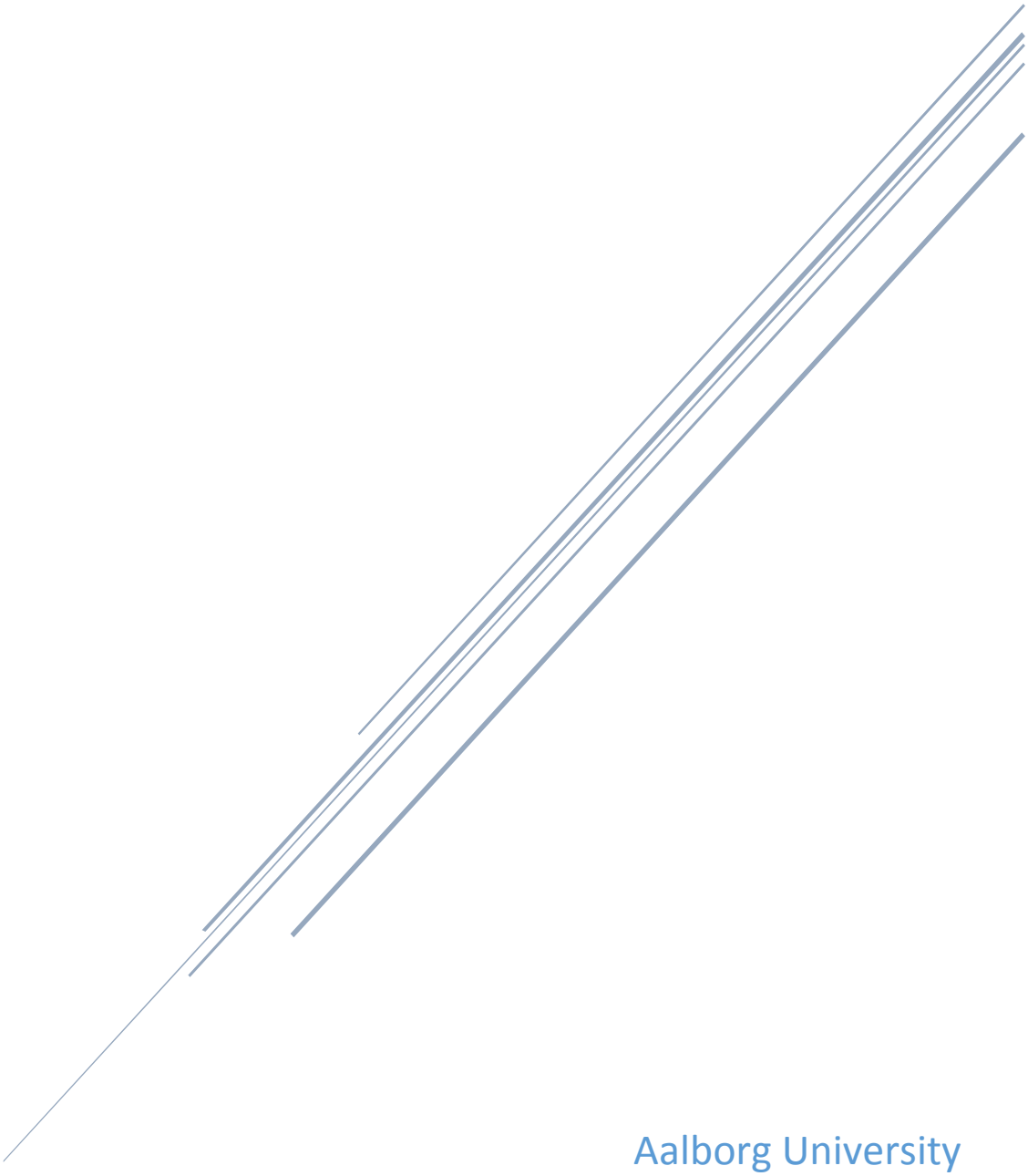
SOCIALLY ASSISTIVE ROBOT

P1 - Fundamental Mobile Robotics



Aalborg University
Robotics

Titel: T.H.R.I.L.L.E.R. (Tiny Helpful Round Intelligent Linguistic Life-planning Everyday Robot)

Tema: Social Robots

Projektperiode: P1

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Projektgruppe: B261

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Synopsis:

In this project, we will be working with socially interactive robots in the work-space. We will make an analysis where we will go in-depth with different diagnoses and how these would be treated in the best way from a non-medical point of view. We will then take a closer look at how to make a robotic solution for this. We will not be developing a full prototype but instead we will be working with the turtlebot where our focus will be on developing the soft-ware.

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Abstract

In this project, we will be working with socially interactive robots in the workspace. We will make an analysis where we will go in-depth with different diagnoses and how these would be treated in the best way from a non-medical point of view. We will then take a closer look at how to make a robotic solution for this. We will not be developing a full prototype but instead we will be working with the turtlebot where our focus will be on developing the software.

Foreword

We, in group B261, would like to extend our deepest gratitude to Elizabeth Ann Jochum (Insert place of work), Kirsten and Trish Nymark (Independent psychotherapeut), for their invaluable expertise in their respective fields, without their help this project wouldn't the same thoughts and ideas that we came up with.
We would also like to extend our gratitude to our supervisor Karl Damkjær Hansen (Department of electrical sciences at AAU), whose been an invaluable asset to us in his keen supervision, always ready to guide us towards our end goals.

Introduction

In this report we will research on people diagnosed with different disabilities, we are going to do this in order to research opportunities for improvements in the quality of life for these patients.
To do this we will research the disabilities itself, while also looking into the institutions in which they live, and spend most of the time we will also go into the needs of these patients. Throughout the project, we conducted several interviews, revolving different disabilities, also regarding social robots.

We will then look at the problems we find within the problem analysis and make a final problem statement. This will revolve around scheduling the day for the patient's, movement and communication. We will narrow these into a single solution, which we will seek to develop during the solving of the problem. In the end of the project, a robotic prototype will have been made, as a solution to the problem statement.
Since this is a time-limited project, we will only be doing a prototype of what we hope to accomplish our ideas and solution. We will have also put some thought on what could be done going forward with the project.

Initial problem statement

How can we improve the quality of life for patients with one or more disabilities?

Problem Analysis

In this problem analysis, knowledge will be obtained, about the different aspects of the initial problem statement. In order to understand disabilities, it is important to obtain knowledge about different diagnoses, based upon the problem these people will face. In addition, there will be parts about the human brain and how trauma to the brain, can affect an individual.

The different diagnosis focused upon in the problem analysis, will be chosen based on the relevance within the world we live in today. Certain disabilities are more frequent than others are and though there is an awareness of other disabilities these are the ones chosen based on the frequency in the world.

After this there will be parts pertaining the professional environment these people, will be situated in, in their everyday life. This will have parts obtaining institutions, caretakers, and the patient needs within these institutions.

In the end, there will be a conclusion that will lead to the final problem statement.

Diagnoses

We will come in to different disabilities there all are very common. These deficits will be brain trauma like frontal lobe damage, ADHD, autism, Asperger syndrome and Down's syndrome. The thing that they have in common is that they all need some sort of structure throughout the day to help them.

The Human Brain

Working with mentally challenged or handicapped patients creates a need for a basic understanding of the human brain. The cognetic functions and responses in between the different areas of the brain. Which parts do these areas control and what does it mean when one of the different areas are damaged?

The human body is capable of doing many things. Thanks to the handling of data from the five different senses, humans are capable of handling difficult situations and take action accordingly. The 1300 grams of fat in the human head, also known as the brain, decide all these actions.

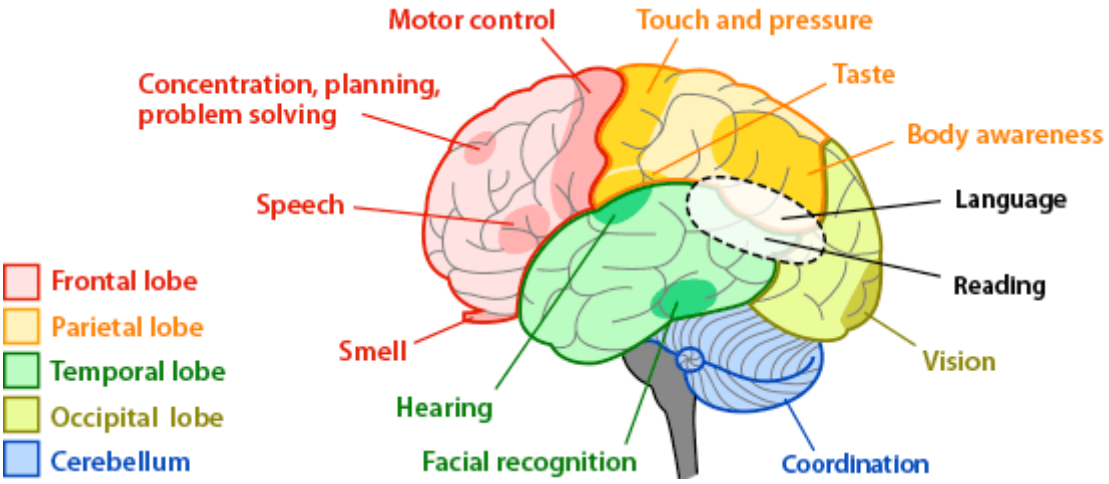


Figure 1 – The brain. California University[i]

The brain is divided into many different areas; each of them handles different kinds of information. The five main areas are the frontal lobe, the parietal lobe, the temporal lobe, the occipital lobe and the cerebellum; these areas are illustrated in figure 1[ii].

Cerebellum is the center of coordination, as an example; if a person were to catch a ball flying towards him, he would probably try to catch the ball with both of his hands. If the cerebellum is damaged, he is likely to fail at catching the ball with both hands together, as the hands would probably try to catch the ball in different areas.

The occipital lobe is the area that mainly controls the eyes and handles visual data.

The temporal lobe is the area that mainly handles information to identify objects or other persons.

The parietal lobe mainly handles information from the 5 senses, senses so that people can feel when other people touch them and finally the frontal lobe which is a bit more complex.

The frontal lobe mainly controls the body and decides actions gathered from the other areas of the brain. It's the area which is used to control the body, speak, concentration and the section which handles takes care of problems solving.

These are the overall functions of the brain, but there are many other small functions the brain does.

Another big function the brain has is memory. The brain has two types of memory, short-term memory and long-term memory and these two are linked. First, a person acquires some information, perhaps a new song the person likes, and then it starts in the short-term memory. If the person really likes the song and listens to if often, he'll start to remember the lyrics of the song because a part of the brain called the hippocampus starts to convert the short term memory into long term memory.

Short-term memory is a part of the frontal lobe, every kind of immediate information gathered is stored in the frontal lobe. This means that if the frontal lobe is damaged, the person will still remember everything he has learned in the past, but will struggle at learning new things.

Looking into the brain and its different functions, it is clear that the problem solution will need a flexible approach in interaction, since different damages to the brain, will result in different issues to the individual. This could be that a person's short-term memory is impaired and things needs to be repeated multiple times, or that verbal communication is impossible and it therefore needs an alternative approach.

Frontal lobe trauma

The causes of frontal lobe trauma are many, including but not limited to car crashes, falls and fire-arm accidents. In accidents like these, the brain is hurdled towards the skull, where the frontal lobe are brushed against the ridged inside of the skull, resulting in bruises and tears in the frontal lobe. It could also be induced by dementia, which degenerates the brain tissue.
It is a great hurdle to live with this kind of impairment of the brain, one of the first persons to be studied after a trauma was induced, was Phineas Gage, who underwent huge changes to his personality. Phineas went from being a quiet churchgoer, to being a loud and violent gambler.
Other changes could be a lack of a filter in regard to what they're saying, lack of initiative and social awkwardness etc.

Taking into consideration that the aim of this project is to provide patients with life improving methods, there's a need to understand what goes on in an institution. This is because, while some patients function on a daily basis in their own homes, some are not as fortunate and have to be admitted to an institution. The following will describe institutions, caretakers and what needs the residents have, based on research and interviews with professionals in the field.

ADHD

Since ADHD is one of the more common deficits and one that causes the patient to often get misguided, it is an illness that, depending on the severity of the ADHD, needs to be supported through life. This makes this illness relevant for the project and therefore a deeper understanding of ADHD is needed.

ADHD or attention deficit hyperactivity disorder is a common neurological disorder, mostly found in children or teenagers, though it can continue into adulthood. Approximately 1 out of 10 children is diagnosed with it and causes the patient to often lose focus and become misguided with his/her initial task. It is more common for boys than girls even though no one has been able to decide the reason for this.

The causes of this disorder varies from genetics to birth implications. What it does is that, a patient with ADHD is missing some signal drugs in the brain (dopamine and noradrenaline), resulting in a lack of attention and/or hyperactivity (without hyperactivity it's called ADD). People with ADHD can often get distracted when working with given tasks because they find it boring so they will lose focus and go do something else. Of course it is different from person to person how they are affected. The condition can show itself in a hundred different ways, while some people have a hard time concentrating. Some concentrate too much and they become hyper-focused and can focus so much they forget certain things.[iii]

It can be a great hurdle to live with ADHD, since the patient might have trouble communicating properly with its peers, this disorder makes planning of tasks troublesome, since patients diagnosed with ADHD typically can be impulsive and unorganized[iv], which in some of the worst cases can result in not paying bills and ending without a roof over their head[v].

In most cases it is important for people with ADHD to have structure in their life so they don't go off topic of what they are supposed to do. When interviewing a psychotherapist named Trish she said the following "very much, in both cases it is important that there is a structure"[vi] when asked if structure is important for ADHD and autism patients. So a problem for people with ADHD is that they need the structure, they need people to structure the day to give them an overview of the given tasks. Meanwhile it is also important that they receive constant stimuli from the given tasks.

In general ADHD causes the patient to lose focus and in general having a hard time concentrating or keeping focus on one subject. The need for a structure and daily reminder to maintain focus in order for the patient to keep his/her responsibilities, such as: work, school assignments etc.

Autism

We have chosen autism because it is a mental disability which covers a lot of different aspects of other mental dysfunctions like ADHD and asperger syndrome. It is not currently curable and is something you have to live with the rest of your life after it have developed during the brain's development state. By this reason a deeper understanding of autism is needed.

Autism is a developmental disorder that most often occurs with young children aged 1.5 years and up to 3 years old. Autism can also occur with older children between 3 to 18 years old, which are still underway to develop their brains. Some of the symptoms of autism could be increased antisocial behavior where you prefer to play alone or just to be alone. It also means that it will make you much worse at comprehending social pressure such as talking with other people or be with them.
Autistics will in some cases lose the ability to sympathize with other people and they will have a chance of becoming aggressive towards other people around them. They cannot keep conversations going and they quickly forget things they have said that lead to them saying the same thing several times in a row.
They develop habits and rituals they have to go through before they can do anything and it is easy for them to get obsessed with something like a wheel on a car or maybe wired dolls. At last, autists have in some cases increased hyperactivity and 3 out of 4 cases of autism the child will be less intellectual were the rest are more intellectual than the average children are. Autism is currently not curable because it is a brain dysfunction, which leads to a decreased mental state.

There are different grades of autism where it goes from a mild grade, where it is only the small symptoms as being forgetful or antisocial, to the extreme where the autistic is aggressive, repeating rituals and is less intellectual.[vii] [viii]

Autistic's have a lot of social problems, depending on the grade of autism, where they have trouble with talking to new people and keeping conversations going. They can also be aggressive and as a caretaker it can be a really hard time when something goes wrong, because it could end up hurting the caretakers or hurting the autistic it self when disturbed as well as provoked. Autistic's are in some cases less intellectual and is having issues with the short term memory so they need a lot of help structuring, organizing and learning.

Asperger Syndrome

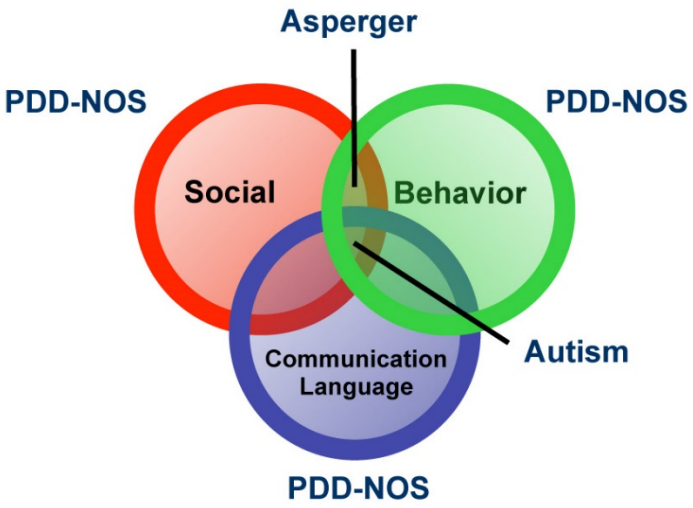


Figure 2 – Autism Spectrum

Since we are already working with autism, it is rather obvious to work with asperger's, since this is an under-diagnosis of autism. The main difference between autism and asperger's is that patients diagnosed with asperger's does not have the same issues communicating. However, they still have the social and behavioral issues (fig. 2). [ix] [x]

A "social defined" problem related to autism is when a person have issues with the ability to make friends or lacking the ability to seek enjoyments or shared hobbies with other people. Other problems are the difficulty of reading other people's signals and emotions, like facial expressions, pos-

ture or gesture. Also difficulty maintaining eye contact when in social interaction with other people.[xi]

A "behavioral defined" problem related to autism is they tend to use all their energy focusing on the things that interest them and completely ignore other people or things. Therefore they tend to be very skilled at a specific thing, but lacking the ability to be good at other stuff.
For example, a person with asperger's can be very skilled at programming, but have issues with basic task, such as focusing on reading, stay focused doing other tasks or structure the day, that is not part of their interest.[xii]

People with asperger syndrome have issues with human interaction and tend to stay away from social interactions. If a caretaker or any other person walk up to the person to tell him/her to, for example, take their medicine, have dinner etc. It can cause certain problems because he/she can become confused or irritated when someone suddenly distracts them from what they were doing.[xiii]

Down syndrome

People suffering from Down syndrome have difficulties doing things on their own, they need a lot of attention from their caretakers. the risk of having a child with down syndrome increases with the age of the mother and it is the most frequent cause of mental disability.. Because of this there is a need to gain an understanding of down syndrome and their inherent disabilities.

Down syndrome is a genetic disorder, that is the most frequent cause of mental disability. The cause of down syndrome is a fault of the 21st chromosome leading to the patient having 47 chromosomes instead of 46.

The symptoms of down syndrome comes both physically and intellectually. Almost 99 % of all people with down syndrome have either a mild intellectual disability (IQ of 50-70) or moderate intellectual disability (IQ of 35-50) a few cases have severe intellectual disability (IQ of 10-35). People with down syndrome often hit Milestones later and in most cases have a mental age between a 8-9 year old child, this can of course vary on a case by case basis[xiv].

People with down syndrome often have physical disabilities, such as slanted eyes, a small chin and mouth but with a normal to enlarged sized tongue, this leads to around 50 % suffer from obstructive sleep apnea (a condition where the upper airway is obstructed leading to “repetitive pauses in breathing during sleep).

They also have poor muscle tone, many have a flat wide face, with a short neck. Growth in height is slower leading the people with down syndrome to normally be shorter in average, with adult men being an average of 154 cm and women being 142.

People with down syndrome often have a weakened immune system, leading to a higher chance of contracting certain diseases, such as: cancer, coeliac diseases, diabetes etc.

This is not to say all people with down syndrome have this but that this is some of the most common symptoms while there is no cure for down syndrome. Many affected individuals are being put in place to ensure, as high a quality of life and as high possibility of independence as possible, this could be an institution with caretakers but the users live in there own apartment.

In general people who suffer from down syndrome tends to have a mentally younger age than they physically are. They have can have some physical disorders, such as a small chin and trouble breathing while sleeping, or in general, a lack of control of the bodily functions. Finally, they generally have a lower IQ than the rest of the population.

Diagnoses Sub Conclusion

By the given diagnoses it can be concluded that the main issue and the most common issue among people diagnosed with the previous described disabilities, is that they have a hard time getting through an unstructured day. An additional thing that can be concluded is that the most of the diagnosed people wants individuality. What is meant by this is that the people want to be self sustainable as well as able to handle their lives themselves.
By taking this from a different angle the diagnosed people whom are living at institutions will have the same problems to deal with.

Within the problem analysis we need to investigate into the environment that people with disabilities live in. This means there is a need to look into institutions and the professional people working with them. In addition, there will be a segment about the needs of the patients within these institutions.

Institutions

When people suffer from a mental handicap, depending on the state of the patient, it is sometimes advised that they move into a care house where they can be properly aided. Since the main thought is to implement a robotic supplement in these institutions, it is important to properly understand what is involved in this environment. Therefore, the assignment below will shortly describe some of the patients needs and different approaches in order to take care of them.

These institutions have been running for long ago, in the Victorian age, they were "shelters" where people who wouldn't follow the society rules could have a place, nowadays, they are places where people can have some rehabilitation and gain as much control of their own lives as possible.
In order to be considered a psychiatric institution, the facilities it provides must only be used by its residents. The main objective of this institution is to proportional integral attention to the users through prevention, rehabilitation and health education[xv].

Reasoning and problem solving, assigning meaning to the words, understanding abstract problems, short term memory for habits and motor activities, control the expressive language, initiating an activity in response to the environment… These are some of the activities every human has to deal with on a daily basis in order to cope with the accelerated pace of life of the society[xvi]. What if, in a matter of seconds, you lose the ability to perform these actions?
These are just some of the problems people who has a frontal lobe injury have to deal with; fortunately, there are some institutions which can help them and their families in order to overcome this situation[xvii].

When treating someone with a frontal lobe damage there are a lot of people involved, "a physiatrist, skilled in neurology and orthopaedics, will use techniques of physical and medical rehabilitation to help the patient to regain as much functioning as possible. A neuropsychologist will run tests to ascertain what aspects of "competence" have been lost as a result of the injury. The patient's motor

functioning, including strength, balance, coordination and movement, will be assessed by a physical therapist, who will suggest exercises and strategies for improvement. A speech consultant will be called in to focus on helping the patient with skills of expression, comprehension and communication. Finally, a social worker generally acts as a liaison to facilitate dialogue among the patient, family and various team members"[xviii].

People with frontal lobe trauma could be aided with this robot in the sense that by constantly motivating the user and repeating over and over again the tasks which must be done, it might convert the short term into long term memory, therefore the user will start keeping track of his/her own actions.

Frontal lobe damage can be either something you are born with or which can be caused afterwards due to both, external accidents when the skull is damaged and injuries to the brain or it can also happen without external interaction when the brain is damaged by the inside of the skull as a result of concussion. The upcoming disabilities can not be caused by external factors, they are usually something you are born with or have a genetic predisposition to, even when certain environments can trigger the reactions.

The main problem, as it is with almost everything in the human body, is that treatments must be based on the individual's' physical and intelligent capacities, there is no generic method to approach a specific condition.
When interviewing Trish, focused on ADHD she talked about 80 to 90 % of them having a really positive effect when taking medicine, but she also stated that medicine is never the only solution and that even though, she explained the lack of an efficient treatment.
"*ADHD is so different from person to person because even when there is people with the same diagnostic in the room, there are going to be a hundred of different ways to show it, some people will have trouble with concentrating, others are really good at concentrating so good that they forget to go to the bathroom, to eat, to phone their husband or wife, they forget to go to work because they are so focused, hipper-focused, so there are great differences on the way it presents itself, so we need to know how it is ADHD for me, what am I good at, because people with ADHD are good at a lot of stuff, they have a great potential, maybe they have a difficult time organizing so it's important to know what do I have to work on and what do I already know so I don't have to focus so much on that."* [xix].

Moving on to autism and aspergers there is no medicine available and once again it will depend on the personal strengths and limitations. Nevertheless, it is true that they can receive help from specialists in order to blend in with society. Another common symptom they share and that could be easily aided is the need to follow a schedule during the day.

When it comes to Down syndrome, there is no medicine either:
"a child with Down syndrome likely will receive care from a team of health professionals, including, but not limited to, physicians, special educators, speech therapists, occupational therapists, physical therapists and social workers. All professionals who interact with children with Down syndrome should provide stimulation and encouragement." [xx].

Knowledge about institutions and how users are treated is crucial when approaching a solution for the improvement of their quality of life. As an overall, it is clear that even when every patient must be treated consequently to not only the diagnostic but also more particular aspects, all the users present a need for a scheduled itinerary.

Caretakers

Throughout this project knowledge have been obtained, about different diagnostics that are often present within institutions. It is however also necessary to gain knowledge about the professional people working within these institutions. The reason it is necessary to understand this, is because to understand the people working in these institutions, could also lead to a more in depth understanding of the users needs and perhaps the places where there is potential for aid as developers.
To gain the relevant theoretical knowledge we interviewed a caretaker who works within an institution with psychological or physical deficits. This was done to ensure more knowledge about how they work in this specific field to see how structuring of the everyday setup for the user is. In addition, the potential product where discussed to gain insight how pedagogues view technology and technological approach within their workspace.

A caretaker is an individual educated in the act of caretaking certain individual within an institutional setting**.** This involves a wide range of different pedagogical task over a wide range of institutions.

This could include three different specialties:
day offer pedagogy which is focused on children in the age range of 0-5 years

Free time pedagogy, which is focused on the age range of 6-18 and focuses on development, well-being and learning.

Social or special pedagogy, which focuses on kids or adult with special needs, people with social difficulties, or people with a physical or psychological deficiencies[xxi].

They also have line subject, which is chosen individually and could be something as expression and music, or outdoor activities.
Caretakers have a wide range of topics covering many different fields such as relations, organizational structure and media.

Caretakers working with, patients with deficits base their work on a patient, by patient basis, based upon the individual patient personality, this means while diagnostics is important, the individual's personal preferences takes precedents. This translates over to a need to know the individual patient, understand their needs and personality, and therefore customize the approach towards this.

Some of the things necessary for certain users is to set up a structure and aid them through the day. Many of the patients have a need for this, this could be patients with autism, Asperger's or Down Syndrome, the way this could be setup could be verbally (spoken out loud) or could be through the use of visual aids, such as pictograms or the likes. The degree to which the day has to be structured for the user, is individual, it could be that one user only needs a general outline of the day to function or for others every task throughout the day has to be setup for the patients to have an overview and function, this is based on the patient's own needs and diagnostics.

When it comes to technology, while caretakers aren't educated in technology use or implementation, they have topics regarding media, which covers topics such as internet, video games and in general the media's most widely used throughout society and how to best reflect and implement these in the institutions.

In the interview with the caretakers Kirsten, it was discussed which technology they used at the institutions. She said that they used iPad and computers and that they used specific software called a voice box, which allows the user to speak through the software. However she states that she is not really a part of their technology use and do not use them in pedagogical tasks.

In conclusion, a caretaker is an individual educated in the act of caretaking. They work based on a person-by-person basis and approach the user based on the individual's needs and deficits.
They work with structure for the user based upon how much the user needs it is based on not just the diagnosed the user has but also on personality. caretakers does not necessary have technological knowledge this will be important to take not on later in the project.

Patient needs

In order to decide how to help the patients the most, it was needed to have a better understanding of what the patient needs. This will not be done in regard to the individual patient, but in a general term, in order to get a broad overview.

For patients diagnosed with ADHD, autism or asperger syndrome, scheduling is crucial in most cases, to make their everyday life less overwhelming. Autism and asperger's have a greater need for these scheduled tasks to be followed, since it can be more frustrating to them if things suddenly change, whereas patients with ADHD are more lust controlled, meaning that if they would rather do what the task has been changed to, it doesn't really affect them, but it might be frustrating if it's the other way around.

Even though the day is structured, patients with ADHD still have a need to be stimulated during completion of the tasks or it will get boring for them. This is generally not an issue for patients with autism or asperger's, since they want to complete the given tasks, as long as it makes sense for them. In order to receive this stimuli, either the task has to be stimulating itself or someone has to insist (in a nice way) that they do it.

For ADHD patients there's quite a few different kinds of medication, some of which require the patients to remember to take their medication at specific points of time (strattera etc.).

For patients with down syndrome, some of the same things apply, like some patients could definitely benefit from scheduling, while others may not, because they might not be as severely affected. In order to schedule the day so the patients understand it, sometimes it's needed to use pictures.

Down syndrome might affect different parts of the brain, why some patients have the need for assistance moving around or even talking. This is typically accomplished by wheelchairs and speech machines. Even though aids like the speech machines are offered to the patients, some patients might not be able to use these by themselves or completely. Because of the sleep apnea, some patients might have a need for using a respirator during nighttime.

Many of the things described as aid for patients with down syndrome also applies to patients with frontal lobe trauma. This is because the center, of the brain, that controls the cognitive skills are damaged, resulting in childish behavior.

For all of the diagnoses, it is important to have someone who understands and accepts them. this of course applies to all humans, but in cases where a person has been given a diagnosis it might be a tough thing to do. The patients often have trouble socializing, so it's peers might find the patient to be "weird". Leading him or her to be picked on or left out of the intern society.

While every diagnosis is different from patient to patient, it would be safe to say that most of them would benefit hugely from a more scheduled day. For some patients it's enough to simply tell them what they have to do, but some might be more affected and need a more delicate way of communication.

So far the report has looked into different disabilities and how it works within institutions that houses people with different disabilities. We have arrived at the conclusion that a lot of people with ADHD, autism etc. need more structure in their life, than the average person. For instance people with autism need a lot of structure in their life, and organizing in their life. And concerning caretakers they can add a human connections to residents living in the institutions.

Current solutions

Now that we have concluded on our theoretical research, we will move on and look at the current market, in order to avoid developing something that already has been made or to see if there might be a product that we can improve upon.

In order to avoid doing sisyphus-work there is a need to research what is currently being done in order to improve the life quality of the patients. A look will be taken on the current solutions in the field leading up to a discussion about what could be done to further enhance their life quality.

In today's institutions dealing with people with certain physical or psychological disabilities, pedagogues are working on ensuring life quality and independence for the user[xxii]. This is done through certain pedagogical tasks. Since all this tasks are based not only on diagnoses but also on the individual person's needs, preferences and personality, it is hard to state what exactly is being done to ensure handicaps quality life standards. Humans in general are all different and two persons with, for example, Down's Syndrome aren't the same and therefore won't react in the same way to pedagogical inputs.
Nevertheless, there are certain methods which are used on a broad spectrum of users, among those we can find schedules[xxiii]. Many users with a broad range of handicaps need the day structured out for them, this makes them feel more in control of the situation which reduces the chances of the user getting overwhelmed by the new events that occur naturally through the day.

When maintaining structure for the users, several methods are used to visualise the events throughout the day. This could be done through pictograms[xxiv] a method where picture to symbolise daily, weekly or monthly events are setup for the user by the aid of the pedagogue these often used to aid people with ADHD, Down's syndrome and especially people with autism or asperger's.

Possible solutions

The following chapter will describe the possible solutions by giving the ratings from the criteria sheet below which is based on a point system. In the delimitation chapter it will be specified which solution that has been decided to focus on.
The way the criteria sheet beneath works, is that every solution will be determined through the criterias in a point system from 1 to 5 with a total score of 20 points. If the score is high the solution

will be better and if the score is low it will not be a good solution and will probably contain a lot flaws. These solution were chosen through the discussion and brainstorm based on the problem analysis.

Schedule Robot: This is a robot that can help people with certain problem as remembering or having the need to get the day scheduled is to help them structure their day and give them a better overview of what is happening. This type of robot is also meant to give the patient more individuality as well as self sustainability.
The robot has 4 points in "social context", because it does not really interact with people but still communicates with them in a social context. The "patient focus" have 5 points because the robot has to work with the patients at all time. The "ability to help" also have 5 points because the robot focus on helping the users to help them remember and to structure their everyday life. The "caretaker stress release" is have 4 points because the caretakers does not have to use as much energy on reminding people of what they have to do today or tomorrow.

Social Talking Robot: This robot will be designed to have social conversations with the patient during the day to keep them calm and happy about their situation.
The 5 point in the "Social Context" for this robot is because of the strong social aspect of talking and having a conversation. The 5 points given in "Patient Focus" is given to this robot because it will for the most of the time only talk to the patient. The 4 point given in "Ability to help" is given to this robot because it help the patient with rebuilding the brain or understand things easier with social talk. The 3 points given to the robot in "Caretaker Stress Release" is given because it is not that much help to the caretaker because it is already easy for them to talk when cleaning, serving food etc.

Alert Robot: This is a robot that keeps an "eye" on the patient as well as what equipment he/she uses and alert them if they have forgotten to, for example, turn off the stove, the light, etc.
The robot has 2 points on "social context" because the robot does not have to interact with a person unless there is something it has to alert them about. "Patient focus" has 4 points because it focus mostly on what the user is doing at any given moment. The "ability to help" is also 4 points because it reminds people if there is something they forget. And the "caretaker stress release" is also 4

points because the caretakers does not have to check if something is wrong with the patient all the time.

Mopping Robot: This robot, which is similar to the well known vacuum cleaner robot will in this case instead of cleaning dust, will it now wash the floor in the house or room of the patient.
This robot has 1 point in "social context" because it is only used to clean. It has 1 point in "patient focus" because it do not have to focus on anything but cleaning. The "ability to help" is 3 points because it helps a person clean, but do not help the user in any other way. The "caretaker stress release" have 4 points because caretakers do not have to use time on cleaning, which is giving them time to do other things like socializing with the patients.

Guidance Robot: This is a robot that helps people who suffers from short term memory like the diagnoses from the problem analysis describes. This type of robot can in addition be used with dementia or amnesia patients too to help them find their way around the city, when they have to go out shopping or go home.
This robot has 3 points in "social context" because the robot only focus on guiding people rather than communicating to them in a social context. It has 5 points in "patient focus" because it helps patients getting outside and let them walk around without being lost. "Ability to help" have 4 points because it helps the users find their way around and help them remembering where to go. And the "caretaker stress release" have 3 points, because it helps them a little on making sure patients are not getting lost when they are outside their room or institution.

Solutions/Criterias	Social Context	Patient Focus	Ability to help	Caretaker Stress Release	**Total**
Schedule Robot	4	5	5	4	**18**
Social Talking Robot	5	5	4	3	**17**
Alert Robot	2	4	4	4	**14**
Mopping Robot	1	1	2	4	**8**
Guidance Robot	3	5	4	3	**15**

Figure 3 - Sheet of criterias

Based on the above illustrated criteria sheet and the conducted interviews, it has been decided that the schedulebot is the most viable option for further work.

Final problem statement

Can we make a robotic solution for scheduling a patient's day, capable of movement within the institutions, while maintaining an user-friendly UI for the caretakers to use?

Problem Solution

In order to obtain the best possible solution for our problem, we have made some thoughts about the structure and design of the software as well as some thoughts on the design of the model. We have been given a turtlebot as the platform for our prototype robot, which is why these model designs will not be made on the actual robot, but reflected upon.

Proposed software

First of, the robot should be able to autonomously navigate and locate the correct patient by facial recognition, making it capable of handling more than one user at a time. It should then approach the patient from the right angle, when actions are triggered.

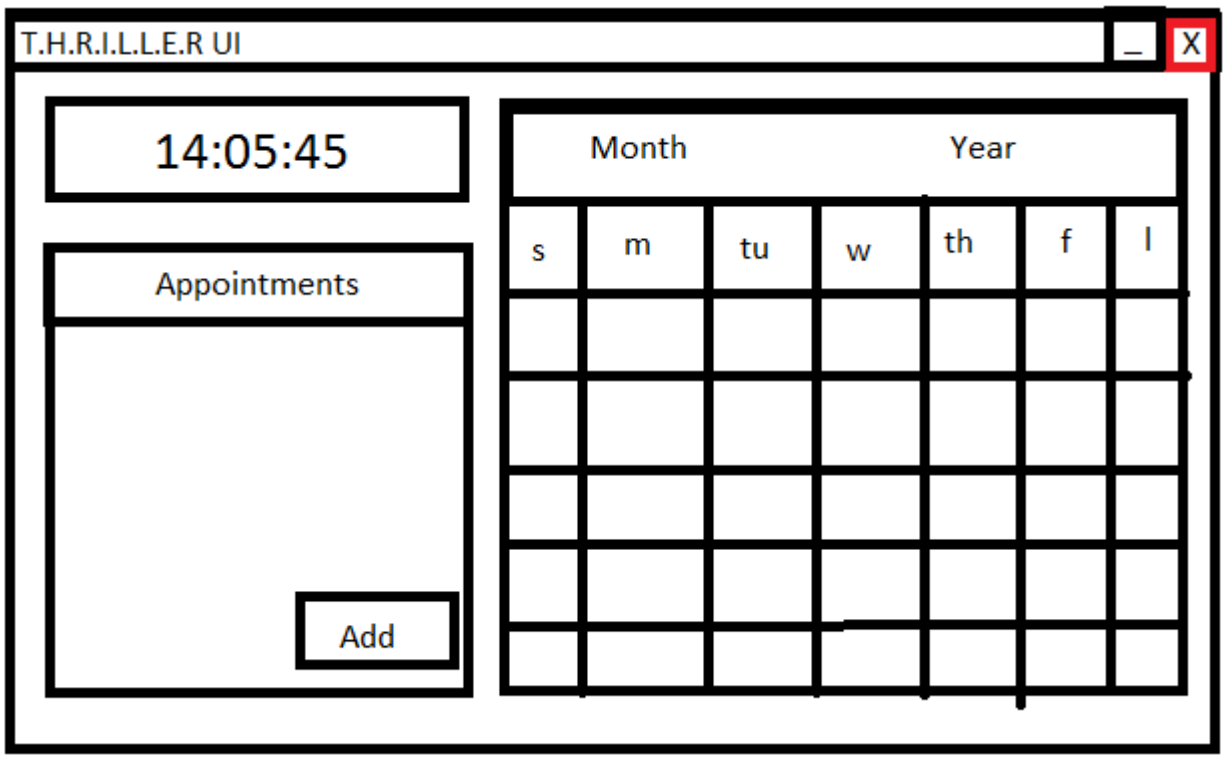


Figure 4 - Ideal UI for T.H.R.I.L.L.E.R

Secondly there will be made an GUI, providing the caretakers with the simple options of adding or editing an event, an easy overview of upcoming events and a visual representation of the calendar and time. It should autonomously keep track of the time and date in order to activate itself.

Furthermore the communication center on the robot will be able to understand and respond to a question or make new appointments by being told when the appointment will be. It will also be able to puzzle a sentence together by keywords only, so that the caretaker can tell it to wake the patient up at a certain time and it will figure out what to say by itself, while calculating the corresponding gestures. The voice of the robot should be as realistic as possible, in order to refrain from having a voice that sounds mechanical.

Proposed hardware

As mentioned in the introduction of this chapter we are using the turtlebot for this project, however in this chapter, the solution will be described as we want the robot to become, disregarding the turtlebot. Instead we are planning on building a nice-looking robot, which isn't intimidating to the patients, but more like someone who could be considered a friend for the patient in order to obtain the best result. At the current stage of development we are split between a small human-like robot and a circular-based model, similar to that of the turtlebot.

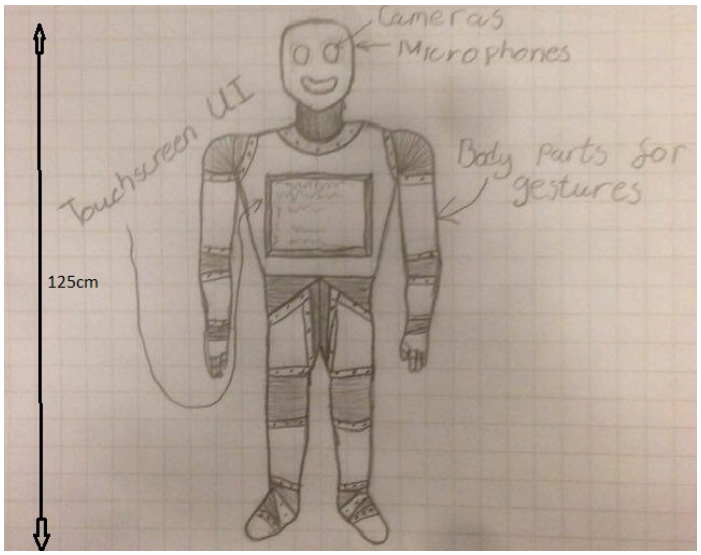


Figure 5 - Human looking robot

For both of the models it is applied that it should have an integrated touch screen for the caretakers to use, it should have "eyes" in form of cameras and an microphone. In order to maximize the battery time we are planning on installing a large battery, that allows it to operate for at least 16 hours straight, allowing for field trips and extended use. The robot should though go back to a charging base every time it's done with a task.

Proposed model nr. 1

For the first proposed model of the robot, we have a human-like robot. This design is especially great for getting the patient to acknowledge the presence of the robot; it also excels in ease of getting to use the screen, because of its ability to climb onto a table or another stable surface,
Using its arms. The robot will be equipped with cameras in the "eyes", which will be controlled by three motors, making it capable of rotation along all three of the axes (x, y and z). It will be equipped with a microphone in each of the "ears", making pinpointing of a sound available to us, while still not making compromises with the exterior design. The touchscreen on the breastplate will display the UI and serve as the primary input option.
For the skeleton of the robot, we will use servos for each joint, making us capable of getting an almost human-like flow in the joints. We will use a gyroscope for making the robot keep its balance, using automatic counter steering in the software.
We have sat the desired height of this model, based on the ability it has to climb to a surface, securing the optimal working position for the caretakers. The design is drafted based on our interpretation of the interview with Elizabeth about how human-like the robot should be.

Proposed model nr. 2

The second proposed model is very similar to the design of the turtlebot. The base will be the same as the turtlebot, but the body will be closed instead of the plateau design of the turtlebot. The camera will be placed on the top of the front "side" together with the microphones. The position of the microphones will be here, so that we can avoid getting too much dust in them. On the top of the model, will be the touchscreen. The size of this model would therefore have to be larger than the human-like, in order to achieve a good working position for the caretakers.

Our initial thought, is to go with the human-like robot, since this model would provide the best learning opportunities going forward. We know that some of the mentioned things aren't something we can do at our current skill level or with the time limit we have, but nevertheless these are the things we believe are necessary for obtaining the optimal results.

Delimitation

To ensure the most effective method of work it is important, to limit the project within the chosen solution. This means focusing on certain specific scenarios, to make the robot as effective as possible.

First the focus of the work on the solution is within a known environment, which means that the robot will be brought up with the environment already saved in the computer, that makes for more streamlined testing that can in further development be expanded upon.

The solution will be made for a single individual, which means that the focus will not be on making user interfaces, will be worked with, is the turtlebot, therefore the project is limited to areas the turtlebot can

Due to time limitations, the robot will not be able to autonomously locate and move to the patient, but instead it will have two or three preset locations, that can be triggered. Since our current platform is the turtlebot, it will not be able to scale stairs or leaps, only non-rugged areas.

HRI

Human robot interaction (HRI) is the study of how humans interact with robots. The study of HRI is a study that can keep going for many years to come and there will always be new things to learn about the subject as Elizabeth Ann Jochum said in our interview

> *"… you are entering the middle of a conversation that has had a long beginning and has a long future in front of it."*[xxv]

HRI is a field that will keep expanding as long as robots are being developed, because the way the human mankind interact with robots will change, as they get more common in the everyday life. Key terms in HRI that is studied a lot, is orientation, turn taking and other human behaviors, but it could also be appearance of a robot. Does the appearance for instance create expectations for the robot?

HRI is an important part of this project since it is about socially assistive robots and the robot will in some way act in a social context with the user. Because of this, there will be a high level of human robot interaction. One of the things that is less important is the appearance of a robot, and that is because how a human act with a robot is different from how a human acts with another hu-

man. The way humans act with robots is more based on their morphology and embodiment and not how it is shaped.

Socially assistive robots

There is more than one kind of assistive robots for instance contact assistive robots that use physical contact to provide some kind of assistance, there is also socially interactive robotics that entertain through social interactions. The research area of socially assistive robots is a field that has been defined by Maja J Matarić and David Feil-Seifer in the paper "*Defining Socially Assistive Robotics"*. According to Maja J Matarić and David Feil-Seifer

> *"Socially assistive robotics must address a spectrum of novel challenges in terms of performance."* [xxvi]

Those novel challenges are 1 User Task Performance, 2 Level of autonomy and 3 Embodiment v. Non-embodiment. In all of these challenges HRI is a dominant force, in User Task Performance a socially assistive robot should be engaging for the user while also be able to respond to the caretakers needs and this is what is important for HRI.When asked how Elizabeth Ann Jochum would define a social robot she said:

> "I would say a social robot is an embodied robot that promotes fluid and natural human interaction."[xxvii]

The Level of Autonomy says that the robot should be user friendly and easy to operate and configure without extensive training, by addressing this you enhance the interaction between the human and the robot which then achieves a greater level of HRI.[xxviii]

When it comes to Embodiment v. Non-embodiment the point made earlier about how it does not matter how the robot looks becomes relevant again. For instance Maja J Matarić and David Feil-Seifer writes:

> *"If the robot does not need to engage in a physical contact task, what is the reason for using a robot at all?"*[xxix]

Here it is stated the looks of the robot is not the most important thing but more the fact how humans interact with it, though the look is not entirely unimportant since humans have a tendency to give goals and intentions to physical mobile object, which is also stated later in the paper *"Defining Socially Assistive Robotics"*.

HRI is a very important component to have knowledge about and take into consideration when working with socially assistive robots since people will be interacting with the robot. Knowing for instance that the embodiment might not be the most important thing could have an influence on the final design of the robot furthermore and level of autonomy can also influence the design but also the user interface.

Ethical dilemmas

The social robot, created in this project, will need to work with people with disabilities and the institutions they live in. For this to be successful there is a need to reflect upon the ethical dilemmas when implementing a robot into this environment. This will be done based on the material written in the problem analysis and the interviews conducted during the project.

The dilemma we will be focusing on is whether the point of having a robot being a part of the pedagogical task within institutions. Is it alright for robots to be a part of the users daily social interaction, especially when these people have special needs? Can we put a robot in charge of an important task such as structuring the day for the patient and to what extent should this be allowed[xxx]? If the responsibility the robot is given is too much, how will we make sure, that the services the patient needs during this time is not neglected? This could be, if the users have questions concerning the task, the robot is telling the user to do or if the patient refuses to do the task assigned to him. Does the robot need to explain why the user needs to do this or in this case will it need to call a caretaker for help?

Not all ethical question or dilemmas can be answered, although reflecting on these and the possible solution to these tasks can be highly beneficial since it broadens the understanding of the challenges when implementing the robot into this environment.

To answer the question set up in the dilemma, how will the robot be responsible for structuring the user's day is; It won't. The robot is meant to be a supplement that helps the caretaker, meaning the caretaker will need to set the robot up with the appointments. The caretaker will need to oversee the progress of the work the robot is doing. The reason for this is that this brings security to the work the robot is doing meaning that the patient should not be responsive, but the caretakers will supplement.

From the ethical dilemmas it can be seen that it is needed to make the robot work in cooperation with the caretakers, the caretakers are the responsible part, it means that if a user is not willing to

follow the task set up by the robot the caretaker will be responsible of motivating the user. The robot is a tool in the pedagogical work and therefore should be used as such.

Stakeholder and SWOT analysis

This chapter will make a stakeholder analysis and a SWOT analysis based upon the problem analysis as well as the problem solution. The stakeholder analysis is connected with the problem analysis in the way of talking about the caretakers and the institutions which will be the ones working with the robot. The government and the next of kin will be variating factors that both can affect the user as well as the institute. It was chosen to use the stakeholder and SWOT analysis based on the fact that the stakeholder grants knowledge about the groups or people influencing the product. This will be helpful to understand who to keep pleased, and who can influence the final product. The SWOT analysis can analyse the product we will create based on the total strengths the product will have within a fitting model.

The SWOT analysis makes a connection with both the stakeholder analysis and the problem solution. The way it makes a connection with the stakeholder analysis is because, the buyer of the robot can be seen as one of the stakeholder as for example the institution. The way the SWOT analysis connects with the problem solution is by using the information about the schedule robot as a product.

Stakeholders analysis

This is here because of reasons..

Users	Government	caretakers	Next of kin	Institutions	Doctors

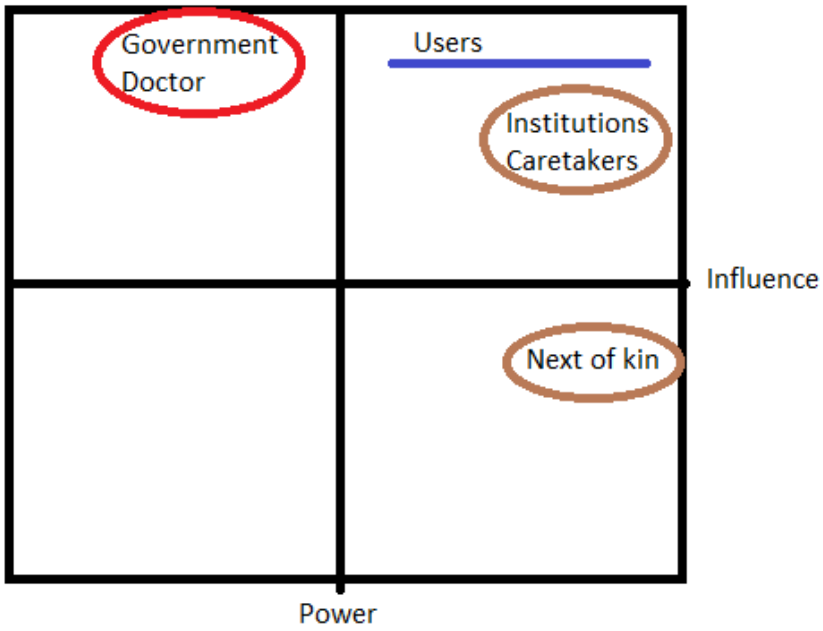


Figure 6 - Stakeholder power and interest chart

During the stakeholder analysis we have identified the following stakeholders who might have some power or interest in the project; users, government, caretakers, next of kin, institutions and doctors. Making a power/interest grid where the stakeholders are prioritized, it is shown how the prioritizing about who keeps them informed, satisfied or managing is placed. Of all the stakeholders, there are three that is to be managed closely and that is the following, users, institutions and caretakers. Users have a lot of power, if they do not wish to use it then they have all the power and it can not be implemented. In addition, the interest for the project is going to benefit and help them.

The institutions have a lot of interest, they are directly involved. There might be some financial interest, making sure that it is not too expensive. Their power is high too because they will choose whether or not to implement it in the institutions.

Caretakers have about the same amount of interest as the institutions but their interest is not a financial interest but rather how it will influence their workday. Their power is about the same amount because they are a source for feedback.

The next of kin have a high interest in the project since it will directly affect their kin, moreover, their power is from low to medium because they know the user and might be able to influence his or her opinions.

The government and doctors both have a high power; the government set the regulations and so on, while the doctors have a professional opinion that can influence the project. Their interest are low as long as all the laws as well as regulations are upheld and what are done with the robot benefits

the user. In addition, the government can be an important stakeholder since they can help finance the project.

	Users	**Caretaker**	**Doctor**	**Govern-ment**	**Next of kin**	**Institutions**
Interest of the stake-holder	Primary user. Interest depends on usability.	High since the product will influ-ence the workday.	Low since as long as laws and regulation are upheld, the level of involve-ment is low. There may be scientific interest if product is relevant.	Low since as long as laws and regula-tion are up-held, the level of in-volvement is low.	High since they are direct-ly involved with the impli-cation of the product.	
Power of the stake-holder	Most power since prod-uct will be made for users needs.	High, they are the main source of profession-al feed-back.	High since their pro-fessional opinion can highly in-fluence the success of the project.	High since the govern-ment will decide whether or not the product can be used.	Medium to low. Though they can influ-ence the user's view on the product they don't directly have power,	High since they have sway over whether or not, it will be implement-ed in their in-stitution.
Potential contribu-tion to the project	Interviews or in gen-eral conver-sation to streamline product.	Interviews, or feedback in general about test-ing.	Scientific research feedback could be a possibility.	Finances, or in contact with the regions.	Very little.	Implementa-tion will be done, in dialog with the insti-tutions. Also feedback based on ob-servation.
Influence on project	Success depends upon the user's inter-est in using	They will help the user inter-act with the product so	Mainly through scientific research, or feedback.	Very little.	Very little.	They will pro-vide the prima-ry grounds for the product, along with the

	the product.	very high influence.				context.
Expected level of involvement	Will primarily be involved with the product.	High.	Medium.	Low.	None.	High.

Figure 7 - Interest of stakeholders

SWOT Analysis

The SWOT analysis analyse if the turtlebot can function in the world without being outsourced or if it even is useful for people. This is checked by 4 main sections of the analysis. The first one is strength, that checks what the turtlebot is capable of doing. Weaknesses, as the second one, checks what is bad about the turtlebot. opportunities, as the third one, checks what other potentials the turtlebot has and last but not least as the fourth one is threats that checks if there are other potential threats for the turtlebot, like other companies, new technology etc.

Strength

The turtlebot is a small, fast and maneuverable robot which gives the robot the ability to drive around in most houses or institutes without the need of making cleared assigned paths for the robot to follow throughout the building. The robot is programmed with a computer that is placed on top of the robot which mean that people who is not used to computer programming can still use the robot without making them feel that they don't know what they are doing.

Compared to a human the robot will always remember a task, whereas humans tend to forget things now and then. For example, if a person needs to take their medicine, the robot will always remember to inform the person about it, whereas a person can easily forget it if distracted.

Weaknesses

The turtlebot is battery powered robot, with a separate battery powered computer, therefore the robot is limited to the amount of power that can be charged into the battery of the turtlebot. Though the turtlebot have a charging station, the computer doesn't. The computer is the main part "brain" of the computer, therefore if the computer's power runs low and shuts down, the turtlebot will shut down as well.

Opportunities

The turtle-bot is programmed and runs through a computer that is placed on top of the robot, so should a user/buyer wish a robot with different settings or wish to create different tasks and etc. the robot could fairly easy be reprogrammed to enable it to do other task or jobs that it originally was assigned to and can be modified to fit most situations that is needed for specific uses. This give the turtlebot an almost unlimited number of different jobs that it can do.

Threats

The turtlebot has a major threat when it comes to future technology. If there were to be build a more advanced robot that can do the same task as the turtlebot, but easier and faster as well as completing additional tasks programed into it, it could replace the turtlebot and remove it from the market.
Other possible threats could be other companies that can do all the same task as the turtlebot, but the difference is the price. Other robots that might be more user friendly to people with little understanding of computers could also be a major threat.

Discussion

Despite the fact that the turtlebot has a few severe threats and weaknesses, the robot has the ability to be upgraded easily, therefore is a better robot should appear on the market, the turtlebot can be upgraded with a few components to make the turtlebot better, faster, etc.
The additional problem with the turtlebot running on two separate batteries, which is the one from the computer and the one from the turtlebot platform, could be solved by restructuring the whole robot to run on one shared power supply that can be charged with the power station, giving it the ability to charge both the computer and the turtlebot and therefore it shouldn’t run low on battery power.

The turtlebot has its ups and downs, but nothing so severe that it makes the turtlebot useless. Giving that the turtlebot is easily upgraded and can easily be modified, gives the turtlebot the ability to fit every situation and keep the turtlebot operational and highly functional despite the technology expands throughout time.

Stakeholder and SWOT analysis sub-conclusion

We can conclude from the stakeholder analysis and partly from the SWOT analysis that the users is the ones who have the greatest influence on the development of the robot since they are the ones who has the final decision on rather or not they want to use the robot to schedule htheir daily life. Although the other stakeholders also have a great influence on whether or not the robot should be used within the institutes or in the homes of the users.

Hardware

In the following chapter, a description of the used hardware and a detailed list of specifications will be provided.

Figure 8 - The TurtleBot

Movement

In order to meet the user's' needs, the robotic assistant must be able to move, which has been accomplished with the Kobuki YMR-K01-W1 robotic turtle. Kobuki is a circular device with a 17 cm radius and 12.5 cm tall equipped with a bump sensor enabling the machine to detect pressure on the surface so it is aware of a collision when it happens. A cliff sensor is equipped as well so the robot will not damage itself since it is capable to avoid falling from a certain height and a wheel drop sensor which is used to detect if the wheel has dropped off the ground.

Platform

On top of the turtlebot there is a small wooden platform, which when measured with the robot base is 40 cm tall. The platform is divided into three sections, which from bottom to top are a 5 cm section just on top of the kobuki machine, a 22.5 section with another small platform where the camera is placed and the third section is just the space above the surface of the last layer where sometimes the laptop is placed.

Camera

Besides from what was originally on the turtlebot, a Xtion pro live RGB and depth sensor has been implemented. This camera has an operation range between 0.8 m and 3.5 m which is a comfortable

distance to work with since less than a meter for the human robot interaction would become awkward or even stressful for the user and more than three meters would perhaps be too distant. It is equipped with a field view of 58º H, 45º W, 70º D. The RGB and the depth sensor, being a former color recognition sensor and the following one is a sensor capable of distinguishing the distances between objects or how far/close they are situated in relation to the robot, so it won't run into them or it will know how to maneuver in order to avoid collisions.

Audio

The Xtion pro live camera is also equipped with two built-in microphones.

Computer.

The kobuki base is connected to a small laptop which controls the machine.

See appendix for specs on hardware

Software

The software is the code that controls the robot and will be implemented to make our desired scheduling robot move as we want. There have been written ROS nodes that will be working together. The software has been divided into three sections consisting of scheduling, text to speech and movement.

ROS

Ros is the operation system used for the scheduling robot, it is a operating system made for robotic use.

It is a meta operating system, which means that it is a operating system but on top of this also allows different processes like nodes to communicate with each other during runtime.

Ros is built on unix based platforms, like ubuntu which is used in this project, there is currently no version that runs on top of windows but it is a possibility. Ros is open-source, meaning that code can be shared, modified and implemented, which means sharing and collecting codes is easy which makes for user friendly help environment, which have been useful throughout the entire project.

Schedule program

In order to make the robot keep track of time for any patients, it is important for it to keep track of time for itself. Since this program is the program the user is going to be affecting the most, it was

decided that the scheduling program would need a user-interface, so it would be to make new appointments, change them and delete them.

User Interface

In the flowchart below, it shows the overall process of what the user would experience while using this program.

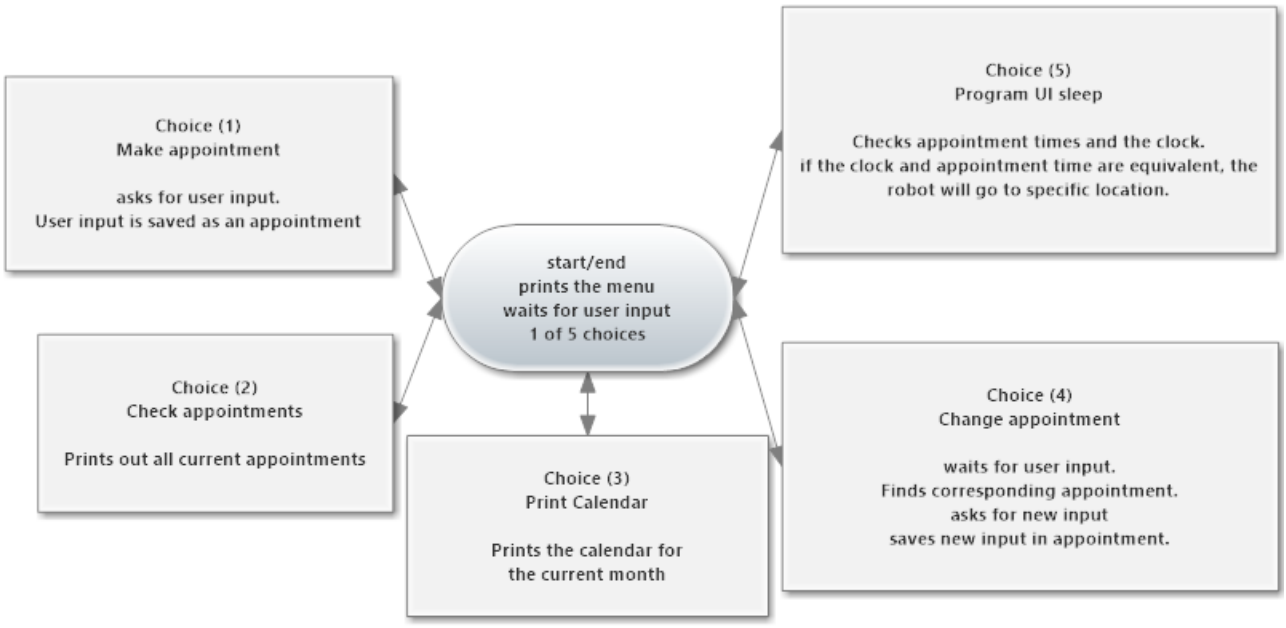


Figure 9

Once the program is start, it will show a menu that both greets whoever is using it and give the user five choices.

The first choice is “Make appointment”. In here, the user will be asked the following questions:

“What is it you want to do?” (User input).

“Enter month of the event:” (User input).

“Enter day of the event:” (User input).

“Enter the year of the event:” (user input).

“Enter the allocated time for the event:” (user input).

After the user has answered the five questions, the program will save this information and then return to the menu. Now it will wait for the user to give it a new task. If the user choses to press “1” again, the same process will happen.

The second choice is “check appointments”. In here, the user will not be able to do anything, but he can check if the appointment has the correct information in it/them. He/she will be notified that the

appointment has a reference number, which the user will have to remember if the user wants to change it. If the user press any key on the keyboard in here, the program will return to the menu.
The third choice is “Print calendar for current month”. In here, the user is again not able to do anything, but he/she will be updated shown a calendar for the month. Same as before, if the user hits a button, the program will return to the menu.
The fourth choice is “Change appointment”. In here, the user is asked to give the reference number, which could be found in choice two, to the corresponding appointment number. The same procedure as in choice one is made, except it asks for new input.
The fifth and final choice is “program ui sleep”. In here, the user is unable to do anything in particular, however now the program keeps track of time and will keep checking all of the appointments to see whether it is or isn’t time to go to a certain location. If the time comes, the program will send a message to the program “simple_navigation_goals”, telling it, that is has to move the robot.

Algorithm

In the previous chapter the UI for the schedule program was explained from the user's point of view. In this chapter we will take a closer look at the algorithm, making up the program.

When the program boots, it loads its different libraries and prints the menu, then it will be on standby, waiting for a user to give it some input and it publishes two chat pubs, namely “location1” and “location2”. Depending on the input, the program will enter 1 of the 5 different menu options, that are made of if statements.
If it enters into the first menu, it will go into the sequence which is one of the main functions of the entire program. As explained in the “user interface” section, it stores some variables and no matter how many times the user would enter this sequence it would not cause a problem. Since it saves all of the data in a struct, and these structs are saved in a vector with no defined size, which means that its size depends on the number of assignments stored in it.

If the user in the menu chooses the second menu option, the program checks the vector which has all the assignment struct in it. Then it checks every position in the vector and prints every struct stored in it.

If the user chooses to go to the third option, it prints a calendar of the current month. It does so by first calling the "daysInAMonth()" function which calculates the current amount of days in this month, it does so, by getting a month value from the function called "checkMonth()". Then it prints a header showing the weekdays, sunday to saturday.
Then it calls for another function called "printMonth()" which based on the "skipToDay()" function. It prints the width/spaces until the first day of the week, which is calculated in the "dayNumber()" function which is based on Zeller's algorithm.

Back in the menu, if the user enters "4" in order to change the information stored in a set event, the program gets the vector with the structs, and asks for a reference number. When this number i given, it takes the struct stored in the position which is equivalent to the input, then it asks for new user input, which overrides the old data and saves the struct in the save position.
If option five is entered, the program begins a sequence where it first checks what the clock is, then it checks every struct stored in the vector to see if any of the set clocks and dates match with the time it has updated itself to. If there is a match it starts to publish to a ros chat pub, but this will be explained in a later section with focus on ros and how it works. Once it has run the ros program, it deletes the struct from the vector, and returns to checking time and structs. Once the vector is empty, it returns to the manu waiting for a new command.

Text to speech (TTS)

In order to meet its social purposes, the robotic assistant must be able to interact and communicate with humans, therefore since the most natural way humans communicate between each other is verbally, implementing this function in the robot was key.
This robot is meant to be actively working in an institution with mentally challenged people. This means that the instructions the robot will provide must be clear and understandable, they must be said at a slow pace if we want the patients to better understand what the machine is saying. Unfortunately, when using the text to speech application, the result is a robotic voice, which not always succeed to make itself 100% understandable.
Our first attempt to make the text to speech function was using Visual Studio but along the way we realized the great threat of not being able to compile it all together with the other software, therefore, the final application is using the sound_play node in ROS because this piece of code is much simpler to implement in the turtlebot[xxxi].

The way this works is based on a talker/listener. When running it manually first we need to get roscore running. Secondly on a new terminal we input "***rosrun sound_play soundplay_node.py***", this will serve as the listener. Thirdly, we open another terminal where we write "***rosrun sound_play say.py "hello world" "***, after running it the machine automatically converts the input into speech. This way we can identify the say.py as the publisher and the soundplay_node.py as the listener.[xxxiixxxiii]

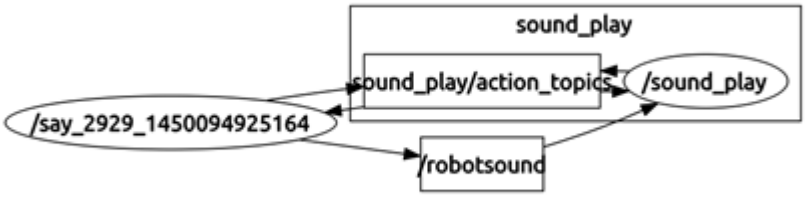


Figure 10

Movement

Within this project the movement will be set up based upon the problem solution and delimitation. The

The movement node, will make the robot capable of moving to two specific known positions. It will do this by the use of a map, that will be used to set the coordinates, within the known environment. Within this section, there will be a chapter describing the algorithm made for the movement part, there will be a part describing the map and mapping process, and in the end a part describing the code usage.

Algorithm

In the beginning óf the prototype creation for the movement part, an algorithm, was setup to ensure an overview of the expectations of what the prototype needed to be capable of doing. An algorithm is a step by step, process portraying, what the robot will have to do. This will focus only on the movement part.

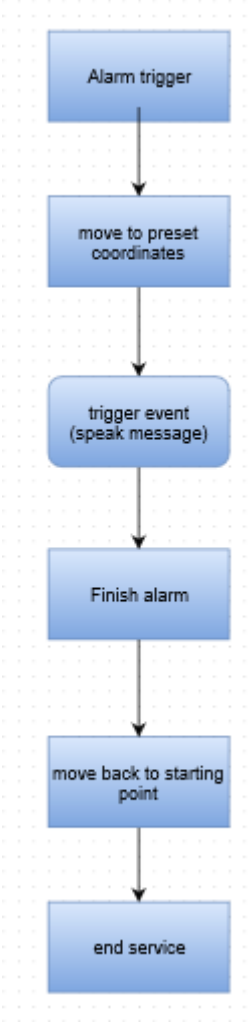


Figure 11

In the case of the scheduling robot, it is needed for the robot to be capable to engage the individual, by moving towards the human, it is also needed that, the robot is capable of having an understanding of when, this is appropriate to do so. This means another node must tell the program, when to start moving towards the human in question.
In the following the algorithm, will be explained on the basis on a flow chart and point by point text[xxxiv].

- Alarm trigger:

The calendar node will have an alarm start at a given time, the calendar node will then communicate to the movement node to start.

- Move to preset coordinates:

The movement node will have coordinates set in the program, based on the pre made map. based on this the robot will move, while avoiding obstacles.

- Trigger event (speak message):

Once the robot have reached its destination, the robot will need to communicate to the voice command node that it has arrived to its end destination. This will start the voice command node to make the robot speak its message.

- Finish alarm:

When the robot has finished its communication with the user. The voice command node must send a message that it is done with its speech message, so that the robot can begin with the next point in the algorithm.

- Move back to starting point:

When the message has been delivered to the user it is important that the robot goes back to its startíng position.

- End service:

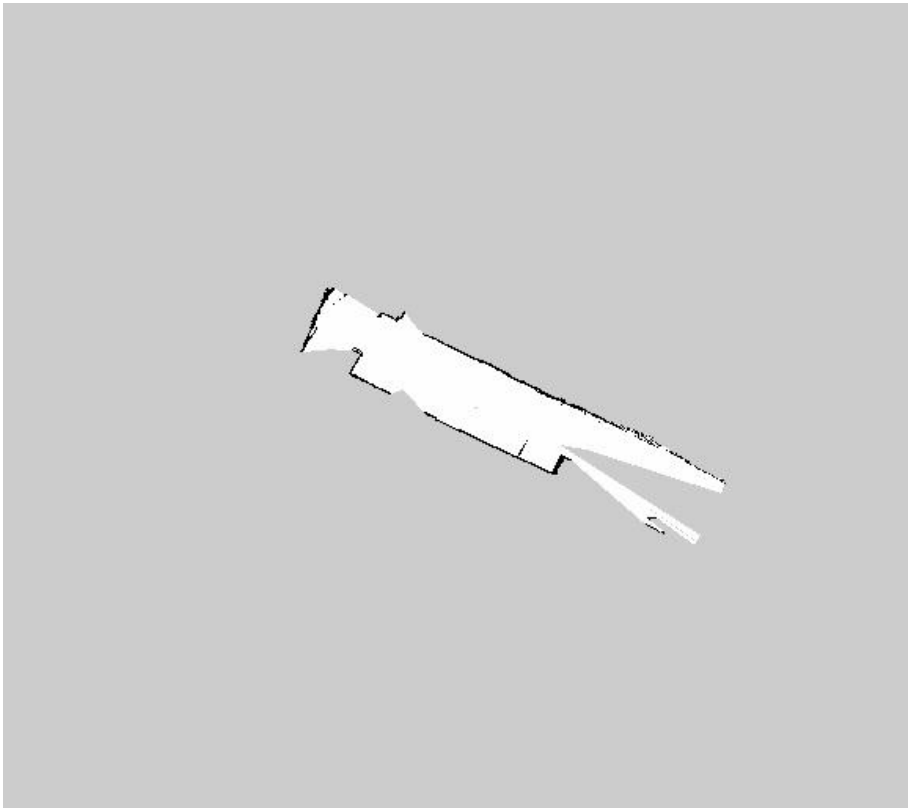
The robot will then finish its program and be ready for the next trigger[xxxv].

Map

To make the robot move within the known environment we can use a map to set up the basis for the coordinates we will use.

This is done using the navigation gmapping_demo, this demo takes in information from the sensor_msgs or the laser_scan packages to build a map. This is done through use of the rviz program[xxxvi].

Rviz is a visualization package that allows the user to see sensor data and outputs. It can be used to witness different visual data from lasers or camera visuals. In óur robot the most useful thing it allows us to do is to build and get information about a map.



Figur 12

When building a map the first thing to do is launch the gmapping demo when this is done start rviz. Then there is a lot of different modes to choose from in the case of this project, the modes used will be the map and the robot model. The robot model is mostly for the convenience of seeing where the robot is located during the map creation. The map mode means that the robot will construct a map based on the sensor data, Under topics set it to /map this means that the topic subscribed to is the blank map we want to create. Then using teleoperation, navigate the robot through the room, if you observe the screen you will see the construction of the map.

After taking a complete round in the room the map should be completed, then you can save the map using the "map_server map_saver" command.
You will see that any objects in the room at that moment will be added to the map. This means the robot can plan a path around the obstacles in the building.
Looking through the rviz programs with the mode in the top called "publish point" you can set how the map coordinates are set up.
After having saved the map you will need to load the map with the amcl node. This node localises the map and sets it as the map currently being used.
When setting up coordinates for which the robot will move to. We need to first set the coordinates focus point to fixed frames, this makes it so that no matter what position the robot has the coordinates remain constant, this is beneficial to us when we want constant point markers for the robot to navigate to.
Once we use the amcl demo and load the map we don't need to open rviz the map is already loaded.

Costmap

Costmap_2d is a ROS package that uses sensors to inflate areas on a pre existing map that are registered to be occupied by objects in front of it. When the costmap was used in this project we had a few issues with it not wanting to update the costmap, which we fixed by changing the global local costmap parameters[xxxvii].

As quickly mentioned above the costmap is created by sensors and inflates occupied areas on a map. The costmap is build up by different layers, there is the static map layer which is unchanging like the one build by SLAM, then there is the obstacle layer which tracks the obstacles on the map and the last layer is the inflation layer that inflates the lethal objects on the map. The costmap is used when the robot is planning its route to the destination, to avoid collision with dynamic or fixed objects in the space it operates. An inflated area on the map can only be cleared if it is within the range of the sensors, for instance it might have seen an object that is behind it but it will not be cleared before it moves back the way it came. There is two different types of costmap there is the global costmap which is inflations of all objects on the entire map that it has seen and then there is the local costmap which is the inflation of the area just in front of it. Another difference between the global and local costmap is that the global is used to generate a long-term plan while the local is used to generate short-term plan.

As mentioned in the beginning we had some trouble in the beginning due to the costmap though the problems was quickly solved by changing the global and local costmap parameters in the global_costmap_params.yaml and local_costmap_params.yaml file, what we changed in the files was the update_frequency and publish_frequency since the problem was that the costmap did not update fast enough, or did not update at all. The used frequencies in this project was changed to 0.01 for both update and publish. The parameters files serve as the parameters for the costmap, how often it updates, how often it publishes and the inflation radius etc. so for instance if the inflation radius is so big that the robot is not able to generate a plan it is possible to make the inflation radius smaller, this could be an advantages if the robot is operating in a hallway, since it will not be able to generate a plan through the inflation.

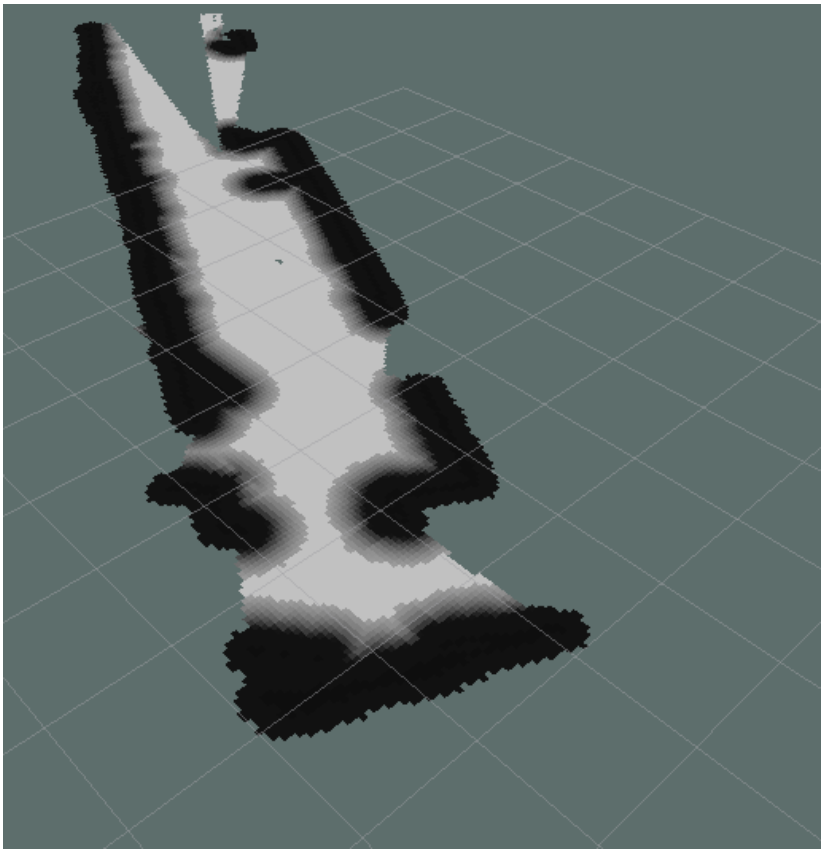


Figure 13

The costmap is an important part since it helps generate a plan where it avoids possible obstacles it might come across so it won't crash with a wall, person or what might else be in the way. The separation between the global and local costmap also serves as if it can not generate a long-term plan it might be able to generate a short-term plan until it can generate a long-term plan.[xxxviii]

Code

With the movement we want the robot to go to specific places using coordinates taken from a map that has been build. The program will be initiated by the calendar and the movement program will then tell the robot to go to a specific point depending on where the task requires it to go, then do a task while there and then return to its starting point.

The first thing we did in the code was to create a section where we ask the program to listen for messages over the channel chatter, if it receives a message over the channel the action client will be told to spin a thread with the command “MoveBaseClient” and then we allow the action server five seconds to come up. The next thing that happens is that a goal is created and that goal is send to the “move_base” with the “move_base_msgs::MoveBaseGoal”, this basically means that the base receives information of where it should drive. The frame_id is set to “map” which allows the program to use coordinates from the map to send a destination and the last thing to create a goal is the coordinates which is published with the “goal.target_pose.pose.position” followed with either a .x or .y coordinate and these are the desired location for the goal the robot should move to. Then the very last thing to do is to send the goal, which is done with the line for sending a goal called “ac.sendGoal(goal)” and then it should start moving to where we want it to be, after the program ask for a confirmation when it gets to its target position. After all this we have to get it back to its starting point and that is achieved the program create a goal the same way it did when it had to go to its target point, but this time it is send to its starting point. We have two movement nodes with each having a different goal but the same starting point, both nodes are connected to the scheduling program.

So in the end this program is able to make the turtlebot go to a specific point on a map that has been created, go to a certain spot where it can do a task and then return to its starting point.

Connecting nodes together

Allowing the different nodes to communicate within the software will be done with a combination of topics and services, these are the different models that can be used to communicate between nodes.

Topics is a method of messaging where nodes can subscribes to a topic, which means this node will receive messages published from that topic and other nodes can publish through this topic, meaning that they can send messages to the subscribed nodes. This system is defined as a “one to many” or a “many to many” communication model, meaning nodes cannot respond to messages received via topics.

Topics can be used when one way communication is needed, like in the communication between the calendar node and the sound_play node. this will allow the calendar node to publish to the “sound_play” what it should vocalize and there is no need for the “sound_play” to respond in any way.

Services are methods of communication that allows methods of two-way communication. This is set up as a request/response system where the node will publish a message and then the receiving node will respond. Services are created using .msg and .srv files.

.msg files are text files that describes the field of the message, it defines the data structure of the message, they are used to generate source code.

.srv files describes the service itself. they are a lot like .msg files, except It is set up as request/respond separated by ‘--’.

The way it is meant to be implemented is by setting up the calendar node to use a service and tell the movement node, which of the preset coordinates the turtlebot should go to. The movement node will then begin to move to the target position, when the movement program has completed, the movement node will respond with a message to the calendar node that it has arrived. Then the calendar will proceed to send a message to “sound_play”. The message sent to the soundboard will consist of “rosrun sound_play say.py” and then a string with the corrosponding message for the turtlebot to say, sorrounded by “”. Finally the movement node will start the return to the starting position, when it has spoken its message.

In the Scheduling program, it is mentioned that it has set up two publisher chats, one named “location1” and another named “location2”, this means that it is now able to send messages out to these two chat pubs and the nodes connected to this chat.
In the movement nodes, it is mentioned that they subscribe to one of the “location” chats (each node subscribe to a different chat than the other node). The movement nodes run their code differently from the schedule program. The schedule program runs its main algorithm and depending on input, it switches to different sections of code, with different functions. The movement program initialises their subscription to their chats and then with the “ros::spin()” function, the program constantly checks if any of the “chatterCallback” voids have received any messages. When they get a message from the publisher/schedule program, it initializes the movement algorithm in the “chatterCallback” void. Afterwards, it continues the “ros::spin()” loop until a new message is received.

Acceptance Test

Now that the hardware and software has been explained, the product had to be tested to see whether or not it worked together.

In a real life scenario, the robot would get an assignment/event given to it, telling it to go to a patient. However as we stated in our delimitation, the robot won’t approach a certain user, on the other hand it has to be able to go to one of two preset spots, depending on the user’s choice. It also has to be able to do it at a specific time, which is stated in the calendar. So when the event triggers, the robot goes to the spot selected, in order to remind the user of a task which needs to be done. When the robot would reach its destination, it would have to speak and give a clear message to the user. Once this task is completed, the robot would go back to its original location and wait until the next event is triggered.
The test proved that the calendar and the movement are well implemented and work together in ROS, so whenever there is an assignment, the turtlebot drives to its destination; however, we did not manage to program the calendar with the talker function during the project period, so the robot was not able to do the speak out loud task.
If an obstacle was in the way, the robot was able to avoid it by finding a way around the obstacle and continue to its destination.
It was also noted that if the robot had two assignments with two different target locations, the next upcoming event location would override the already running program and complete that job instead.

In general, the robot was able to do and complete most the tasks while following a timer. However, it wasn't able to speak.

Further development

In the previous chapter it has been described what we have accomplished during our project time. This still doesn't fully live up to our desired problem solution.

The development of the software has had the focus in this project, still we need a lot of work on this going forward. we still need to make it locate and move autonomously to the patient, using facial recognition and different methods of measuring.

The UI needs to get an overhaul of the design in order to turn it into a GUI, we have been looking into this, but as time was a precious resource and there isn't an native, intuitive library for Linux in c++ for this, we decided to put our focus on the movement part instead.
As for the hardware, it is self-explanatory that we didn't got any work done on this, as we didn't have the funds, nor time to get around to do this. We have put some more thought in it though and decided to go with the human-like model. The reason for our choice lies in the fact that this is the model we feel will provide us with the best learning opportunities as well as that this is a rather new field of study, allowing us to join in, in the golden age.

Discussion

As the project come underway, we accomplished some of our goals, but also stumbled upon some problems along the way. One of the main problems was the "Text to speech" program, which we wanted to implement into our robot.

The communication part of the project turned out to be more difficult than we first assessed, We started out by looking at different API's, but these turned out to either be too difficult to work with at the moment or they weren't compatible with Linux. We then turned to the ROS node, Sound_play, which also turned out to provide us with a few problems, we made it work on a simple basis, but unfortunately it was too late for us to go further into it and implement it in our project. We chose to keep it in our report, since we felt like it had to be there as we would like to keep on working on this.

We had a lot of thoughts on the project, including running the program on two systems, in order to use the text to speech, this would have been great to use, but in the end we decided to work with Linux only, since this would provide us with the best opportunities and we wouldn't have to set up some kind of serial connection between a windows machine and the turtlebot pc, this we deemed too complicated and decided it would be a better option to focus on one system.

Conclusion

One of our main goals with this project was to make a robot, which is capable of scheduling a patient's day or future plans. If we look upon the acceptance test, we can see that the program was able to successfully trigger an alarm and give the movement program a location to move to, via ROS code.

Our second goal was to have a robot capable of moving to the patient in order to remind the user about an upcoming appointment, though it was able to move to preset locations, it was however not able to speak.

finally we wanted to make a user friendly UI for the caretakers to use.

We managed to do this to some extend, but we do not have a test with another person trying out the UI.

In general, we can conclude that we were able to make a robotic solution, capable of moving to a patient at the right time and that the robot has a suitable UI for this.

Appendix

Hardware specs

Xtion pro live camera specifications:

Operation range	Between 0.8m and 3.5m
Field view	58º H, 45º V, 70º D
Interface/power	USB 2.0
Sensor	RGB & depth
Supported platforms	Intel X86 & ADM
Supported OS	Win 32/64: XP, Vista, Win7, Linux Obuntu 10.10: x86, 32/64 bits
Programming language	C++/C#(windows), c++ (Linux)
Audio	2 x built-in microphones

Kobuki specifications:

Sensors	Docking IR, bump, cliff & wheel drop
Power connectors	19V 2A, 12V 5A, 12V 1.5A & 5V 1A
Programmable buttons	B0, B1 & B2
Serial extension port	- Rx/Tx - 3.3V/ 5V - 4x Digital input - 4x Digital output - 4x Analog input
Programmable LEDs	LED1 & LED2
Battery	4S1P Li-Ion
USB cable	
Power cable	
PC USB data connection	
Recharging jack	
Firmware download switch	

Charger	
Power cable	
USB cable	
Platform	

Asus X200M specifications:

ID + color	1B – BLACK
LCD 11.6 hd slim 8gl,led)	11.6 HD SLIM (GL,LED)
VRAM	N/A
CPPU	INTEL N2830/BGA
HDD	500G 5400R SATA
ODD	WO ODD
RAM	DDR3 1600 2G {ON BG.}
TPM	WQ / TPM
WLAN	802.11BGN_WW
USB	USB3.0 + 2x USB 2.0
OS TYPE	WIN8.1 64 BIT / WITH NEW BING
KB LANGUAGE	GERMAN
POWER CORDE	GEE
ACCESSORY	3 CELL 33 WH

Interviews

Transcript from interview with Elizabeth Ann Jochum

Kasper: We are just going to let you know that we are going to record the interview.

Kasper: What would you define as a social robot?

Elizabeth:I would say a social robot is an embodied robot that promotes fluid and natural human interaction. Before I answer anymore of your questions could you tell me a little bit about your project?

Kasper: Yeah so we are working with a social assistive robot that are going to…

Christian: We hope for it to help people who have brain damage or some sort of disability one of the illnesses we are looking into is people with downs syndrome, autism stuff like that and we wish to make a robot that can somehow aid them structuring their day and help them around, so they can be a bit more independent.

Elizabeth: Downs syndrome, autism and brain injury.

Christian: Yeah.

Elizabeth: So those are all like three wildly different conditions.

Christian: The main topic is some sort of disability, so they can't think properly. They are not necessarily stupid but they can't handle like short-term memory for example.

Elizabeth: That is a very specific thing, downs syndrome patients do have short-term memory as do autism patients as well, so I guess my question for you are how specific. You are actually designing for a population?

Michael: More or less..

Michael: Yeah we are designing a prototype of the robot, well in brief terms we are, not exactly of how we would like it to look, because we have got this turtlebot we have to go out on.

Elizabeth: And the software will do what?

Michael: The software will keep track of time and keep track of movement, no not movement of appointments and then it will tell the user when there is a meeting or an appointment before the meeting or appointment is there, also we have to make something that will make a natural approach for the turtlebot, so it doesn't drive up from behind and startle the user.

Elizabeth: And can you tell me is this bachelor project or a master's project?

Michael: No this is for our first semester project.

Elizabeth: Okay so you are bachelor students?

Michael: Yes.

Elizabeth: Okay, that is important for me to know. And you are bachelor students in engineering?

Christian: Yes, in robotics.
Elizabeth: Okay great, and let me just ask you how much research have you done? Cause I guess I'm your HRI component is that right?
Christian: Yes, we have done a lot of research into the brain itself what it can do and what would happen if something is missing, then we have been researching into different illnesses like the ones I mentioned earlier, I think that was it.

Michael:I don't think we have got that much research on HRI yet.

Elizabeth: Well that's fine, that's good to know but have you done any research into social assistive robots or assistant robots just in general?
Christian: We have asked our supervisor about that question and he said that we should ask you.
Elizabeth: Okay so I'll send you right now a link, you should be familiar with Maja Mataric her work she is at the university of southern California, and she defined the field of socially assistive robotics. And she has a huge lab and she has been working in this field for more than 20 years. So I'm just going to give you three articles that should properly make it into your report, and none of them are mine so I'm not promoting my own work here just so you know.
Elizabeth: She defined the term socially assistive robots, and she parched them out in this great article that I will send you. So this field that you are venturing is a big one, and should see that, so the conversation that you entering is a big one and it is important that you know that you are entering the middle of a conversation that has had a long beginning and has a long future in front of it. And so going back and quoting like really taking a look at what it means to design a robot that will go in a home or a hospital and serve a population, and especially with regards to autism research there is a lot of research about that, that is done quite separately, and so when you are talking about a social robot or a robot with social capabilities that is meant for sort of assistance, it is really important that you are clear about who your target audience is and who your user is and that you don't lumb them all together downs syndrome, autism and brain injury and memory loss. Because they are not at all the same thing and they require, even though you have done a lot of brain research you should know that the outcome is quite different so the patients or the target population here have a different set of abilities, a different set of importances and they require different things. So it is important not to lomb them together but if you can narrow it down, your focus, just a little bit and that will also help you narrow your research down, so when you are looking up social assistive robotics you can look at the studies that only deals with autism or that only deals with brain injury or that only deals with downs syndrome.

And the other thing is that most autism patients or studies are done with young children with autism, and most studies with sort of you know elderly care robots in homes, things like approaching sort of reminding people, keeping track of time, reminding people of their appointments, reminding people of their medication. These sort of social assistive robots for the elderly that is a separate population so it is important for you guys to be clear in the beginning of the report not just the distinction of what your target population is suffering from but also what the age group is.
Michael:I think we have landed on 18 to 25 or something like that.

Elizabeth: And how did you arrive at that?
Michael: Well it is not too young and they are not too old, and they are kind of the same age as we are so it feels natural.

Elizabeth: Okay, and then the environment for where your robot is going to be tested and eventually deployed?
Michael: Well, we are going to test it here at the university. I think.
Elizabeth: Apart from movement how does your robot communicate is it through natural language dialogue or?
Michael: We are hoping to get some voice implementation so it can actually talk.
Elizabeth: And does it have any voice recognition?
Michael: It should have, not in the matter that it can differentiate from different people who is talking, who is who, but in the way that it can understand what is being said.
Elizabeth: That is very difficult to do, there is a lot of people in the engineering school…
Elizabeth: Well especially when working with robots, they mostly don't do what you tell them to do, and mostly they work in the lab and not in the wild and mostly they work like the night before your presentation and not when you are actually presenting it to class, so welcome to the world of robotics where I have been spending a lot of my time and you will learn that frustration. So in terms of your degrees of sociality, what kind of social behaviors you want and expect from your robot, what are the three sort of most important things?
Christian: The first one would be that the user should not feel startled by the approach of the robot, so of it has to "oh this guy actually has an upcoming event he said on me" I have to approach him and tell him about it. Then the person should not feel startled when it comes up to him, like it should not rush to him some of the aspects of that we would like to know a little bit into.That is the number one priority. The second would be general movement, like it has to drive or go about other human but it should not startle them as well in the way it moves that would be obstacle avoidance.
Elizabeth: Okay, and the third most important?

Michael: Well that must be able to keep track of time and events.
Elizabeth: And the fourth?
Michael:I think talking/listening.
Elizabeth: Which one?

Michael: Both.
Elizabeth: Those are two different capabilities.
Michael: Well then it should be listening.
Christian: Yeah listening first, talking fifth if we have a fifth one.
Elizabeth: Why listening before talking?
Christian: Because if it misunderstand what the user wants it could be, well bad things could happen mess up in dates and so fourth.
Elizabeth: So is the robot seeking confirmation from the human or is the human seeking confirmation from and information from the robot, who is assisting who?
Michael: The robot wants to communicate with the human.
Elizabeth: Okay, so is it more important that the robot be able to talk or listen?
Christian: That is a difficult question, because if it can't listen properly it is not going to be a good conversation but if it can't speak properly either.
Elizabeth: Do you care about a good conversation or do you care about time and events?
Michael: Time and events.
Elizabeth: Okay so I'll ask you again is it more important that the robot be able to hear or be able to speak?
Michael: Speak.
Elizabeth: Why?
Michael: When you are putting it that way it must be speak.

Elizabeth: But is it only because I'm putting it that way? So why?
Michael: Well personally I think it is more important for it to be able to listen to what is going on in the room and whenever there is a new appointment it should be able to automatically update the database.
Elizabeth: Okay so the robot always knows what time it is and what appointments are coming up right? Because the time and events is running. Does the human?
Michael: No not necessarily.
Elizabeth: Wait I have a robot in my office.
Elizabeth: Yeah but mine is cuter. And I have a rock, so lets say the rock is the brain dead human or the partially brain dead human right? Cause this is the person with limited functionality and this is the object that is going to help the rock, what time it is, remember when the rock has to go take a bath, remember when the

rock has to go take medicine. Is that rocky or human? Okay you are working with a population that has limited functionality and I'm feeling, and of course robots always have limited functionalities that the functionality of the robot should be to help the patient with the things that they can't remember or do. So is the rock or the person with short term memory loss going to remember to ask the robot?
Michael: No the person is properly not going to remember.
Elizabeth: And is the person who has short term memory going to ask the robot or be likely to ask the robot when it should take its medication?
Michael: No it is not likely.

Elizabeth: It might, you know but in terms of reminders time sensitive reminders and time sensitive events the robot is there to help the person cause that is where there deficiency is, and so it may be that your human with short term memory loss ask is it time to take my medication yet, and then the robot can respond with yes or no. But if the important thing is getting the medication to the user or reminding the user of time sensitive events.
Michael: The objective is to have the user feel a bigger sense of independency, while still assisting the user.
Elizabeth: And then you have to order your priorities there, what is more important, that the assistance be there or that the user feels independent? So you are always setting priorities, because not everything is equally important, so what is more important? That the patient receives assistance or that the patient feels independent?
Christian: What we hope to accomplish, which make it our top priority, is that once these people who have not necessarily lost their long term memory which means they are not dumb, we imagine they feel sort of sad because they can't do the same things they were once able to like remember properly or handle certain situations so their quality of life is now lowered, we hope that this robot then can make them feel more independent so they won't rely on other humans all the time, that they can do things themselves. Our highest priority over anything else then would be feeling independent.
Elizabeth: And how do they feel independent?
Christian: Hopefully because they are not getting assistance from caretakers, other humans in general, that they have this thing and now they can do things more by themselves. That is what we hope to accomplish.
Elizabeth: That is good, that helps me because that is the end goal, but you don't necessarily start there and so to get there to get the user feeling more confident, increase quality of life, feeling more competent in their daily life they need a certain level of assistance. Like if you think about stroke rehabilitation patient they need a lot of help in the beginning and then gradually the trainer, nurse, robot or whatever can offer less and less support. But you don't start by saying you will feel better when you walk, so you aim for walking, you aim to provide as much assistance as the patient need, and that is how the patient comes to experience more independency, more competence.

Michael: But I don't think when it comes to people that have trouble keeping a schedule, I don't think there is necessarily going to be a decrease in assistance over time, of course it depends on how badly the patient is hit by this condition.

Elizabeth: Well it depends, if you are talking about an accident victim who has short term memory loss in the ages between 18 and 25 my guess is that short term memory loss is going to be because of some sort of accident or trauma, but not part of a long term diagnosis which down syndrome and autism both are, or you could be talking about an Alzheimer patient which is increasing through the elderly and Alzheimer is a degenerative diagnosis so it gets worse over time and I actually think that for what you are describing an Alzheimer patient or dementia might be your target population for the object that you are building.

Michael: Well our idea up to now is more like a broad spectrum of attention deficits including downs syndrome, autism, Asperger's but also including ADHD where structure could be a very big help for improving the quality of life, but it could also be applied to people with Alzheimer and dementia.

Elizabeth: Well obviously the dream is to design one robot that serves a lot of different functions and serves a lot of different populations, but the other issue is to be really careful especially when you are going into a healthcare environment and healthcare settings and going into research not to lumb them all together. Well obviously the goal is to design a product and a device that has as wide a use as possible, but I would just be wary of lumbing all of these things together thinking they all require same sort of level. So when you are designing any robot the first question you ask is what does it have to do? And some people say well okay then what does it look like? Or how does it communicate? And in this case you say, well it has to mobile and be able to communicate using natural language dialogue, any other lights or sounds?

Michael: No, lights sounds not including talking would just be disturbing.

Elizabeth:I'm going to give one other name, someone who name is somewhat synomonis with robots both humanoids and non humanoids during studies with autism patients her name is Kirsten Dautenheim.

Christian: Is it necessary to make a social robot act like a human?

Elizabeth: Let me ask what you think?

Christian:I think it is necessary, because if you have to interact with somebody it is best to have something you recognize like language for instance if I was to speak with Kasper I would turn myself to him and speak with him because that is the most comfortable way and then Michael knows that I'm speaking with Kasper now some general conversation stuff which is basic but it is how everybody else does it, so it would feel more normal, what I imagine is it would be easier to implement the robot if it had human like features such as turning to the person it is talking to, calling out their name or something like that. We also think it would be more personal and give a higher sense of actual social interaction.

Elizabeth: The things that you just described Christian, you are talking about orientation, turn taking and the things you described were all sort of behaviors and those a key terms in HRI, those are big studies that you will spend a lot of time understanding natural turn taking, understanding orientation and turning looking and

describing, but what you are comparing right now are how human act with other humans but humans act with robots very differently and they interact with robots based on their morphology or their embodiment instead of how the robot is shaped. So if you are dealing with a turtle because that is what you are given, you are not designing a robot from scratch, so obviously the interaction that the human is going to have with the robot is going to be, I mean if it is a turtle on a table we are going to interact with it one way if it is a turtle on the floor that is moving around we are going to interact with it more like we would a cat or a dog or a vacuum cleaner. So the idea of gaze detection or eye following and obviously language is based on turn taking. I'm sending you one last article you will have to read it is about designing motion for a robot. What I'm trying to say is that how a robot is shaped suggest different types of affordances so a robot that have a face or has something like eyes or something that looks human will suggest that it can interact with us like a human, but a robot that looks like a turtle we are going to expect it to act like a turtle we are not going to expect it to do things humans do, in fact we might be more willing to grant it some leeway.

Christian: So just so I'm not writing anything wrong down, what you are saying is that looks can suggest what it is supposed to do but it is not a given factor?

Elizabeth: Yeah, and sometimes the looks create unrealistic expectations, and what I would say, and this is my opinion, that how a robot move and behave is more important than how it looks, that movement is actually the primary consideration big proponent of your sort of thing of certain approach and there has been a lot studies, the ones I have send you here are specifically about social robots Guy Hoffman's paper is about movement but there has been a whole host of studies done in HRI about how robots should approach people in various settings. People spend their entire life researching only that so that might be something you do for your masters project or sixth semester project, because this project is really ambitious what you guys are doing it is super exciting. But each one of these things that you listed to me as important robot approach, obstacle avoidance, time and events and then communication, all of these things and then adding natural language to it like those are eight topics and we haven't even talked about design.

Elizabeth: Which is good because if you had to design one from scratch you would never get out of the gates. So each of these topics are topics that have long long long history and people go deep and spend their whole life in them, and you are trying to do everything. So congratulation on attempting the impossible.

Michael: You talked a little about robots mimicking human behavior, what would be the steps to get started on this? To make the robot behave more like a human.

Elizabeth: Well I guess it depends, it has to start with the morphology with the actually design of the robot, how it is shaped and how it moves, because I would argue that you could properly make your turtlebot move like a human but it wouldn't necessarily look human so your advisor Karl properly works with the now robot…

Christian: Yeah he talked about he was on a project where he was making his own robot for the same subject, I don't know if the angle he has is the same as ours but it was like people with some sort of damage in the brain so they had reduced functions.

Elizabeth: So obviously you study humans, but you study humans how they interact with other humans, you study humans in the wild, you study conversations but you don't necessarily imitate them that has been the whole shift, and I used to work on the geminoid project, it is at Aalborg I did my post doc there. I just send you a link, so if you go and click on that link and you go up to robots and you look at the geminoids that he has build, just click on the first one. So this is the first geminoid, and this is the first sort of research, we have one in Denmark as well at Aalborg University and built by that laboratory and these are ultra, ultra realistic humanoid robots, and they are essentially animatronics.

Christian: Yeah now I know it, Karl did tell us a little about it, but it had a few things where you could tell it was a robot.

Elizabeth: Well a lot of things, and if you ever want to come by the lab where I work you can absolutely have a look, and you will see the minute it start moving that you know it is a robot, but these are properly the most ultra realistic humanoid like this is the far end of the uncanny valley. So there is a whole continuum between an industrial robot that just look like a robot and the gemenoid that looks ultra realistic, and so some people thinks that this is actually how, and they have a robot hotel in Japan that is staffed by all these gemenoids, they should look if we should interact with them. And I guess I'm less convinced about that because I think it sort of depends on how we interact, when we interact and what we need from them, and naturally we don't want all our robots to be social and naturally we don't want all our social robots to be human, we can engage with them through, like they can have human like behaviors they can have natural speech but they don't necessarily need to look human or animal for that matter. I mean it depends on your preference and some people gets really freaked out by the gemenoid and prefer something more mechanical, I have paper coming out right now that compares the gemenoid with a more sort of mechanical looking robot, how they communicate and interact with them and the study shows that people actual prefer the more mechanical looking robot.

Christian: Well you already went a little bit into it, but we would like to know a bit more if you know at least, some of ethical dilemmas? What is your experience with people who are not as excited about robots as we are?

Elizabeth: There are people who publish about this that know a lot more about it than I do, but robot ethics is a very parch topic at the moment but specifically which regards to ethics of medical robots, I mean I guess it sort of depends on which issues you are asking about, are you talking about surveillance, are you talking about privacy. There is a fantastic paper written about robot HRI last year, if a program sets op encouraging behavior at what point can the robot be forceful in its tone and that might be offensive to the patient. So there are so many questions about ethics, for me I will say the two most important things that I would consider

important is that when you are designing the robot for a specific population, specifically a vulnerable population like the ones you are describing, is to involve them as early as possible to whatever level you can in the design. That is called participatory design because I think that there is a mistake that engineers often make, and since you are young and just getting started in engineering you have chance to put an end to it, which is that you design something thinking it works perfectly and then you give it to the users and then it is not at all what they want of need. It looks perfect from your end but you haven't anticipated some of the needs and challenges of the user population, so I actually think that it is an ethical issue. Basically these are insurances that you are actually building something that people want and can use, the other thing about ethical guidelines is in research studies is to pay very close attention to permission and also if you are recording and doing any video analysis that you don't make them available.

Interview with Trish

T: Hello
M: As I wrote you, we will be recording, I hope that's all right
t: How many are we?
m: Me and Laura
M: so, first off, just to clarify Trish, what range of work are you in? And what kind of diagnosis's do you specialize in?
T: I'm educated as a nurse and I've worked both with children and in children psychiatry wards And on top of that i studied to become a psychotherapist, which is a bit like a psychologist, but not as academic and I've been working with psychiatric diagnosis for the last 15 ..16..17 years.
m: and that's primarily ADHD if I've understood it correctly?
t: eh, yes and no, quite a bit of it is with add and ADHD, but there's a number of other things like stress, depression, eating disorders, angst and other things, but quite a few other people contact me because of ADHD.

t: I've been working with that diagnosis for the last 13 years
m: that sounds great
m: is it also some autism or aspergers?
t: yes I forgot to mention those.
m: what are the typical symptoms in the three diagnosis', ADHD autism and aspergers?
t: They're a bit different and they're a bit the same, if we can start with ADHD, then there's three main symptoms and that's; problems with concentrating, hyperactivity and impulsivity. If you look at people with aspergers or autism, they have quite a difficult time being in contact with other people,

especially they have a very difficult time reading body language, have a very difficult time with social interactions, because it's so non-concrete, they function best when things are very concrete.
m: yes
t: It's very important for people with aspergers that it makes sense, what you're going to do, otherwise they just don't do it, so in such way that can overlap with ADHD, because also for people with ADHD, there's a lot of things they have trouble doing, because of different issues including that it doesn't make sense, but it could also be because they're not good at planning, it could be because they've got too many ideas in their head. It could be because they got a better offer, they want to do their homework, but then somebody asks them to come play PlayStation, if you have ADHD, so you go play PlayStation.
m: well that kind of leads us to another question, what I'm hearing is that it's very important for these people to have their day structured, is that right?

t: very much, in both cases it is very important that there is a structure, that you do it regardless of what comes in the way, people with ADHD they need structure but they have a more difficult time because it gets boring and then they don't want to do it anymore and that would be a great difference between somebody with aspergers and somebody with ADHD, someone with aspergers would do it, because he is supposed to, it says so on the calendar, it says from 9-10 we have math and maybe the teacher comes with a better idea "hey hey, let's go out and play" and the kid says "but its math" and they get really mad without other people understanding because it would be great to go and play instead of math, but he has a very difficult time adjusting, particularly with aspergers. People with ADHD can also have the same problem but it would be very easy for them to drop math and go out and play because its more fun, but when it's the other way and they were supposed to do something fun and the teacher comes and he says "no, we are not going to do that we are going to do English lessons the person with ADHD would have a very difficult time adjusting to that, especially when they are going from something which is nice and fun to something that's boring whereas someone who has aspergers and autism quite often, not always, but quite often they have an easier time, as long as they follow the schedule, they are just fine but they have trouble understanding a change on the schedule "

m; okay, so the ADHD patient needs constant stimuli to do his tasks while the aspergers and autism don't really need to be that stimulated

t: that's it, as long as it makes sense for them it, it has to give meaning for them and if it doesn't they just have a very difficult time doing it if it doesn't make any sense so they just don't do it. Where in ADHD that's part of it as well but there are so many other things to it, not just making sense. Does that make any sense?
m, l: yes, totally
m: we would like you to just briefly outline the causes of the diagnostics. Like what's behind ADHD
t: the hypothesis at the time is that ADHD is a chemical imbalance in the brain, there's some different transmitters up in the brain in particularly one when we are thinking of add or ADHD it's called dopamine and the other one is called noradrenaline in Danish they call it something else, I don't know why but they do. and in some of the researches that I've looked they can see that people with ADHD either that they have too little dopamine and noradrenaline or the type of dopamine and noradrenaline they have it breaks easy so when it has to be transmitted in the brain from one cell to the other it just dissolves during the synopsis and when that happens they are going to have a really difficult time concentrating and keeping themselves stimulated about being focused, they are rather more concentrated on what's happening outside the window, what sounds do i hear, what am I smelling, what do I fell...that's the theory. Now, I believe there about nine to twelve different genes they found out with people with ADHD that has something to do with the dopamine

autism and aspergers, that a bit more difficult they still not sure what it is, they believe it has something to do with genetics but they are not a 100% sure at the moment anyway they can see some countries, I believe its Iceland that has a very very high rate of people with autism and because the people who live in Iceland are a very isolated group they are quite sure it has something to do with genetics but they are not exactly sure what

m: what has been done in the field of treating aspergers and autism or ADHD in order to improve their life quality of these people?

t: that's a really big question. at least for ADHD if you look at treatments 80 to 90 % of them can have a really positive effect when taking medicine, there are several ways to treat them and medicine can never ever ever be the only one implemented besides it is needed psych education, we need to learn about what the diagnostics is and how is it going to affect me personally, because ADHD is so different from person to person because even when there is people with the same diagnostic in the room there are going to be a hundred different ways to show it, some people will have trouble with concentrating, others are really good at concentrating so good that they forget to

go to the bathroom, to eat, to phone their husband or wife, they forget to go to work because they are so focused, hyper-focused, so there are great differences on the way it presents itself, so we need to know how it is ADHD for me, what am I good at, because people with ADHD are good at a lot of stuff, they have a great potential, maybe they have a difficult time organizing so its important to know what do i have to work on and what do I already know so I don't have to focus so much on that.

When it comes to aspergers and autism there is no medicines for that diagnostic many people with autism and aspergers can also have ADHD in which case you give them the medication for that. many people with aspergers and autism have a difficult time with angst, which mean they will take certain medicine for that , many people unfortunately with both, ADHD, aspergers and autism they become depressed because of so many times they have tried to do things to go into relationships or education and they just fail and fail and fail, when this happens quite often you are going to get depressed and if that's the case you also have to give them the medication for that , people with aspergers is quite often because they have difficulties with social relationships, they really really want to have a boyfriend or a girlfriend or have some good friends at school but they have absolutely no idea of how to do it, how do i contact that person that I like, or as a little kid,, how do I get into that game that they are playing? if you look at the little kids they quite often they see a couple of children playing football, they also want to play football so they go and take the ball and then everybody gets angry with the child with aspergers who takes the football ball, they yell at him, "hey we don't want you here, go away" and that little kid he just want to be part of that game but he doesn't know how to get into it, many of the adults I also work with now, they really would love to have a boyfriend or a girlfriend, but they have no idea of how do I communicate with the opposite sex, which is already difficult even if you don't have a diagnostic, but it gets even harder when you just can't read people's body language.

if you don't catch the tone of the voice, and realize that they are being ironic, or saying something for fun, and you take it seriously and then you're going to have a very difficult time communicating with other people, so social skills are particularly for people with autism and aspergers maybe a little bit for people with ADHD but there's a big difference, because sometimes it is difficult to know if it is aspergers or an ADHD, quite often the biggest difference is that people with aspergers they don't have interest in having contact with other people, they are fine living in their own world, playing with their computer and stuff like that, while people with ADHD they really want to be, they enjoy people, they love them, but in spite that even goes bad, they still have a difficult time, and quite often people with aspergers they are more than happy to live in their own little universe. I can't even remember if I answered your question now....

-hahhaa-

m: we might have gone a little bit on the side note but I think we got what we wanted out of the question

t: medicine is one of the treatments, and education, cognitive skills, social training...
m: we would like to introduce our project and get your feedback, the basic idea is that we have this turtlebot

l; a small robot, like those vacuum cleaner, but with a small platform on top where we place our laptop, this is the robot we have to work with, but on our project we were planning to have it as a social robot which will be in an institution with people who have some mental disabilities, we would like it to be a social robot which can actually try to help them, maybe scheduling their day, or just being there, so they can talk, or just ... remember you have to take your pills and things like that
t; how is it going to work? Is about what size and.. ?
m: (we describe on video) and it has a bunch of sensors, for example a camera to move around without hitting obstacles and stuff like that, I don't think there's not much more reasons to go in depth into the technical aspects of it but the main idea is that we have this data-base or calendar where you can put your things into, the things like tasks and then the robot will approach you like half an hour before, or maybe 5 mins, we don't know the ideal time yet, but it will approach you and say something like you have a meeting in half an hour.
l: then as well something, because we are also going to work with people who suffer from frontal lobe trauma the problem is that they don't have, as we understood short term memory, so one of the problems they found is that if they are told to go on a fishing trip in a week, from the time it takes from now to then, they already forgot and then they don't want to go because they feel like wow, I just realized that and I don't feel capable of doing it, and maybe one of the things the robot could is to remind them with phrases like "are you excited about the fishing trip? " so the kind of remember and that way the day they actually go because it is not a surprise.

t: yeah, its wonderful, there is a lot of good stuff in what you guys are saying, because they are motivating and keeping the focused on what's going to happen yeah, great : How far are with it ?

m: well, we started coding some of the notification functions, some guys are working on the movement, but we just started on movement

l: we need to focus a little bit on the speaking because we want the robot to speak obviously but we have to get that done soon.
m: it's a pretty tough task

t: but you guys got a great angle at it because of the lot apps that remind people to go to the meeting, or go to bed on time, brush you teeth and it works for some people but there are also some people who just turn it off, the alarm rings, they stop it and just continue doing what they were doing but if the robot can kind of follow you around and irritate you in a good way to do what you are supposed to do then it would really helpful for a lot of people. When do you have to deliver your project?
m: at the end of December, soon.

m: is there anything else that you think that the robot should be able to do in order to aid the patients more effacingly ?

t: i think if the robot can be insisting in a nice way, until they complete whatever task it is, for example, if you are supposed to take your medicine, will the robot be able to register and see if that person puts the pill on his mouth, will it be able to do things like that and register when you do things? Or how does that work?
l : for this project we are not sure, we will be able to do so much about that, like actually checking, but it could be an idea to develop in the future
t: yeah, because that it continues until it registers what the person should do because that's where the apps or the calendar fail, because they just turn off the alarm and keep not doing it, so it's good if the robot keep until the task its done
m : yes, our main idea was to make feel the user more indecent, doing things on their own instead of having a caretaker telling you what to do, the goal would be to tell the patient "this is coming up in an hour " and then the patient should on his own, try to accomplish it
m: yeah, you kind of answered how to make sure for the patients to use this technology

l: well, but it's not for sure, for example with autism, aspergers, one of the problems we are facing is that if they already have trouble with people as in communicating or socializing, we are unsure about if they will we able to welcome a robot, maybe yes, because they don't see it as another person, as another human so maybe they feel at ease with a machine maybe, but we are not sure about how they could maybe react to having a machine with them

t: a bet this is going to be a huge difference, because some people, as you say that's great, its nerdy and non-human and stuff but there's also some others, because aspergers is also as in ADHD there is variations and different degrees and I'm sure that there's some people who will say, no way, I don't need something freaky or so in my house, but I'm right now thinking of some people that i know that might actually think this is really cool and they would like to have in their life's.
m: do you find any ethical dilemmas by using the robot instead of a human caretaker.

t: yeah, but the biggest one I'm thinking of is the government, if they believe they can save money if it goes well and the robot is good they can actually put these robot instead of other people to help people and if they can do that cheaper, because robots don't get paid they don't go on vacation and a lot of other things, which could also be an advantage for some people cause they have the same robot all the time but also the dilemma is that this people will have less and less human concept, now, worse case, if the robot it's so efficient that they don't need more people, we are losing the human contact, the human touch.

m : the way we have thought of it is not as in the robot taking over the pedagogs job, but just being an aid to make sure that the pedagogue has more time for each patient during the day and have more social interaction / connections.

t: i agree and understand that your intentions are good, but I'm just thinking as in it happened other times for the elderlies, they found some robots that can help, so the idea was that the people that is taking care of the old people at the retirement home they would have more time to be in contact with them, but instead of that, they fired them. because it was a more economic system, so the one problem is what the government will do with it if they see a way to save money, it is hard to know how those people it's going to use it
m : we are also working with down syndrome, is that kind of the same?
t;: some of the needs are the same, but biologically speaking down syndrome is because you have an extra chromosome

m : yeah, not biologically but
t: but you can have also a lot of variety, you can have down syndrome where they have no language and people who are mentally developed as two or three years old, or you can also have downs whose brain is really really good functioning and they would also we helped a lot with the robot you guys are talking about, that would help them with some of their daily reminders and choirs, but basically I'm thinking about anyone who is mentally challenged or have difficult time

with some of the functions in their brain which have to do with planning and organizing , structuring, anyone with those challenges would benefit from your robot, and people even with Alzheimer.
m: ok, thank you that was it.

Kirsten – caretaker

T: Hvor meget tid bruger du om dagen på social interaktion

K: Jamen vi er jo sammen med dem fra de kommer til de er i seng, så i hverdagene er vi sammen med dem fra halv 4 og så til omkring. De fleste bliver puttet til omkring en 8 tiden om hverdagen. Og så i weekenden er vi sammen med dem hele dagen

T: hvor vigtigt er det at strukturere dagen for brugeren

K:det er meget forskeligt det er alt efter deres handicap. Selvfølgelig alle er, og især de børn har brug for lidt sådan tydelighed omkring hvad det er de skal i løbet af dagen, for de fleste af dem kan det være frustrerende hvis de ikke ved det, men nogen af dem har brug for det mere grundigt end andre

T: ja selvfølgelig, kan du sige hvad det er for nogle diagnoser det kan være for at man har det behov

K:Nej for det er meget forskelligt, det kan både være Downs syndrom der med det kan have brug for at gøre det med piktogrammer, især mange børn med autisme, har brug for at hverdagen bliver struktureret på den ene eller anden måde

T: okay du sagde allerede lidt om det men hvordan opnår du det mål af at kunne struktureret det for dem der har brug for det

K: jamen hvordan jeg opnår det, det er jo noget med at lære dem at kende. Før kan man jo ikke finde ud af hvordan man bedst strukturere det for dem, så det er jo igennem at lære børnene at kende at man kan kunne det,

T: men du bruger sådan noget som piktogrammer eller

K: Jeg bruger piktogrammer, jeg bruger talemaskine

T: med talemaskine mener du så bare sådan en computerprogram der kører eller?

K: ja der er der en enkelt, nej to børn der har, den ene styrer selv hvis han har brug for at sige noget, han kan ikke selv tale, så han kan selv komme og vise det eller det er meningen han skal lære det

d:et er meget svært at faktisk at lære at komme til nogen at vise at jeg vil gerne sige det og det han skal mindes om det hele tiden

T: kan du sige noget om, hvor mange sådan nogen ting der skal struktureres i løbet af dagen sådan altså det vel ikke sådan at hvis barnet skal på toilet

K: jo det er meget forskelligt, nogen børn skal bare have en struktur der for eksempel lad os tage en weekend, vi tager en almindelig weekend der er der nogen som bare følger dagens struktur og ikke køre piktogram, der er nogen som har brug for, at man ligesom inddeler dagen i forskellige for eksempel at nu hvor du har spist så ska så skal vi udenfor at det er nok. Men der er også nogen der kan have brug for at vide, at når du har spist så skal du på toilettet, når du har siddet på toilettet så skal du have vasket dine hænder, det er neget forskelligt hvor voldsomt de har brug for det, at vi hjælper dem med at strukturere dagen

T: føler du at de pædagogiske opgaver du skal lave i løbet af dagen på sådan noget som dannelse og mulighed for selvstændighed og livskvalitet og sådan nogle ting bliver forhindret af sådan noget som at skulle opsætte struktur

K: altså nogle børn kan man godt sige at der kan man godt at nogle gange strukturen måske er lige lovlig stram og der kan det selvfølgeligt være svært men med langt de fleste børn der er det jo en del af det pædagogiske arbejde netop at få lavet den der struktur for dem der gør at de enten ikke, altså de kan jo blive dybt frustreret hvis de ikke forstår hvad er det næste jeg skal, så kan de blive voldsomme. Nogle bliver voldsomt udad reagerende, andre kan også slå sig selv, altså der er mange måder at vise deres frustation omkring det hvis de ikke har den der struktureret hverdag

T: ja vi har snakket meget omkring selvstændighed og livskvalitet altså det der står i servise loven at man skal opfylde som pædagoger men er brugeren ud efter at opføre sig selvstændigt

K: det har alle børn og voksne og mennesker, det bedste er hvis du kan få deres selvstændighed frem det er jo noget af det vigtigste faktisk og det er jo også der at struktur kan blive så stram at man sådan kan men det er jo der hvor man sådan for eksempel kan hvis du for eksempel ikke kan snakke så kan forsøge at udlede hvis man kører en struktur med piktogrammer så kan man måske nå frem til at man kan lave valg med flere, for eksempel en aktivitet kan man bruge to billeder så vælger du den bedste det er jo også en del af.

T: ja jeg tænker også over teknologi om det er noget i bruger der snakker jeg om alt fra mobiltelefoner og computere til tv og internet og lignende lom det noget i bruger og jeres brugere bruger altså børnene bruger

K: børnene bruger computere og de bruger IPad men det er meget forskelligt

T: er det noget i bruger med brugeren, altså er i involveret i deres teknologi brug

K: Ja med nogen af dem er vi

T: på hvilken måde hvis du ku

K: jamen for eksempel hvis du har et multi handicappet barn der sidder i en kørestol så kunne det være det at der er nogen programmer hvor man for eksempel kunne være et billede af en ko og så siger den muh ikke det at kunne lære barnet det for første gang at det er en muh lyd ikke så kan man så gå over til den næste dyr ikke. Altså der sidder man meget med det ene barn imens. Og lære den det

T: men bruger i teknologi aktivt til aktiviteter med børnene altså hvis i har en masse børn der kan lide og spille computere opsætter i så computer aftener eller sådan

K: nej det gør vi ikke så meget af altså, vi har snakket om at gøre det med et par enkelte af de store sådan til sidst, men der er forskellige ting der gør at det næsten bliver umulige ikke os, altså de er jo ikke sådan kognitive dygtige, dem der så er kognitive dygtige de er et meget få tal og vi er jo en aflastnings afdeling så det er jo faktisk der at vi har et par stykker der er rigtigt dygtige og de vil faktiske ikke rigtigt være sammen med de andre børn, men de vil gerne sidde og spille det der LOL ja sammen

T: okay, det der her egentlig handler om det er at vi har skulle lave en robot til børn og voksne med nedsat funktions evne, især inden for det med struktur og en form for selvstændighed, det robot skal kunne det er i forhold til visse events i løbet af en dag hvis nu barnet den skal spise klokken 6 og skal i bad klokken 8 så ville den kunne recitere eller fremvise den ved form af piktogrammer alt efter den individuelles behov i løbet af sådan en robot den ville så kunne følge efter den person efter behov eller blive kaldt på hvis den har brug for det så jeg tænkte hvad tænker du selv, ville det være noget der ville kunne forbedre livskvalitet eller være noget der kunne være behjælpeligt

K: Ja altså det kommer an på i hvilken omfang i tænker det hvis det er mig der skal ind hele tiden og aflevere den og den så der skal sige det, eller hvis barnet selv har robotten og den så selv siger

hov nu skal du gå ind og spise eller det nu du skal gå i bad det ville jo give dem meget mere selvstændighed

T: ja altså det ville være en individuel robot der ville kunne virke på individuelle behov, så vores tanker os med det det er om pædagogerne ville kunne sådan en os det er klart det ville være rart at have sådan en robot men hvis pædagogerne ikke forstår brugen af sådan en her eller ikke kan involvere sig i sådan en her altså om det med teknologi at have en robot kørerne i sådan en institution om det er noget du som pædagog ville være interesseret at have kørende i en institution for det er der jo mange forskellige holdninger om

K: okay det ville jeg ikke kunne se andet end at altså hvis det kunne være med til at give det enkelte barn mere selvstændighed så ville jeg syntes det ville være rigtigt fint, hvis det kunne virke jeg syntes det kunne være rigtigt fint os fordi jeg tænker sådan et sted vi er jo en aflastning så ville man måske det der med at køre en struktur og der måske bliver kørt en struktur på skolen der ville være sagt at man så køre den samme struktur når man er derhjemme det ville man så måske hvis den fulgte barnet i stedet så kunne den gøre mere for så køre den faktisk det samme program igennem uanset om du var hjemme om du var ved os eller på skolen

T: altså at den ville være mere konsekvent

K: men jeg tænker da sådan lidt at vi oplever jo egentligt tit at man kan gå hen til et barn og sige nu skal du gå hen og vaske hænder vi skal spise så viser man den piktogram af at vaske hænder så tænker jeg hvad ville en robot gøre når barnet siger nej

T: helt sikkert og der ville det jo ikke ku være en der ku og det tror jeg heller ikke jeg etisk ville være med på at lave en robot der bare kommanderede barnet

T: altså det ville jo sagtens kunne være at det man for den til at gøre er at det den skal er at sige nu skal du ud og vaske finger og hvis det er sat på bestemte tidspunkter så ville den være lavet sådan at den ville kunne sige at du skal til at gøre x på det her tidspunkt eller den ville kunne hjælpe brugeren med at komme op ved at sige at nu skal du til at op så er der vel forskel på altså der er forskel på hvor dyb interaktionen den kan have med en bruger end en pædagog kan ville jeg kunne forestille mig

K: ja det tror jeg også

T: så det er jo ikke en der kommer for at erstatte pædagogen men en der kommer for at supplere pædagogen, på at tage noget af den tid der måske ville blive brugt på det her med struktur

K: altså jeg tror det vigtigste ville være er at man blev mere ensrettet omkring ihvertfald i børn der har rigtigt meget brug for at strukturen er der at man bliver ensrettet over alt ved hjælp af sådan en robot fordi som nogen børn hvor man godt kan stå udenfor at tænke hvad er det for noget det der med at det hele som nu skal du på toilet nu skal du gøre det og nu skal du gøre det men for nogen børn betyder det faktisk at deres vælter hvis ikke de ved nøjagtigt hvad de skal

T: så ville du sige at det er et specielt set af brugere der ville kunne bruge den her robot

K: jeg vil sige at det er dem der er så dygtige at de bare har brug for den guidance med rigtigt mange ting med for eksempel at gå på toilettet og gå ud og vaske fingre der gør de der ting når de lige bliver sagt som egentlig så som ellers ikke ville gøre det

The code

Schedule program.

```
#include <iostream>
#include <iomanip>
#include <ctime>
#include <cmath>
#include <vector>
#include <unistd.h>
#include <cstdlib>
#include "ros/ros.h"
#include "std_msgs/String.h"
#include <sstream>

using namespace std;
```

```
int numOfDaysInAMonth (int);
void printHeader (int);
void printMonth (int);
void skipToDay (int);
int year;
int result;
char* tid;
char clok[] = {  };
char tid1;
int io;
int check_m;
int check_m1;
int check_q;
int check_q1;
int q;
int q1;
int m;
int m1;
int control1;
char timeArray[24];
int userInput;
int userInputTwo;


struct Event
{
   string dateNotice;
   int date1;
   int date2;
   int date3;
```

```
    int timeH;
    int timeM;
    int timeS;
    int location;
};

/*************************************************************************/
/* Checks clock tics on the pc since January 1 since 1970                */
/*************************************************************************/
int checkYear()
{
    int currentYear;
    time_t currentTime;
    struct tm *localTime;

    time( &currentTime );                  // Get the current time
    localTime = localtime( &currentTime );

    currentYear = localTime->tm_year + 1900;
    return(currentYear);
}

int checkHours()
{
    int currentHour;
    time_t currentTime;
    struct tm *localTime;

    time( &currentTime );                  // Get the current time
    localTime = localtime( &currentTime );
```

```
    currentHour = localTime->tm_hour;
    return(currentHour);
}

int checkMin()
{
    int currentMinute;
    time_t currentTime;
    struct tm *localTime;

    time( &currentTime );                  // Get the current time
    localTime = localtime( &currentTime );

    currentMinute = localTime->tm_min;
    return(currentMinute);
}

int checkSeconds()
{
    int currentSeconds;
    time_t currentTime;
    struct tm *localTime;

    time( &currentTime );                  // Get the current time
    localTime = localtime( &currentTime );

    currentSeconds = localTime->tm_sec;
    return(currentSeconds);
}
```

```
/*************************************************************************/
/* Checks clock tics on the pc since January 1 since 1970                */
/*************************************************************************/
int checkMonth()
{
   int currentMonthcheck;
   time_t currentTime;
   struct tm *localTime;

   time( &currentTime);
   localTime = localtime( &currentTime);

   currentMonthcheck = localTime -> tm_mon +1;
   return (currentMonthcheck);
}

/*************************************************************************/
/* Checks clock tics on the pc since January 1 since 1970                */
/*************************************************************************/

int checkDay()
{
   int currentDaycheck;
   time_t currentTime;
   struct tm *localTime;

   time( &currentTime);
   localTime = localtime( &currentTime);
```

```
   currentDaycheck = localTime -> tm_mday;
   return (currentDaycheck);
}

/*************************************************************************/
/* Zeller's Algorithm                                                    */
/* Checks day of a month and outputs whether it is monday, sunday etc.   */
/*************************************************************************/

int dayNumber(int m, int d, int y)
{
   if (m == 1 || m == 2)
   {
      m = m + 12;
      y = y - 1;
   }
   return (d + (int)floor((13 * (m + 1)) / 5) + y%100 + (int)floor((y%100)/ 4)
   + (int)floor(((int)floor(y/100))/4) + 5*(int)floor(y/100)) % 7;
}

/*************************************************************************/
/* The main algorithm for the calendar program                           */
/*************************************************************************/

int main (int argc, char **argv)
{
   cout << "Welcome to the Turtlebot T.R.I.L.L.E.R's user interface." << endl;
   cout << "What would you like to do?" << endl;
   cout << "\n1: Make a new appointment." << endl;
   cout << "2: Check appointments." << endl;
```

```
cout << "3: Print calendar for current month." << endl;
cout << "4: Change an appointment." << endl;
cout << "5: Program UI sleep." << endl;
cout << "\nToday is the " << checkDay() << "-" << checkMonth() << "-" << checkYear() << endl;

vector<Event>listOfEvents;
Event p;

                ros::init(argc, argv, "mouth");

                ros::NodeHandle n;

                ros::Publisher location1_pub = n.advertise<std_msgs::String>("location1", 1000);
                ros::Publisher location2_pub = n.advertise<std_msgs::String>("location2", 1000);

                ros::Rate loop_rate(10);

                int count = 0;

while (true && ros::ok())
{

   if (userInputTwo == 1 && ros::ok())
   {
      system("clear");
      cout << "Welcome to the Turtlebot T.R.I.L.L.E.R's user interface." << endl;
      cout << "What would you like to do?" << endl;
      cout << "\n1: Make a new appointment." << endl;
      cout << "2: Check appointments." << endl;
      cout << "3: Print calendar for current month." << endl;
```

```
    cout << "4: Change an appointment." << endl;
    cout << "5: Program UI sleep." << endl;
    cout << "\nToday is the " << checkDay() << "-" << checkMonth() << "-" << checkYear() << endl;
    userInputTwo++;
}

cin >> userInput;

if (userInput == 1)
{
    system("clear");

    cout << "What is it you wan't to do?: ";
    cin.ignore();
    getline(cin,p.dateNotice);

    cout << "\nEnter the month of the event: ";
    cin >> p.date1;

    cout << "\nEnter the day of the event: ";
    cin >> p.date2;

    cout << "\nEnter the year of the event: ";
    cin >> p.date3;

    cout << "\nEnter the allocated time for the event: ";
    cin >> p.timeH;
    cin >> p.timeM;
    cin >> p.timeS;
```

```
                cout << "\nEnter the location (1 or 2): ";
                cin >> p.location;

        listOfEvents.push_back(p);

        cout << listOfEvents.size() << endl;

        userInputTwo = 1;
    }

    else if (userInput == 2)
    {
        system("clear");

        cout << "If you wish to change something in one of your appointments," << endl;
        cout << "please note the reference number for the specifik appointent.\n" << endl;

        for (int n=0; n < listOfEvents.size(); n++)
        {
            cout << "Date: " << listOfEvents[n].date2 << "-" << listOfEvents[n].date1 << "-" << lis-
tOfEvents[n].date3 << endl;
            cout << "Time: " << listOfEvents[n].timeH << ":" << listOfEvents[n].timeM << ":" << lis-
tOfEvents[n].timeS << endl;
                                cout << "At location: " << listOfEvents[n].location << endl;
                                cout << listOfEvents[n].dateNotice << endl;
            cout << "Ref nr: " << n << "\n" << endl;
        }

                cin.ignore().get();
```

```
    userInputTwo = 1;
}

else if (userInput == 3)
{
    while (true)
    {
        system("clear");

        int currentMonth = 1;
        int numDays;

        year = checkYear();

        cout << " Year: " << year << endl;

        while (currentMonth <= 12)
        {
            numDays = numOfDaysInAMonth(currentMonth);

            if (currentMonth == checkMonth())
            {
                printHeader(checkMonth());
                printMonth(numDays);
            }
            currentMonth++;
        }

        cout << "\n" << endl;
```

```
            cout << checkHours() << ":" << checkMin() << ":" << checkSeconds() << endl;


            userInputTwo = 1;
            break;
        }
    }

    else if (userInput == 4)
    {
        int RefNr;
        string newUserInput;
        system("clear");
        cout << "Enter reference number to the appointment you want to change." << endl;
        cout << "Ref nr: ";
        cin >> RefNr;


        cout << "\nDate: " << listOfEvents[RefNr].date2 << "-" << listOfEvents[RefNr].date1 << "-" << lis-
tOfEvents[RefNr].date3 << endl;
        cout << "Time: " << listOfEvents[RefNr].timeH << ":" << listOfEvents[RefNr].timeM << ":" << lis-
tOfEvents[RefNr].timeS << endl;
        cout << "Location: " << listOfEvents[RefNr].location << endl;
                    cout << listOfEvents[RefNr].dateNotice << endl;


        cin.ignore().get();
        system("clear");


        cout << "Enter new description for date: ";
        cin.ignore();
        getline(cin,listOfEvents[RefNr].dateNotice);
```

```
    cout << "\nEnter new month: ";
    cin >> listOfEvents[RefNr].date1;

    cout << "\nEnter new day of month: ";
    cin >> listOfEvents[RefNr].date2;

    cout << "\nEnter new year: ";
    cin >> listOfEvents[RefNr].date3;

    cout << "\nEnter new time: ";
    cin >> listOfEvents[RefNr].timeH;
    cin >> listOfEvents[RefNr].timeM;
    cin >> listOfEvents[RefNr].timeS;

            cout << "\nEnter new location: ";
            cin >> listOfEvents[RefNr].location;

    cin.ignore().get();
    userInputTwo = 1;
}

else if (userInput == 5)
{

        while(true && ros::ok())
{
                    sleep(1);
                    checkYear();
                    checkMonth();
                    checkDay();
```

```
                checkHours();
        checkMin();
        checkSeconds();
                cout << checkHours() << ":" << checkMin() << ":" << checkSeconds() << endl;

        for (int n = 0; n < listOfEvents.size();)
        {

                        if (listOfEvents[n].date3 == checkYear() && lis-
tOfEvents[n].date1 == checkMonth() &&
            listOfEvents[n].date2 == checkDay() && checkHours() == listOfEvents[n].timeH &&
            listOfEvents[n].timeM == checkMin() && listOfEvents[n].timeS == checkSeconds())
             {
             system("clear");

                                        if (listOfEvents[n].location == 1)
                                        {
                                                std_msgs::String msg;

                                                std::stringstream ss;
                                                ss << listOfEvents[n].location;
                                                msg.data = ss.str();

                                                ROS_INFO("%s", msg.data.c_str());

                                                location1_pub.publish(msg);

                                                ros::spinOnce();

                                                loop_rate.sleep();
```

```
                ++count;
            }

            else if (listOfEvents[n].location == 2)
            {
                std_msgs::String msg;

                std::stringstream ss;
                ss << listOfEvents[n].location;
                msg.data = ss.str();

                ROS_INFO("%s", msg.data.c_str());

                location2_pub.publish(msg);

                ros::spinOnce();

                loop_rate.sleep();

                ++count;
            }

            //cout << listOfEvents[n].dateNotice << endl;

            listOfEvents.erase(listOfEvents.begin() + n);

        }
        n++;
    }
```

```
                                if (listOfEvents.size() == 0)
                                {
                                userInputTwo = 1;
                                break;
                                }
        }

      }
   }

   return 0;
}

/*************************************************************************/
/* Function to check for leap years.                                     */
/*************************************************************************/

bool leapYearCheck()
{
   bool leapYear;
   if ( ((year % 4) == 0) && ((year % 100) != 0) )
                {
                leapYear = true;
                }
   else if ((year % 400) == 0)
                {
                leapYear = true;
                }
   else
                {
```

```
                leapYear = false;
                }
  return leapYear;
};

/*************************************************************************/
/* This function returns the number of days in a month                   */
/*************************************************************************/

int numOfDaysInAMonth (int m)
{
  if (m == 1)
    return(31);

  else if ((m == 2) && (leapYearCheck() == false))
      return(28);

  else if ((m == 2) && (leapYearCheck() == true))
    return(29);

  else if (m == 3)
    return(31);

  else if (m == 4)
    return(30);

  else if (m == 5)
    return(31);

  else if (m == 6)
```

```
        return(30);

    else if (m == 7)
        return(31);

    else if (m == 8)
        return(31);

    else if (m == 9)
        return(30);

    else if (m == 10)
        return(31);

    else if (m == 11)
        return(30);

    else if (m == 12)
        return(31);

    else
        return(-1);
}

/*************************************************************************/
/*    It takes the number of the month and prints outs the name of the    */
/*  month and the frame of the calander                                   */
/*************************************************************************/

void printHeader (int m)
```

```
{
   if (m == 1)
      cout << " January" << endl;

   else if (m == 2)
       cout << " February" << endl;

   else if (m == 3)
       cout << " March" << endl;

   else if (m == 4)
       cout << " April" << endl;

   else if (m == 5)
       cout << " May" << endl;

   else if (m == 6)
       cout << " June" << endl;

   else if (m == 7)
       cout << " July" << endl;

   else if (m == 8)
       cout << " August" << endl;

   else if (m == 9)
       cout << " September" << endl;

   else if (m == 10)
       cout << " October" << endl;
```

```
   else if (m == 11)
       cout << " November" << endl;

   else if (m == 12)
       cout << " December" << endl;

   cout << " S  M  T  W  T  F  S" <<endl;
   cout << "_____________________" << endl;
}

/*************************************************************************/
/* Helps with the skipToDay function                                     */
/*************************************************************************/

   void skip (int i) {
      while (i > 0) {
         cout << " ";
         i = i - 1;
      }
   }
/*************************************************************************/
/* This function prints out the days in the month after the header for   */
/* each month                                                            */
/*************************************************************************/

void printMonth (int numDays)
{
   int day = 1;
   int weekDay;
```

```
   weekDay = dayNumber(checkMonth(),01,checkYear()) - 1; // -1 because Zeller's algorithm goes from 1 to 7 while the function works from 0 to 6.


   skipToDay(weekDay);
   while (day <= numDays)
   {
      cout << setw(2) << day << " ";
      if (weekDay == 6)
      {
         cout << endl;
         weekDay = 0;
      }
      else weekDay++;
      day++;
   }
}

/*************************************************************************/
/* Prints spaces in monthly calendar                                     */
/*************************************************************************/

void skipToDay (int d)
{
   return skip(3*d);
}
```

Movement program

Ear

```
#include <ros/ros.h>
#include <move_base_msgs/MoveBaseAction.h>
#include <actionlib/client/simple_action_client.h>
#include <tf/transform_datatypes.h>
#include <clear_costmap_recovery/clear_costmap_recovery.h>
#include <pluginlib/class_list_macros.h>
#include <vector>
#include "std_msgs/String.h"
#include <sstream>
#include <iostream>

        int io = 0;

        typedef actionlib::SimpleActionClient<move_base_msgs::MoveBaseAction> MoveBaseClient;

        void chatterCallback(const std_msgs::String::ConstPtr& msg)
        {
                ROS_INFO("%s", msg->data.c_str());
                std::string inputFromCal;
                inputFromCal =  msg->data.c_str();

                if (inputFromCal == "1")
                {
```

```
ROS_INFO("Besked modtaget!");

                //return(io);
bool succes;
//tell the action client that we want to spin a thread by default
MoveBaseClient ac("move_base", true);

//wait for the action server to come up
while(!ac.waitForServer(ros::Duration(5.0)))
{
                ROS_INFO("Fail!");
}

move_base_msgs::MoveBaseGoal goal;

//we'll send a goal to the robot to move 1 meter forward

goal.target_pose.header.frame_id = "map";
goal.target_pose.header.stamp = ros::Time::now();

goal.target_pose.pose.position.x = 4.0;
goal.target_pose.pose.position.y = -1.1;
goal.target_pose.pose.orientation.w = 1.0;

ROS_INFO("Sending goal");
```

```
ac.sendGoal(goal);

ac.waitForResult();
//io = 0;

if(ac.getState() == actionlib::SimpleClientGoalState::SUCCEEDED)
{
        ROS_INFO("Succes");
        succes = true;
}
else
{
        ROS_INFO("No succes");
        succes = false;
}

if (succes == true)
{
        while(!ac.waitForServer(ros::Duration(5.0)))
        {
                ROS_INFO("It failed, waited for server!");
        }
```

```
                                        move_base_msgs::MoveBaseGoal goal;

                                        //we'll send a goal to the robot to move 1 meter
forward

                                        goal.target_pose.header.frame_id = "map";

                                        goal.target_pose.header.stamp =
ros::Time::now();

                                        goal.target_pose.pose.position.x = 0.3;

                                        goal.target_pose.pose.position.y = 1.2;

                                        goal.target_pose.pose.orientation.w = 1.0;

                                        ROS_INFO("Sending goal");

                                        ac.sendGoal(goal);

                                        ac.waitForResult();

                                    }

                                }

                            }
```

```
int main(int argc, char **argv){

        std::cout << "io: " << io << std::endl;

        ros::init(argc, argv, "ear");

        ros::NodeHandle n;

        ros::Subscriber sub = n.subscribe("location1", 1000, chatterCallback);

        ros::spin();

}
```

Ear1

```
#include <ros/ros.h>
#include <move_base_msgs/MoveBaseAction.h>
#include <actionlib/client/simple_action_client.h>
#include <tf/transform_datatypes.h>
#include <clear_costmap_recovery/clear_costmap_recovery.h>
#include <pluginlib/class_list_macros.h>
#include <vector>
#include "std_msgs/String.h"
#include <sstream>
#include <iostream>

        int io = 0;
```

```
typedef actionlib::SimpleActionClient<move_base_msgs::MoveBaseAction> MoveBaseClient;

void chatterCallback(const std_msgs::String::ConstPtr& msg)
		{
			ROS_INFO("%s", msg->data.c_str());
			std::string inputFromCal;
			inputFromCal =  msg->data.c_str();

			if (inputFromCal == "2")
			{
				ROS_INFO("Besked modtaget!");

					//return(io);
				bool succes;
				//tell the action client that we want to spin a thread by default
				MoveBaseClient ac("move_base", true);

				//wait for the action server to come up
				while(!ac.waitForServer(ros::Duration(5.0)))
				{
					ROS_INFO("Fail!");
				}

				move_base_msgs::MoveBaseGoal goal;

				//we'll send a goal to the robot to move 1 meter forward

				goal.target_pose.header.frame_id = "map";
				goal.target_pose.header.stamp = ros::Time::now();
```

```
goal.target_pose.pose.position.x = 2.73;
goal.target_pose.pose.position.y = -1.24;
goal.target_pose.pose.orientation.w = 1.0;

ROS_INFO("Sending goal");
ac.sendGoal(goal);

ac.waitForResult();
//io = 0;

if(ac.getState() == actionlib::SimpleClientGoalState::SUCCEEDED)
{
        ROS_INFO("Succes");
        succes = true;
}
else
{
        ROS_INFO("No succes");
        succes = false;
}


if (succes == true)
{
        while(!ac.waitForServer(ros::Duration(5.0)))
        {
                ROS_INFO("It failed, waited for server!");
        }
```

```
                                                move_base_msgs::MoveBaseGoal goal;

                                                //we'll send a goal to the robot to move 1 meter
forward

                                                goal.target_pose.header.frame_id = "map";
                                                goal.target_pose.header.stamp =
ros::Time::now();

                                                goal.target_pose.pose.position.x = 0.3;
                                                goal.target_pose.pose.position.y = 1.2;
                                                goal.target_pose.pose.orientation.w = 1.0;

                                                ROS_INFO("Sending goal");
                                                ac.sendGoal(goal);

                                                ac.waitForResult();
                                        }
                                }
                        }



  int main(int argc, char **argv){

                        std::cout << "io: " << io << std::endl;

                        ros::init(argc, argv, "ear2");
```

```
    ros::NodeHandle n;

    ros::Subscriber sub = n.subscribe("location2", 1000, chatterCallback);

    ros::spin();

}
```

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