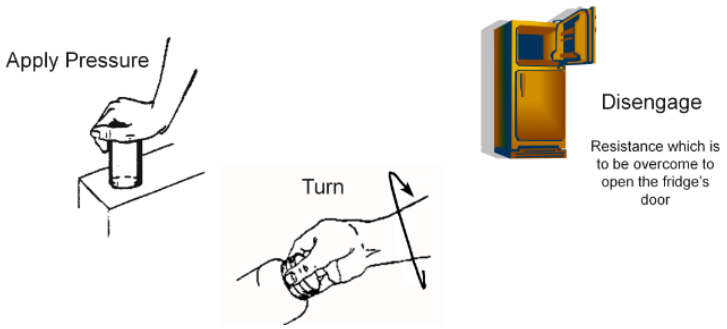

Figure 5: Additional MTM-1 atomic motions (source: Deutsche MTM-Vereinigung e.V.)

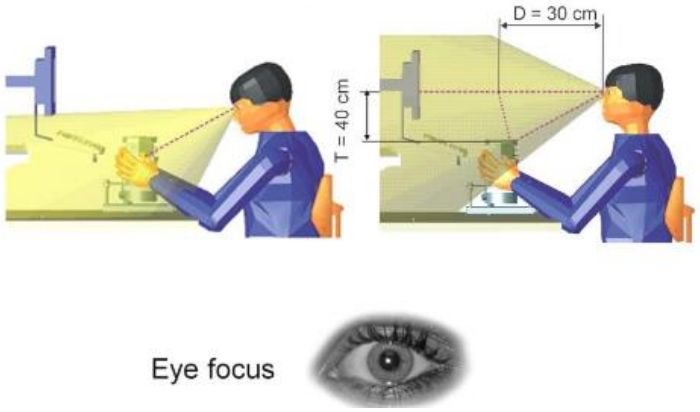

Figure 6: MTM-1 eye movements (source: Deutsche MTM-Vereinigung e.V.)

There are 15 basic motions for whole body movements, such as taking steps in different directions, bending, kneeing and standing up. Further, there exist different variation to those motions as to their precision, length and dynamics.

If an analysis of a complex and extensive motion sequence as of is required, working with the MTM basic motions can be cumbersome and time consuming, since it deconstructs motions to a very fine-grained level. Therefore precompiled versions of the MTM system were developed, providing time information about motion blocks which represent more extensive but very frequently occurring motion sequences. The MTM Universal Analysing System (UAS) is one example which has one motion block “pick and place” comprising the five MTM basic motions depicted in Figure 4.

Figure 7 illustrates the different variants of Methods-Time Measurement. While MTM-1 comprises the lowest granularity – and therefore the most fine-grained motions – MTM UAS groups those atomic activities to high-level tasks. However, this aggregation is inevitably accompanied by a significantly increased number of units. In particular, MTM-1 has approximately ten instances (excluding lower body motions), whereas for Daimler’s C-values (derivate of MTM UAS) this number is in the upper two-digit range. This can be mainly traced back to the fact that higher aggregation levels always lead to an increased dependency to the use-case: the C-values, for instance, contains four different blocks modelling the activity “connecting a hose”.

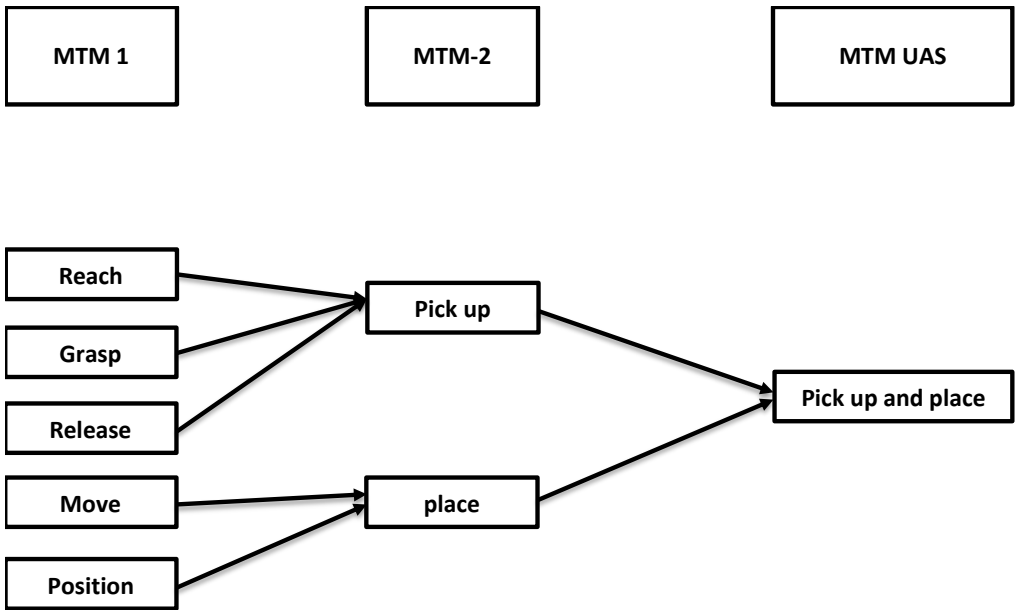

Figure 7: overview of different MTM granularity levels

Concluding, MTM-1 seems to be ideally suited to cover most of the actives, which are targeted by the MOSIM consortium. To obtain a generic list of activities enabling the simulation of use-cases beyond MOSIM, the initial list of atomic MMUs needs to be partially extended.

3.2 Atomic motions within common activities

To simulate common activities following atomic motions are required. The subsequently defined list also comprises a short description and parameter influencing the motion. The latter has to be regarded as a theoretical draft, which will be iteratively extended throughout the project.

3.2.1 Move

Description	Move is the basic element employed when the predominant purpose is to transport an object to a destination
Influence parameter	• Destination (position + orientation) • Force/weight of object • Object dimensions • Static/dynamic • 1- or 2-handed transport • Classes 1. Object to other hand or against stop 2. Object to approximate or indefinite location 3. Object to exact location

3.2.2 Reach

Description	Reach is the basic element used when the predominant purpose of the motion is to move the hand or fingers to a definite destination or to a general location.
Influence parameter	• Destination (position + orientation) • Classes 1. Reach to an object in other hand or to an object in fixed location or on which other hand rests 2. Reach to object whose general location is known. Location may vary a little from cycle to cycle 3. Reach to object jumbled with other objects in a group. Search and select may be involved in this case 4. Reach to a very small object or where accurate group is needed 5. Reach to indefinite location to get hand into position for body balance or next move or out of way • Types of reach 1. Hand is not moving at beginning and at end of reach 2. Hand is moving at either beginning or end of reach 3. Hand is in motion at both beginning and end of reach

3.2.3 Release

Description	Release is the basic element to relinquish control of an object by the fingers of hand.
Influence parameter	• Types of release 1. Normal: In this fingers are just opened to let go the object 2. Hand over: It occurs and is completed when the following reach motion starts.

3.2.4 Grasp

Description	This basic element is performed when the main purpose is to secure sufficient control on one or many objects with fingers or with hands to allow the performance of the next basic element.
Influence parameter	• Type of grasp 1. Pickup 2. Re-grasp 3. Transfer 4. Select 5. Contact • Diameter / dimensions

3.2.5 Position

Description	Position is the basic element employed to alignment and engages one object with another object, where the motions used are so minor that they do not justify as other basic elements.
Influence parameter	• Object Destination (position + orientation) • Class of fit 1. Loose 2. Close 3. Exact • Symmetry of object 1. Symmetrical 2. Non symmetrical 3. Semi symmetrical • Ease of handling 1. Easy to handle 2. Hard to handle

3.2.6 Turn

Description	It is the basic element employed when the hand, either empty or loaded is turned. Such movement rotates the hand, wrist, and fore arm about the longitudinal axis of the forearm.
Influence parameter	• Angle turned • Force/weight

3.2.7 Disengage

Description	Disengage is the basic element used to break contact between one object and another. The objects are separated away.
Influence parameter	• Class of fit 1. Loose 2. Close 3. Exact • Ease of handling 1. Easy to handle 2. Hard to handle • Force and recoil 1. Slight (recoil < 2.5 cm) 2. Intermediate (recoil < 12 cm) 3. High (recoil < 30 cm)

3.2.8 Apply Pressure

Description	This basic element is performed when precise control is exerted. It appears as a distinct pause before performing subsequent basic elements.
Influence parameter	• Type of apply pressure 1. Application of pressure only 2. Re-grasp or sequence and apply pressure

3.2.9 Walk

Description	This basic element is performed when a human walks to a destination
Influence parameter	• Velocity • Walking path / destination position • Type of locomotion 1. Normal 2. Stagger 3. Crouch

3.2.10 Eye travel

Description	Eye Travel is the basic element for changing the viewing direction of a character by moving the head to the left, the right, up or down
Influence parameter	Distance between points of focus

3.2.11 Eye Focus

Description	Eye Travel is the basic element for focusing on a specific object in the scene by moving the eye.
Influence parameter	-

3.2.12 Gesture

Description	This basic element is performed to express emotions (greeting, understanding, etc.).
Influence parameter	• Type of motion: • Wave • Point at

	• Shrug • Nod • Sign Language

3.2.13 Position foot

Description	This basic element is performed when a character places its foot on a certain point or object. This mainly refers to the usage of pedals or footswitches.
Influence parameter	• Destination (position + orientation) • Force

3.2.14 Jump

Description	This basic element is performed when the intended motion for a character has a component in the vertical direction. Jump is performed either on a single spot or from one position to another.
Influence parameter	• Speed • height • horizontal displacement

3.2.15 Sitting down / Standing up

Description	Sitting down or standing up from a support (chair, bench, car seat, etc.)
Influence parameter	• Speed • support's height • Position and dimensions of additional collision objects (e.g. rocker panel, steering wheel) • Motion strategy / pattern

3.2.16 Climbing

Description	Climbing up or down a vertical surface (ladder, wall, etc.)
Influence parameter	• Speed • Position and dimensions of foot and hand supports • Inclination of ascent • Motion strategy / pattern

3.3 Atomic motions within manufacturing activities

To simulate manufacturing activities following atomic motions are required. Please note that the list is redundant to common activities.

3.3.1 Move

See 3.2.1

3.3.2 Reach

See 3.2.2

3.3.3 Release

See 3.2.3

3.3.4 Grasp

See 3.2.4

3.3.5 Position

See 3.2.5

3.3.6 Turn

See 3.2.6

3.3.7 Disengage

See 3.2.7

3.3.8 Apply Pressure

See 3.2.8

3.3.9 Walk

See 3.2.9

3.3.10 Eye travel

See 3.2.10

3.3.11 Eye focus

See 3.2.11

3.4 Atomic motions within entertainment-related activates

To simulate a major proportion of entertainment-related activities following atomic motions are required. Please note that the list is redundant to common activities, however further specialized activities have been added.

3.4.1 Move

See 3.2.1

3.4.2 Reach

See 3.2.2

3.4.3 Release

See 3.2.3

3.4.4 Grasp

See 3.2.4

3.4.5 Position

See 3.2.5

3.4.6 Turn

See 3.2.6

3.4.7 Disengage

See 3.2.7

3.4.8 Apply Pressure

See 3.2.8

3.4.9 Walk

See 3.2.9

3.4.10 Eye travel

See 3.2.10

3.4.11 Eye focus

See 3.2.11

3.4.12 Attack

Description	Performing a physical attack on someone or something (kicking, punching, shooting)
Influence parameter	• Distance from the target (position + orientation) • Force • Mode of attack

3.4.13 Throwing

Description	Throwing an object at someone or something
Influence parameter	• Distance from the target (position) • One- / two-handed

	• Force

3.4.14 Fall Down

Description	Falling willingly (after a jump) or not (stumbling)
Influence parameter	• Speed • duration • landing position • scenario

4 Exemplary motion decomposition using atomic MMUs

To underline the genericity and applicability of the defined atomic MMUs, Table 2 maps the tasks being defined in D 1.1 to the atomic motion list. This table deliberately refrains from providing a temporal order the MMUs due to the context-dependency. Rather, the table illustrates which MMUs might be necessary to simulate a high-level task.

Table 2: preliminary mapping between tasks being defined in D 1.1 and atomic motions.

	Move	Reach	Release	Grasp	Position	Turn	Disengage	Apply pressure	Eye travel	Eye focus	Walk	Gesture	Position Foot	Jump	Sitting down / standing up	Climbing	Attack	Throwing	Fall down
Bend and Raise	x	x		x															
Close		x		x				x											
Connect cables	x	x			x			x											
Connect hose	x	x			x			x											
Cut	x	x					x	x											
Document/Write	x					x		x											
Enter											x					x			
Exit											x					x			
Fasten	x	x	x	x	x			x											
Fit	x	x	x	x	x			x											
Get and Place	x	x	x	x	x														
Glue	x							x											
Grab		x		x															
Hammer	x							x											
Hold	x																		
In and out a Cab															x	x			
Insert	x				x			x											
Jog											x								
Jump														x					
Lay	x		x		x														
Look (left/right/up/down)									x	x									
Lubricate	x							x											
Move/tilt (joystick)	x							x											
Open		x		x				x											
Place/Insert part	x				x			x											
Plug in (electrically)/ Connect cables	x	x	x	x	x			x											
Position	x				x														
Press (button)		x		x	x			x											

	Move	Reach	Release	Grasp	Position	Turn	Disengage	Apply pressure	Eye travel	Eye focus	Walk	Gesture	Position Foot	Jump	Sitting down / standing up	Climbing	Attack	Throwing	Fall down
Press in		x		x	x			x											
Press pedal								x					x						
Pull	x			x															
Pull off	x			x															
Push		x		x				x											
Put	x	x	x	x	x														
Read									x	x									
Remove	x	x	x	x	x														
Return part	x		x		x														
Run											x								
Scanning	x							x											
Sit (down)															x				
Slide on	x		x		x			x											
Squat											x				x				
Stagger											x								
Stamp	x							x											
Stand up															x				
Take/Pick part	x	x		x															
Technical tightening time											x								
Tighten	x	x	x	x	x			x											
Thread	x		x		x			x											
Tie	x	x	x	x	x			x											
Unfasten	x	x	x	x	x	x	x	x											
Use device	x	x	x	x	x	x	x	x	x	x									
Use lifting tool		x		x				x											
Use trolley		x		x				x			x								
(Visually) Inspect									x	x									
Walk											x								
Wave												x							

Finally, please note that even though MTM-1 is chosen, it is nevertheless possible to implement high-level MMUs, which group several atomic units. Figure 8 depicts this concept of nested MMUs comprising several sub-models. As shown, the aim of this deliverable is to define the lowest level of motions.

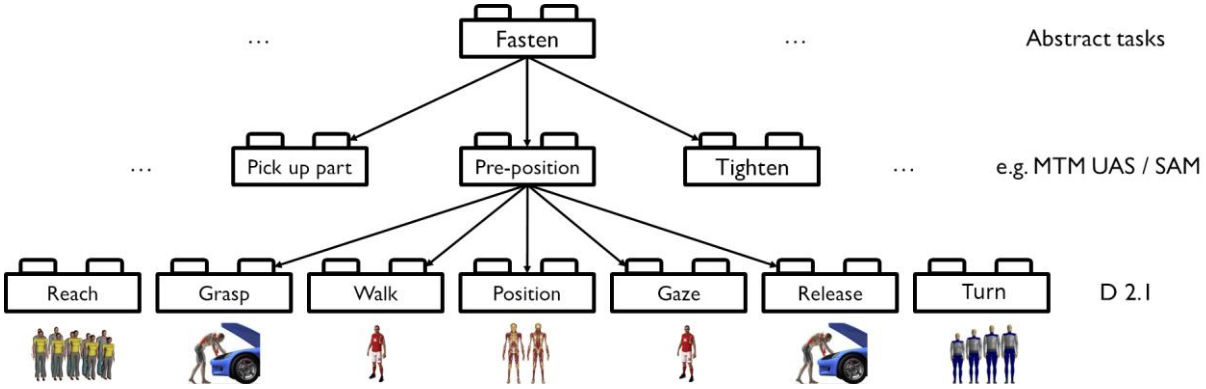

Figure 8: targeted motion decomposition and aggregation hierarchy.

5 Summary and conclusions

Building upon on a comprehensive list of nearly 60 use-case dependent human activities, this deliverable initially carves out three clusters. In particular, the groups of common, manufacturing and entertainment-related activities are identified, which form the basis for all subsequent steps. Next, an individual list of atomic motions is determined within each cluster. Altogether 19 atomic motions have been identified, which can be utilized to simulate complex human motion by means of aggregation:

1. Move	5. Position	9. Eye travel	13. Position Foot	17. Attack
2. Reach	6. Turn	10. Eye focus	14. Jump	18. Throwing
3. Release	7. Disengage	11. Walk	15. Sitting down / standing up	19. Fall down
4. Grasp	8. Apply pressure	12. Gesture	16. Climbing	

The succeeding work packages will implement Motion Model Units for each element of this generic list. In order to allow a usage beyond MOSIM, special care has been given to genericity so that the findings can be applied to a wide range of domains beyond well-defined use-cases.

6 Appendix

Table 3: The common activity list in the MOSIM project contains definitions and examples (see D 1.1)

Activities	**Definitions & Examples**
Bend and Raise	To bend and raise
Close	Closing doors, windows by grabbing a handle rotating. Pressing it and pulling/pushing the object
Connect cables	To do connections with cables (loose to fixed, loose to loose)
Connect hose	To connect a rubber hose on a nozzle
Cut	To cut an object with a cutting tool
Document/Write	Use either pen and paper for writing, or tablet/laptop
Enter	Entering cabin/vehicle can be higher level of set of actions: open door, get in, close the door
Exit	Analogy to enter just in the opposite direction.
Fasten	To place a screw in a hole and screw it two turns
Fit	Inserting one component into another
Get and Place	To grab a part and to place it in a position from its original position
Glue	Joining parts by using an adhesive. Includes application of the adhesive or removal of the protective film on self-adhesive parts (e.g. labels)
Grab	To grab an object with hand
Hammer	To hit an object with a hammer
Hold	To hold an object in hand
In and out a Cab	To go in and out a cab
Insert	Joining in which the one joining part is inserted into a molding element of the other joining part.
Jog	To jog from one position to another
Jump	To jump on the spot or from one position to another
Lay	Place component on a flat surface. For example, placing something on a table
Look (left/right/up/down)	To rotate head (optional: eyes) left, right, up or down
Lubricate	To apply lubrication to a part with a tool

Activities	**Definitions & Examples**
Move/tilt (joystick)	Moving joystick in desired direction. Possible options are: tilt left, tilt right, tilt forward, tilt backward, and diagonal motions
Open	Opening doors, windows by grabbing a handle rotating/pressing it and pulling/pushing the object
Place/Insert part	To place a grabbed object in a position different from its original position
Plug in (electrically)/ Connect cables	Connecting / plugging a plug or connector-like part, allowing the flow of electrical power or information.
Position	Move component to a specified position (defined by coordinates)
Press (button)	To press a button/turn a switch
Press in	Pressing in / pressing on a part (possibly with additional connector (s))
Press pedal	Pressing pedal with a foot, for example brake or accelerator in a vehicle. As parameter intensity or percentage of the pedal stroke can be given
Pull	To pull an object in a direction
Pull off	Remove element using force. For example, pulling off component installed on a conical section of a shaft
Push	To push an object in a direction
Put	Place component inside a container or within some constrained space
Read	To read information on a screen or label
Remove	Take an object (that is currently part of an assembly) and put on a side
Return part	To place a grabbed object back on its original position
Run	To run from one position to another
Scanning	To Get scanner and scan information
Sit (down)	To sit on a chair or stool
Slide on	Installing sliding components on a rail, or sliding component into position
Squat	Moving from standing to squatted position, for example to do manipulation on lower level of an assembly
Stagger	To walk unsteadily from one position to another, as if about to fall
Stamp	To stamp a mark on a surface
Stand up	To stand up from a sitting position
Take/Pick part	To grab an object and remove it from a position
Technical tightening time	Machine time for tightening
Tighten	Joining parts by a screw or by a screw-like connector (e.g., nut) using a tool

Activities	**Definitions & Examples**
Tie	To wrap and tie an object with a zip tie
Unfasten	Use wrench to remove nut/screw
Use device	Repetitive actions using a manual device (hammer, ratchet…)
Use lifting tool	To get control of remote and use lifting tool to place a part into a final position
Use trolley	Get control and move with a trolley on a certain distance
(Visually) Inspect	To lean closer to a point and visually inspect it
Walk	To walk from one position to another
Wave	To move the hand to and fro in greeting or as a signal