Knowledge databases in French, German and English

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Del 3.2	Executive Summary
This deliverable describes the principle of the using of the natural language processing (NLP) and the importance of the knowledge database technically and in this step of the project. It explains the kind of different properties of the database.	

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1. Introduction

Life and living conditions of elderly people are as varied as the younger. Who is old, does not automatically need only help or care but rather more social activities and entertainment. According to the newspaper “Berliner Morgenpost” (http://www.morgenpost.de/familie/article1594988/ Lieber-ein-Leben-mit-Roboter-als-ein-Leben-im-Altenheim.html) older people prefer a life with a robot than a life in a nursing home. For this reason, the intention of the ALIAS project is to research and develop a robot that is able to live together with people and especially being like a partner to them.

The most popular robots for older people are robots that perform daily tasks like cleaning or valeting. This is not the cause of the robot within the ALIAS project. The robot cannot be just a machine that will be controlled with some buttons by the user, but it’s meant to act more like a “friend”. As a matter of course it is important that the robot helps older people in there essential activities but also it has to fulfill a few of their requirements of entertainment and enterprise. Therefore, the robot must be able to understand people and in particular older persons independent of the language or the manner how the user speaks. Otherwise, the robot must comprehend the user and be responsive to some instructions. Depending on this instruction, the robot must respond in an adequate way. This response can be a physical reaction or a linguistic answer. Not only commands via a touchscreen need to be interpreted correctly but the incoming voice commands, too.

By using the natural language processing (NLP) within this project, the human language can be understood. In this domain, cognesys has specialized. By using of the Cognitive Ergonomic System, CES, understanding the meaning of the context, i.e. in our case the dialog between the user and the robot, will be possible independent of the formulation of the sentence or the question. In the ALIAS project, this is the task of the dialog manager (see deliverable D 3.4).

To achieve this goal the robot needs a database of available “knowledge” in order to understand its user and to respond to him in an adequate manner. This database is a main part of the knowledge management. The knowledge of a human being is based on learning and it is the result of human action and cognition. For this cause it is important to obtain this knowledge and to map it in the database of the robot. Generally, the knowledge consists of two parts: one part of “general knowledge” and another part of the “expert knowledge”. The general knowledge describes a knowledge that will be applied in the daily life of people independent of their environment and the society. This general knowledge enables the robot to recognize the actual meaning even when detailed information is missing. The more knowledge is available to the robot the better it’ll be able to understand its user. The so-called expert knowledge is of at least the same importance. This expert knowledge will be based firstly on the available applications of the robot and secondly on the individual properties of the user. This knowledge is specific to the situation in which the robot is used; it contains facts and rules that are used to understand the requirements of older people.

In this document we will define the main meaning of a knowledge database. The challenge here is that up to this point there is very limited general knowledge available. In the current step the database contains some basic knowledge only, but it'll be extended and further development during the following steps. We will describe what different methods we deem appropriate to obtain global and expertise knowledge databases.

Depending on the list of functions, which can be found in the Wikimedia page of the project, we will represent different scenarios and explain the idea of this process.

2. The principal of the input understanding

The CES (Cognitive Ergonomic Solution) or the artificial human intelligence (AHI) is a universal linguistic interface which is composed of the knowledge database and the cognitive algorithms. This system technically provides the understanding of text or voice information and enables automatic detection significance of linguistic information.

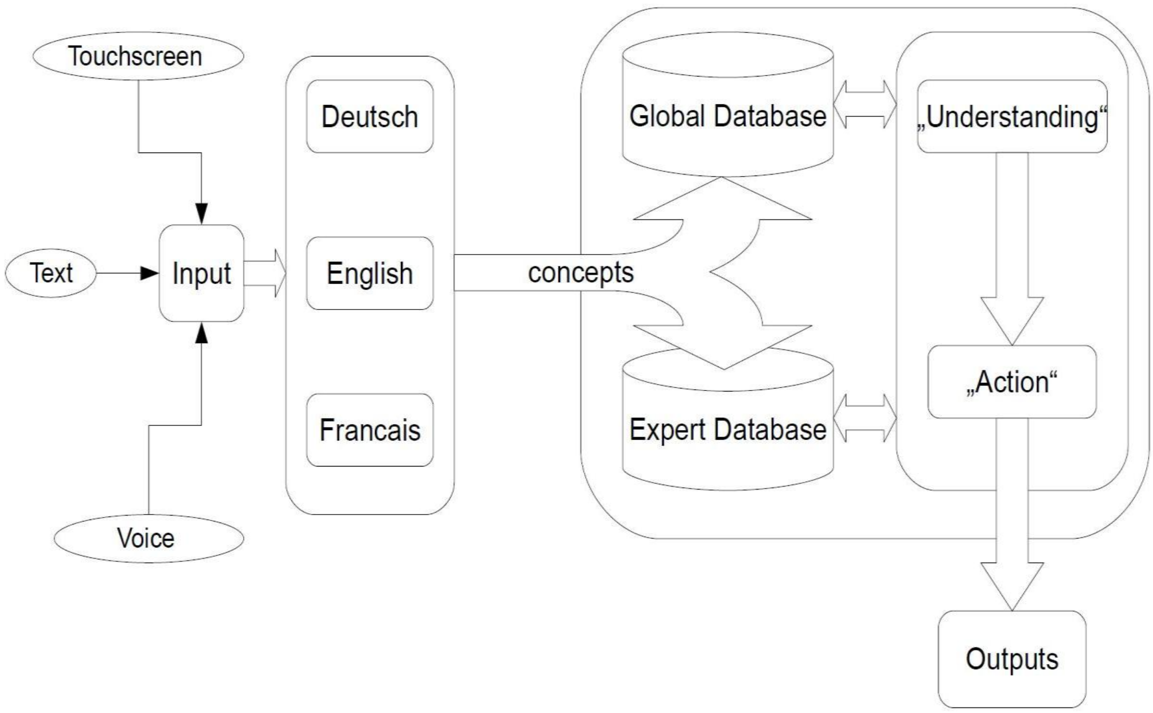

Figure 1: The principal of the CES process.

In the following, we will define the principal of the language processing system with the goal to show the importance of the knowledge database and the kind of the using.

At first the ALIAS robot receives inputs via different modalities as depicted in Figure 1. This can be a voice sentence, a text or command that the user can choose from the touchscreen. The input can be generated in the three languages: English, German and French. For this reason it is important that in the next step the input will be classified within the language in the pre-processing of the system. After this processing a set of concepts will be activated. In this step these concepts are independent from the original language of the user.

In contrast to the statistical methods for the speech processing the cognesys system does not analyze the probability of the occurrence of words or strings, but extracts and processes the conceptual meaning of verbal messages. With the capturing of the meaning CES has the ability to separate the correct statement from logically wrong statements and consequently generates logical actions and events from the recognized statements. The core system of CES consists of an AHI based on a conceptual knowledge database (the global or the general database and the expert database). The signification of natural language information will be recorded with the knowledge database and interpreted by the AHI.

Through the interplay of the knowledge database and the AHI the performance the basic mechanisms of human thinking can be reproduced. Two points make the CES advantageous and efficient:

- The understanding of the meaning of the information in a way that meaningful statements may be generated even though syntactically or grammatically wrong or incomplete information.
- Inferential thinking, including the identification and implementation of the logical consequences of the action.

By linking and combining concepts contained in the natural language inputs with rules of human thinking, CES can reconstruct the meaning of the verbal message. Based on the conceptual knowledge database, the system will then check the usefulness of the identified statement. By this, an assessment of the speech input based on logical and semantic criteria is possible.

An example from the input via voice could be if the user says: “can you please call the caretaker of the house”. The CES system will at first analyze the sentence using the following procedure: the cognitive algorithm compiles the inputs by the linking of all concepts in a meaningful context, which leads to the following results:

a. Analysis: “the caretaker” is a person and “to call” is a verb
b. Inference: caretaker -> to call
c. Expertise: the list of contacts
d. Conflict: the caretaker doesn’t exist in the list of contacts

The discovered conflict activates the feedback module. A possible reaction could be: "you don't have a caretaker in your list of contacts" or "I don't know this person". Alternately, the system can object the statement without any reaction. This will depend on the given situation and context of the robot.

If the user says: "I want to call my sister". The system is able to understand the global meaning; in this case the call process can be executed. However, if the list of contacts doesn't contain a person with the indication "sister", the robot cannot start the call process and can ask the user about the person "I cannot find this person. In the case that the list of contacts contains more than one sister, the robot can reply: "To which sister do you want to talk?"

The robot has to understand not only words, but the context of the sentences. In the following example we will explain the disadvantage to the keywords knowledge process. The robot might receive the following inputs:

1. Robi, I want to play.
2. Robi, I don't want to play.
3. Robi, I want to play music.

A voice control occurs on isolated keywords like "play". The Robot will be activated for example by his name "Robi" and the performance of the integrated function "gaming" could start which is a correct reaction for the input 1. For the other sentences 2 and 3, the action would be inappropriate.

By using CES, the robot is able to think and to understand as illustrated by the previous examples. By learning and training of information in the general and expert knowledge database, the robot should be able to execute all the inputs independent of the language and according to the meaning to respond with appropriate reactions to it. However, to obtain these properties, an abstract explanation it is important to explain abstractly the understanding process and the subjection with the world knowledge.

3. The Knowledge Database

The understanding process considers the actual situation in which e.g. a human being is at the moment with available and linked concepts in a knowledge base (e.g. the human brain). To understand a language, it is important that humans have the ability to conclude the basis of established facts and to identify causal relationships. It is also important that humans are able to recognize the goals and motives that the knowledge achieved from experience. The human brain must be able to understand the words, signs or gestures and to combine them to obtain sentences by which the human can communicate with his or her society and to understand situational context. This includes the ability to understand the evidence given by other words and to understand situational context, for example:

"I go to the bank„ or "I save the data in the bank"

These sentences are an example that shows that the understanding process cannot be successful without the general knowledge and the understanding of the discussed situation. In both sentences the same word "bank" is used but without world knowledge there is no possibility to differentiate the meaning. If a boy uses his notebook and says "I save the data in the bank", he means the bank of his computer. Otherwise, if he is in front of a bank building and says "I go to the bank". These examples describe that the meaning obviously depends on the current context.

Since the robot will interact with a human, it is important that it is able to understand the speech and the language of the dialog and for this reason it needs a "human like" world knowledge.

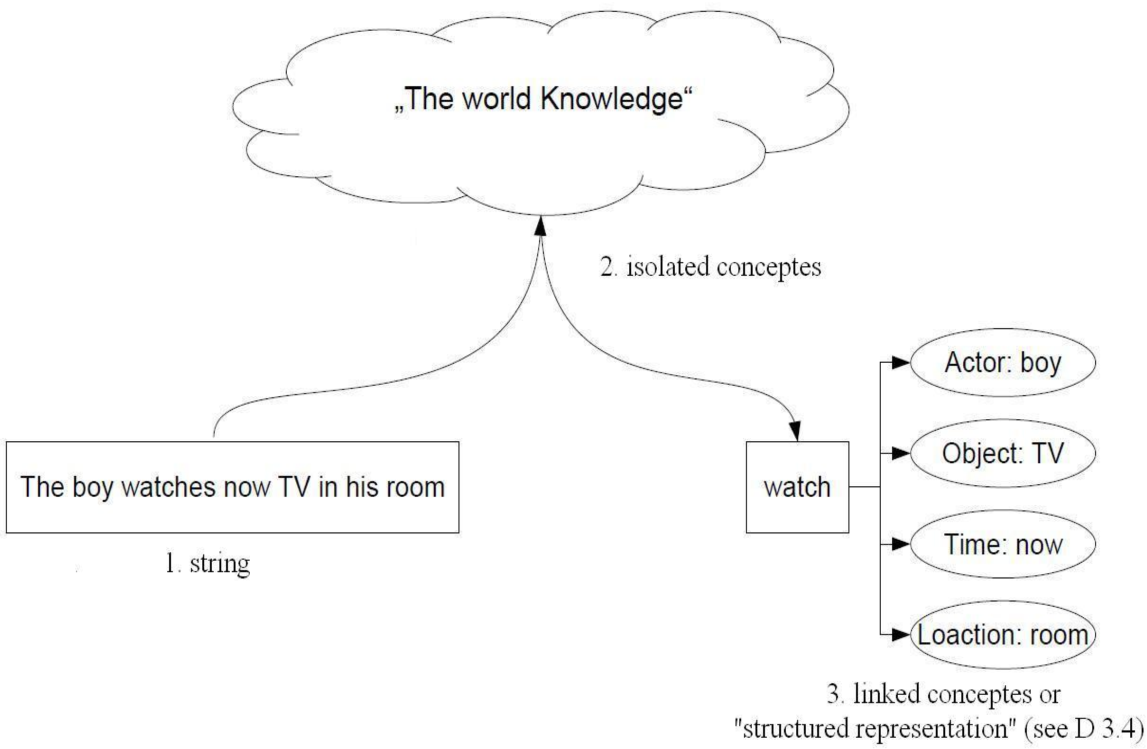

Figure 2: The Understanding Process.

3.1 The world/general Knowledge Database

The world knowledge is a set of the stored information about the world. This information is necessary for an organism. In the memory of a human being, lot of information is available he or she learned from his or her environment. This experience is the basis for his or her world knowledge. By this knowledge the human is also able to understand the meaning of sentences and to control the behavior.

In the technical field and, thus, also in the ALIAS project the memory of the human will be simulated with a database that contains the world knowledge. This knowledge database is a special database for the dialog management. It provides the basis for the collection of information and contains explicit knowledge in written form. However, in many cases this world knowledge is not sufficient to enable the robot to understand all inputs of a dialog to decide and perform appropriate actions. Another kind of knowledge database must be constructed, namely the expert knowledge database.

3.2 The Knowledge Database relevant for Daily-life situation of Older People

Special cases demand special expert knowledge. For this project details about the life of the older person are described in our expert knowledge database. The older person may have the same interests as younger persons, but a different manner of entertainments and helping forms make their kind of life different. In this case the expert knowledge database is strongly depending on the project and the functions that the robot can fulfill. The expert knowledge is composed of two main parts: A part that contains information regarding the life of the older people. For example in the health domain, older persons usually consume more medicine than younger persons, for this reason it is necessary that the robot contains some data about this domain. Of course it must be regarded that there are some restricting rules in particular in the health domain. Hence, in the exposition of the expert knowledge database we must have more details about the life and the interest of the older people. The second part of the expert knowledge is user specific. That means that the knowledge is strongly depended from the individual life of the user. For example, the members of the family of the user should be known by the robot and marked in the list of contacts of the robot.

The challenge at this level is that there is no research available which could provide a bases expert knowledge in this perspective. For this reason the exposition of the expert knowledge database will be based on the list of functions.

3.3 List of functions

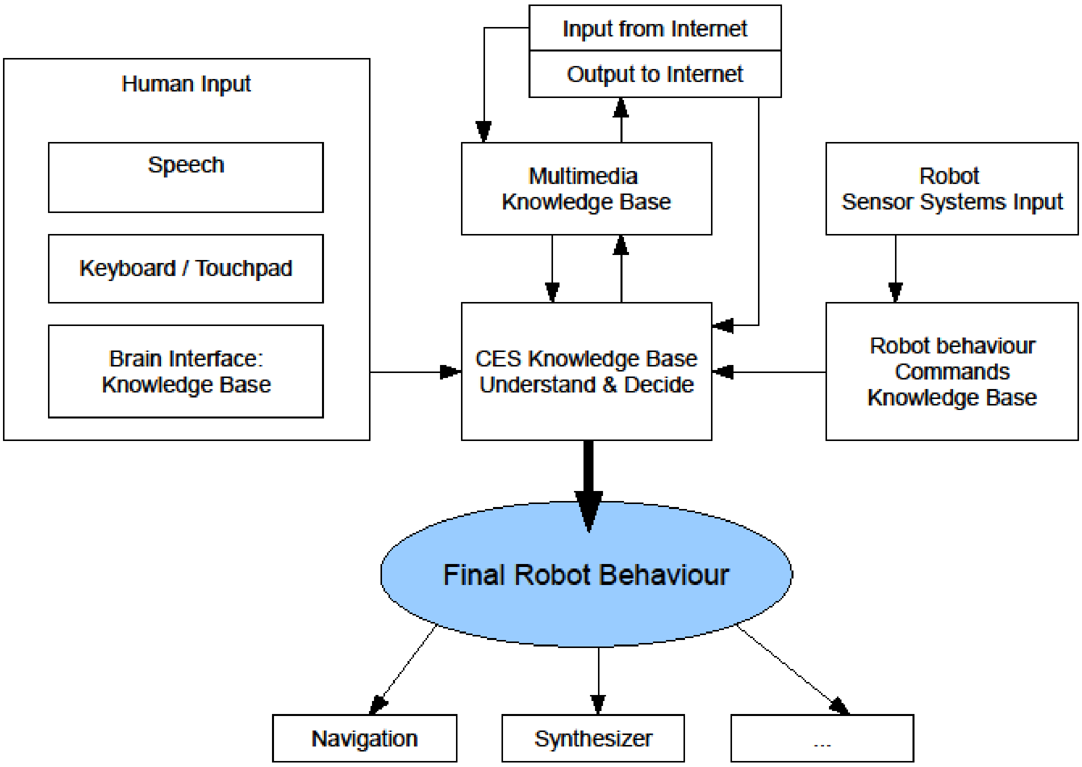

Figure 3: The global system.

In previous steps of the project, a list of functions was proposed. In the Table 1 there are some examples from the table in the ALIAS Wikimedia.

Looking at this list, for each function there are responsible groups to realize this task, nevertheless, the dialog management with the CES knowledge must be able to understand all of these different functions. This dialog management as described in Figure 3 is a core of the understanding of the system and it is the important component that decides about the behavior of the robot. With this process the dialog can firstly control the inputs that it receives from the other modules and with the adapted reaction or function the robot can expend an appropriate response. Secondly the robot can understand the concepts and the different part of his system and decide what the next reaction can be. The user can say e.g. “I want to hear music” or “I want to play chess” or “I want to call with me child” or “I want to write an email” or “I need my list of contacts”. Each of these different examples of sentences selects different functions (see Table 1). But at first the dialog manager of the robot obviously has to understand of the meaning.

Functions	Details
Reading support functions	Read out function for digital books, read newspaper
Gaming	Mentally challenging online-games. Brain teasers; Sports games a la Wii, that help to train balance and coordination; Games which can be played by young and old people together; Games which can be played by young and old people together: Replacing missing game-partners
Writing support function	Function for writing letters. function for writing and adding shopping lists
Telephone	Skype
Being a friend – ALIAS should:	should: a) take a joke (e.g. reading out the joke or the motto of the day); b) announce date and day; c) say "good morning", "good night", "please" and "thank you"; d) Make offers e.g. "Would you like to go for a walk?" e) welcome the senior and his visitors; f) not only give yes / no - answers
E-mail	e.g. share photos
Easy-to-use contact list	Contact via Photo

Table 1: A List of a few examples from the list of functions (extract)

The robot can only execute one of these functions if the dialog manager understands that the input was a request regarding this function. For example, the robot can start the telephone process just if the user said: “I want to call”. How this process will be implemented, is irrelevant for the dialog management. This does not mean that he can only understood this sentence “I want to call”, but he can only use this function “the Skype program” if it understand the meaning in the dialog.

3.4 Example scenarios

With the goal to obtain a sumptuous collection of words and lexicons for the general and expert database, it is important to display some scenarios in order to collect different formulations so that the robot has a certain reaction. The goal is not only a switch of words but more to produce different sentences with the same meaning. In each of the following scenarios we have started with the reactions, for example the navigation or the starting of the call process. It has to be formulated in a way that the robot can fulfill this reaction.

3.4.1 Navigation scenario

From the idea that the robot should have the ability to move in different directions, we have considered this reaction or movement as the first basic scenario. The robot should be able to understand as many possible formulations as possible and should respond by a proper reaction / movement. In the following, different kinds of navigation movements are described together with the adapted sentences. It should be stressed that these are not inflexible commands or even fixed formulations. This is only the way to train the robot the meaning of the scenario. The goal is that the user finally can ask him to move in a natural formulation and language.

The Robot moves in the direction of User: In the following Table 2a, there are some examples of sentences or questions in three envisaged languages, which the user can say so that the robot must move in the direction of the user.

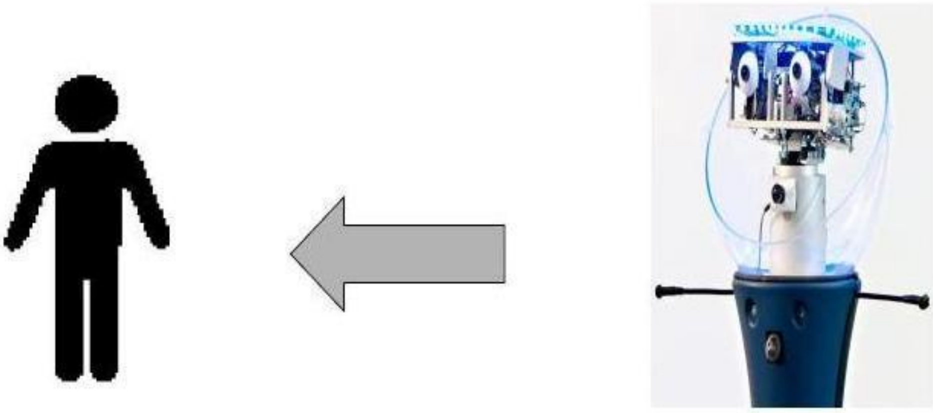

Figure 4: the robot moves in the direction of user.

Deutsch	English	Francais
-Kannst du bitte kommen -Kommst du bitte -Warum stehst du so weit weg -Bitte komme näher zu mir -Komm mal her -Es wäre gut, wenn du näher stehen würdest -Ich kann das nicht lesen, das ist zu klein, bitte komme näher zu mir -Der Bildschirm ist zu weit weg	- please come to me - would you join me? - would you mind moving to me? - move to me - come to my side - join me please - appear by my side - step forward - come here - come closer - come to me - drive towards me	Tu peus venir stp. - viens! - Pourquoi tu est la bas - tu peus t'approche un peu - viens ici - je peus pas lire l'ecran, tu peus s'approche - l'écran est loin

Table 2a: Examples of sentences and questions.

The Robot moves in the opposite direction of User: If the user wants that the robot moves away from him, the formulations below in the envisaged three languages can be used for example, c.f. also Table 2b.

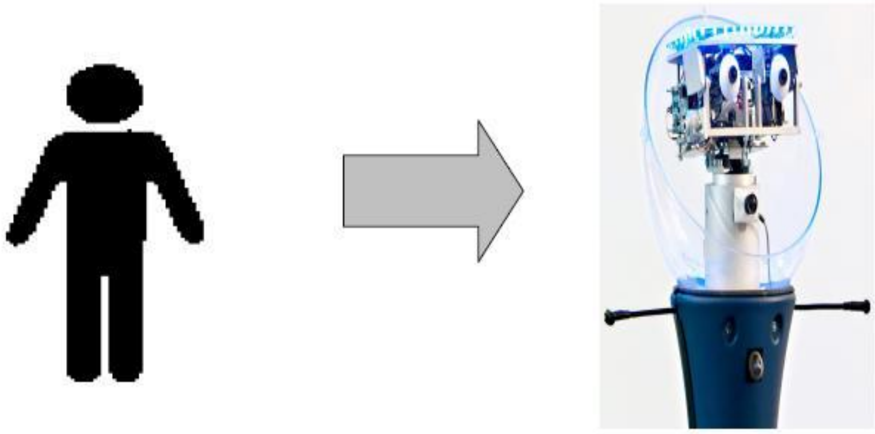

Figure 5: the Robot moves in the opposite direction of User.

Deutsch	English	Français
- Kannst du bitte etwas weg gehen - warum so nah - Das ist jetzt nah - du stehst zu nah - kannst du einen Schritt zurück gehen? - bitte gehe zurück - kannst du aus dem Weg gehen? - bitte gehe ein Stück zurück - verschwinde - bitte etwas mehr Abstand - Such dir einen anderen Platz - rück' mir nicht so dicht auf die Pelle - geh' / fahr' bitte dort drüben hin (!mit Ziel!)	- please move back - could you move backwards? - please step back - please go away - would you please keep your distance (from me)	- tu peus reculé? - pourquoi aussi proche comme ca? - c'est très proche comme ca? - recule! - tu peux partir - vas tu à un autre endroit

Table 2b: Examples of sentences and questions.

Robot moves to the right/left: If the user is in the situation that he wants the robot to go left or right, for example in case that the robot is not in really in front of him, he can use some of the collected formulations and questions in Table 2c.

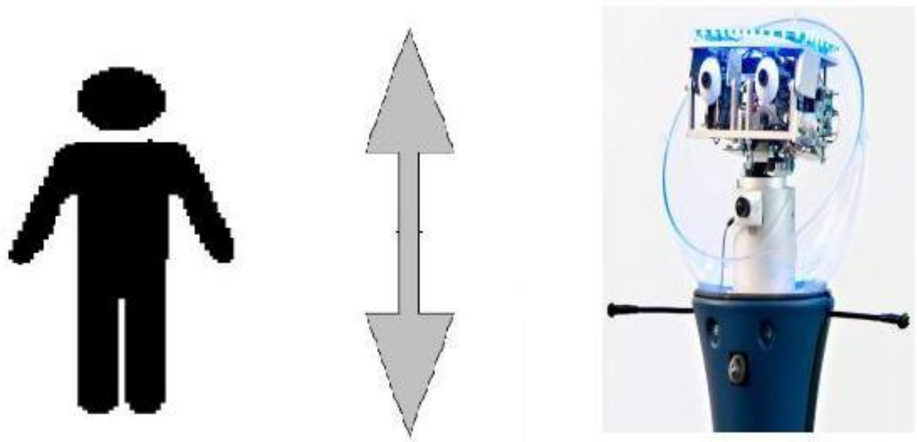

Figure 6: The robot moves to the right/left.

Deutsch	English	Français
- Kannst du bitte nach rechts - Kannst du etwas nach links gehen - gehe bitte ein Stück nach rechts - trete zur Seite - aus dem Weg bitte - einen Schritt zur Seite bitte - Geh bitte ein Stück / einen Schritt zur Seite. - Mach bitte Platz. - Lass mich bitte vorbei / durch.	- could you move to the right? - A bit more? - please move sideward - sidestep please - Please step to the right. - Please step to the left. - Please step aside. - Make way for me, please.	- tu peux aller a droit - tu peux aller un peu vers la gauche - tu peux te deplacé à coté - un peu à doite stp - je dois passe!

Table 2c: Examples of sentences and questions.

Robot should turn around: One possible case is if the user is standing behind the robot, so it should turn around to show the display in the direction of the user. Please see different formulations in Table 2d.

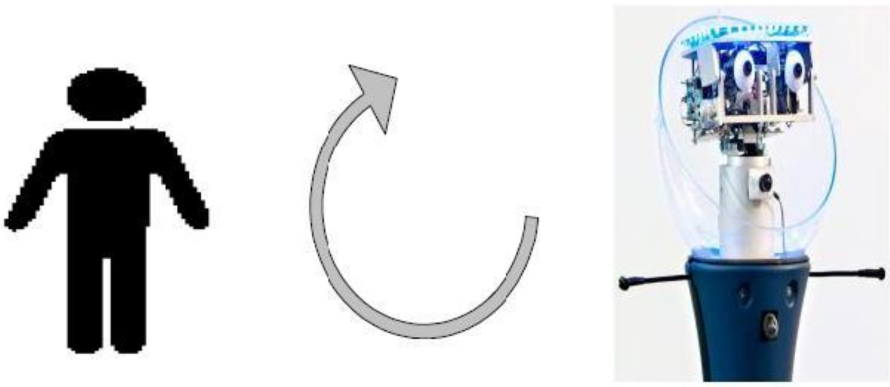

Figure 7: The robot should turn around

Deutsch	English	Français
- Kannst du bitte dich umdrehen - Drehe dich um - kannst du dich zu mir drehen? - ich sehe den Bildschirm nicht, kannst du dich drehen? - ich kann die Tastatur nicht erkennen, bitte drehe dich - Dreh' dich mal um - Bitte wenden.	- please rotate to me - please traverse to the right / left - I can´t see the display/monitor, could you rotate - let me see the display - please turn around	- tu peux stp tourner - tu dois tourner un peu! - je peux rien voir moi, toune toi un peu!! - je vois plus le clavier, tourne toi - je vois plus l’ecran, tourne toi

Table 2d: Examples of sentences and questions.

The robot has to stop: In Table 2e, some sentences and questions which the user might say to stop the robot are given. Here, a possible scenario could be that the robot is moving in a certain direction and the user wants him to stop.

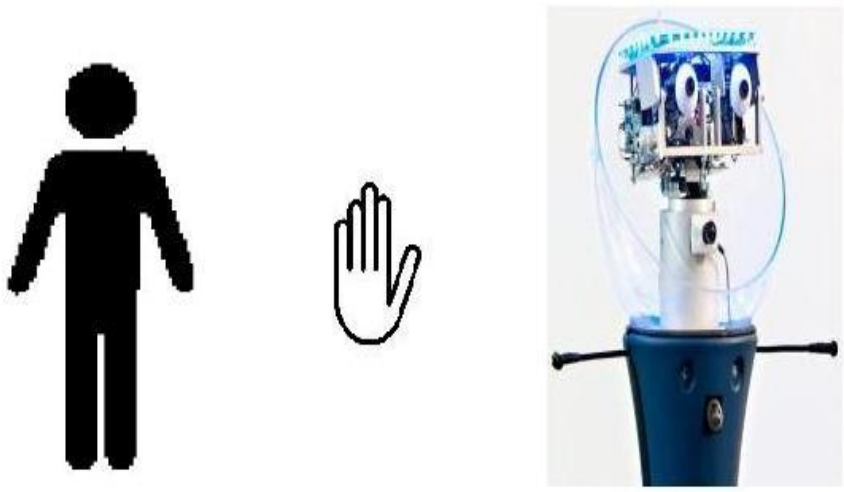

Figure 8: The robot has to stop.

Deutsch	English	Français
- Bleib bitte stehen - Bleib wo du bist - Nicht näher kommen - bleib da - nicht bewegen bitte - Bleib bitte stehen - Bleib wo du bist! - Stopp! - Halt! - Nicht weiter! - Warte.	- please stop - stand still - make a pause - don´t move - remain there please - keep standing there - stay there - Stay where you are!	- attend! - Arrête toi! - ne t' approche plus - Stop - Reste la!

Table 2e: Examples of sentences and questions.

3.4.2 Call-scenario

When the user wants to call his family or friend, there are many possibilities of formulations for this. This scenario in Figure 9 is one possible version how the robot returns a communication program (Skype© in this example) program. The robot must be able to ask the user in this case to open the program and to show it on his display. Because the program Skype can be used in other functions, see Table 1, maybe there are other scenarios with the response “Skype will open”. But in this scenario it is important to observe the major version of the formulation so that no mistake can be made.

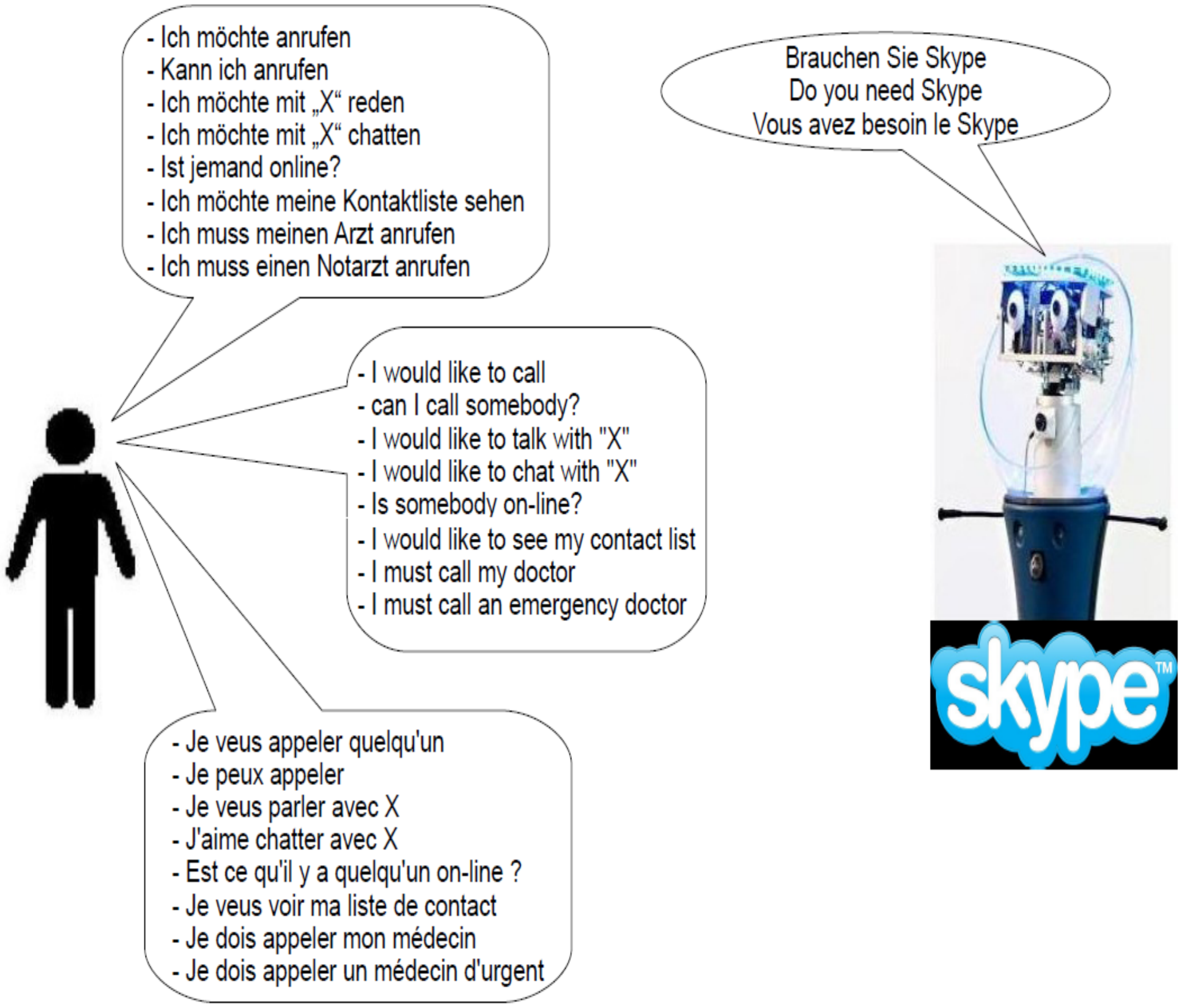

Figure 9: The robot responds by opening the Skype program.

4. The challenge: How can the robot understand his user independent of the language

In the previous sections the global idea about the CES system was presented and the importance of the knowledge database to obtain a robot that can understand and think about of the information from the input. At this step of the project we have only a database that contains parts of the general knowledge. What the robot knows today is for the moment insufficient and he is not able to understand everything what the user will say or write at the first. Secondly it cannot think about the inputs yet because he doesn't have expertise knowledge.

The next steps

To tackle the abovementioned shortcomings (purely due to some delays within the project due to partner exchanges) the next step will be an expansion of the already existing general knowledge database. This process is basically performed by the use of the scenarios (see Section 3.4) and will then be expanded by other scenarios. To obtain more knowledge we have created and uploaded these scenarios of navigation movement events on the Wikimedia page of the ALIAS project. All partners are invited and asked to contribute. The goal is to collect a variety of different formulations and verbalizations of sentences or questions in the three languages German, English and French. By this is meant, that we need different wordings of the same meaning to train our engine so that in the end the user will be able to talk to the robot more or less naturally.

What we don´t need is a sentence which is already there but in a different order of words. Required are other formulations (with another wording) that have the same meaning. This additional information will then be inserted in the database. Since every human being thinks in a different way we are looking for more participants and therefore our partners are in this step an important aid.

A part of the expertise knowledge database is based upon the exceptions of the activities and the functions which the robot cannot realize. An example for these exceptions is the giving of objects since the robot doesn't have "hands". Another example of exceptions is in the health functions, for a security reason this function must be limited and controlled so that the robot can be not authorized to give information for every drugs or an alternative to a special medicine or any other restricted advice, for example.

The other part of this database is the special information about the user. This information is very personal and dependent of the user. For example if a user has a person with the name Paul in his list of contacts, the robot will be able to find it out in case that the user says "I need Paul" and that he wants to speak with him. If this is not the case and the list of contacts doesn't contain this name, the robot has to ask the user and an example of reaction can be "who is Paul".

There are also some other statements which are important for the elderly people and the robot must have a reaction about this. For example if the user says: "my heart hurts", in this case the robot can understand two meanings.

First situation: the user is ill so he needs a doctor and a call process can start.

Second situation: it is a psychology reaction of the user and he wants to speak with a friend or someone of his family.

In such situations, a confirmation is needed from the user for the robot. The robot can respond to the user with "Do you need a doctor?" and thus the user has the chance to give a precise statement. For this reason and for increasing the safety and reliability of the outputs, it is important for the understanding process and the robot to obtain an affirmation before the last reaction will be performed. This could also be realized by showing different options on the display.

The basis vocabulary

At this phase of the project the partner Fraunhofer provided a list with about 10.000 words which will be recognized by their speech recognition module. Adding the meaning of these words to the already existing database is also one of the next steps. After this, the collection of the sentences and questions in different formulations and languages will be added to the database, too. With this step we can start to train our system and thus the robot to understand the formulations. In the beginning, we will start with the navigation scenario and after this we will enlarge the knowledge by inserting more scenarios. It is important to note that the vocal inputs of the user in the end will be highly dependent from the speech recognition. Because of the vocabulary base of the speech recognition we will start with the languages German and English.

5. Conclusions

How effectively the understanding and the thinking process will run, is strongly dependent of the complexity of the rates or the dialogue. If the robot can understand his user in the future depends largely on how his dialog management will be able to understand the inputs correctly and to choose correct outputs. The advantage of the cognesys system is that it will not only understand words but the whole meaning of the sentence. This technique allows to get a meaning of the of natural language utterances. However, it is important to use a differentiated database. That means a database which contains sufficient global and expertise knowledge.