MEMENTEN

I n d e x

Motivation

As much as modernization benefits us with better nutritional conditions and medical technology, also brings population aging. Countries with high elderly ratio are already challenged with the raise in health care costs as their working populations diminish[1]. Among various changes that comes with aging, a lot of them are directly or indirectly associated with memory decline, including self-concept, social interaction, as well as work and leisure activities[2]. Having witnessed such reality from our own experiences and the research process, we came to the conclusion that it is worthwhile to put our effort into this specific topic.

„I've been always interested in memory issues because of my Grandma, who has dementia. I want to make something that would help her hold onto her memories"

\- Hiyeon

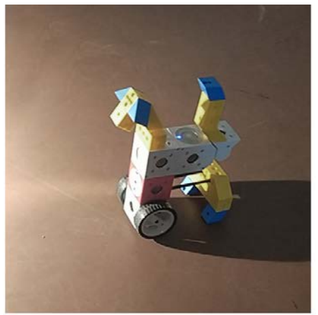
„Through my work as a volunteer in the senior care house, I've built connections with a lot of people with dementia, and saw them and their families struggling every day. I'd like to help them! "

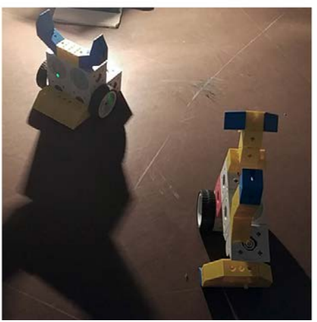
\- Valeriia

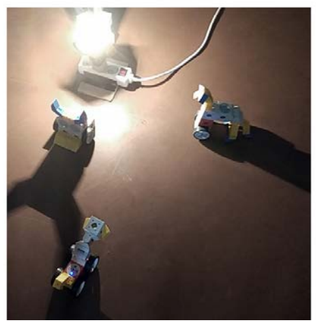
While the physical incapabilities can usually be approached with technological solutions straightforwardly, it is simply not the case with cognitive impairment. People with cognitive issues usually have much more difficulty using technology, requiring more attention to its design and development[3]. Under this major premise, our team had gone through vigorous research and design processes, starting from the discussion on what roles should robots play in their lives.

What could a machine do against loneliness, boredom, disorientation, lack of communication and memory loss?

Workshop







Our first task was to learn more about robotic principles and the work behind it.

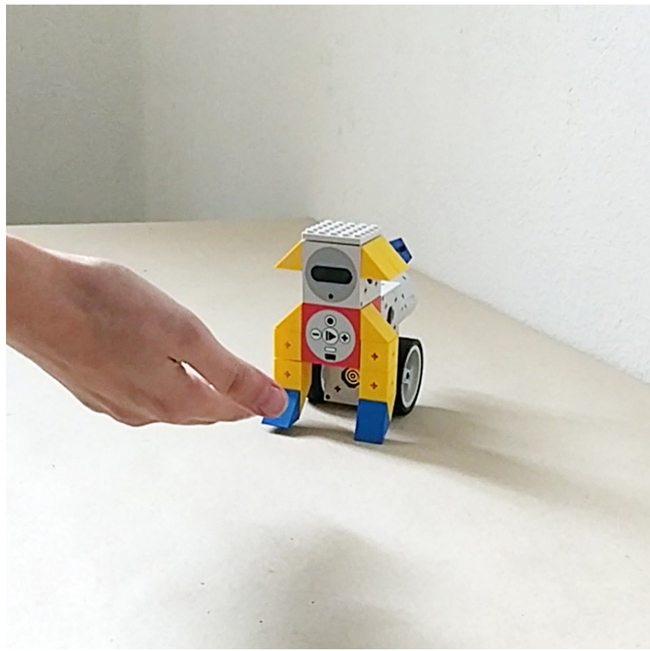
Luckily, we had TinkerBots to help us with it: Christian Guder, the CTO and the Co-Founder of the company, and also an alumnus of Bauhaus University Weimar, came to teach us basics about robotic behaviors with the help of their robotic building kit, namely TinkerBots.

We spent the next few days building robots with simple, but funny and meaningful behaviors. It was an interesting process: we could easily connect different parts with various functions together.

Next step was programming the robots with Arduino to make them read the sensor values and let their actions depend on them.

We wanted to build a friendly robot, which would greet a person and demonstrate sympathy. That's why we made it look like a dog, as what could be friendlier?

Our Pet had a distance sensor, that allowed it to know if somebody would come near to it. At first, it would just wiggle its tail to greet you. If you would come closer, it would move towards you and wiggle its tail even faster to show its excitement. Such a good boy!

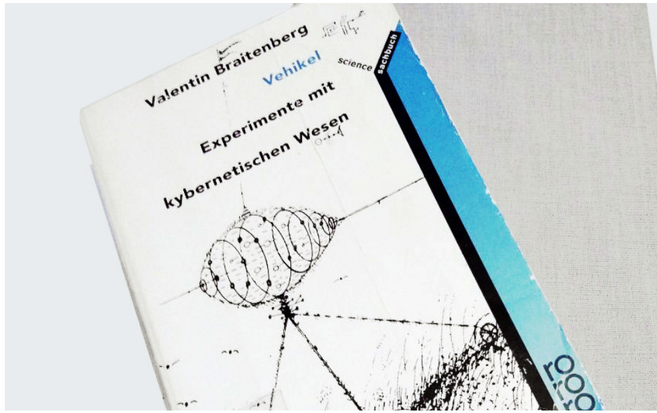


Research

Literature

Vehikel : Experimente mit kybernetischen Wesen
- Valentin Braitenberg.

"Wir haben in letzten Jahrzehnten erfahren, daß manches, was den menschlichen Geist auszeichnet: logisches Denken, abstrahieren, Gestalten erkennen, ganz treffend auch die Funktionsbeschreibung von komplexen Rechenmaschinen auftaucht." [p.3]



How do we build a robotic machine with certain behaviour? – we asked ourselves as we participated in the TinkerBot-Workshop. Of course we could call every reaction a behavior, but that is too simplified. Was it possible to make a robot make decisions not only based on sensor values, but on its principles and memory? This book explained it to us in philosophical and near-biological terms, building the behavior up from moving, aggression and love to prediction, optimism and egoism.

Soziale Maschinen bauen : epistemische Praktiken der Sozialrobotik

- Andreas Bischof

What exactly makes something a robot? Was it something we needed for our social projekt? This questions were part of our everyday conversations and concerns in our work.

"Roboter sind verkörperte, computerisierte Maschinen, die zum erfolgreichen Funktionieren unterschiedliche Komponente koordinieren müssen" [p.16]

– we learned, but there were much more to it. A robot should not only coordinate its components: it should sense, analyse, plan and act [p.17].

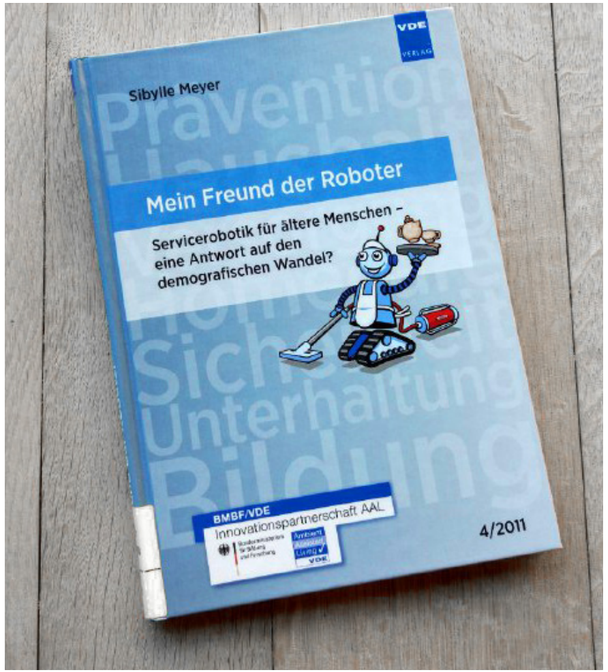
Our Tinkerbot-Pet read his sensors and moved himself, if the rates went higher than a certain amount we told him (still a small analysis and part of the planning). But did it make him a social robot?

"Die technische Aufgabe der Sozialrobotik besteht darin, mehrdeutige Phänomene in eindeutige Zweck-Mittel-Relationen zu überfüllen" [p.54]

– we found the answer, hidden in between descriptions of challenges of social robotics. It meant, our robot could be social, because his task were to be friendly, showing a complex emotion, based on sympathy and personal effects.

He managed it by following a simple scheme: "need something to come closer (reason) – swinging the tail (method) – moving towards it (method)".

Through this analysis we learned, what are robots and how we could construct them technically social. But how do we make it socially acceptable? This was a question to carry on with.



Mein Freund der Roboter : Servicerobotik für ältere Menschen - eine Antwort auf den demographischen Wandel? - Studie im Auftrag vonVDE - Sibylle Meyer.

This book was very helpful for us, as we were asking ourselves, how could we make elderly people accept our robots. This part took our concerns away:

„Schlüssel zur Akzeptanz bei älteren Menschen ist der subjektiv angenommene Nutzen einer technischen Innovation: wird ein Anwendungsszenario… als besonders wichtig eingeschätzt und wird die hierfür präsentierte technische Lösung überzeugend, einfach und handbar eingesehen, erreicht das Anwendungsszenario hohe Zustimmungspunkte“ [p.32]

So, our most important task became to make an understandable machine, whose control and interaction would be easy and intuitive. As we wanted to make a robot, which could help people with dementia or memory problems, we also were trying to find most important functions.

As described in the book (p. 85–86, «Roboter als Alltagsassistenten»), most of the test persons imagined a robot making memos for them (of meeting, medicine, favorite TV-shows, drinking, eating and moving), recording and playing personal voicemail and playing games or quizzes together. It is also important, that robot would communicate politely and be stationary. But most importantly,

“Ein Sozialroboter darf menschliche Kommunikation nicht ersetzen, sondern soll diese erweitern“ [p.86]

Inspired by this, we made ourselves on work. There was still a lot to do, as this book never had people with dementia among their control group, so we still had their opinions missing.

Fürsorge-Relationen. Theoretische und empirische Sichtweisen auf Care (Journal)

“Care ist zu einer Schlüsselkategorie geworden, die alle Bereiche miteinander verbindet… Es ist einfach existentielle Tatsache, dass Menschen nicht überleben können, ohne dass andere sich um sie kümmern” [p.11].

This sentence in a journal about problems and latest discussions in care showed us, how important it is to still think about human contact and interaction. As said in the previous book, our robot had to empower his users to interact with people around him and also broaden the communication.

Unfortunately there were no opinions about robots involved in healthcare or interviews with patients. As Karin Jurczyk says in her interview,

“Die Forschung zu Care ist aus der Perspektive erwerbstätiger Erwachsener gemacht und wir sollten unterschiedlichen Care-Nehmer/innen anhören” [p.13].

Act of Reminiscence

Reminiscence is the key element of our design to trigger memories. One recent study by Tiong et al[4] conducted interviews with care staffs and medical professionals to figure out the most significant or useful interactions and conversations to assist dementia patients' memory. One noticeable character that they found from the patients is that they are observed to show more affection towards their belongings and familiar surroundings, and also that they tend to behave out of familiarity. Especially, they are seen more engaged and socially active when recalling their own history or events. One participant mentioned that patients' favorite belongings or artefacts can be used to calm down the agitated situations. The interviews also support the idea that visual materials such as photos and videos are useful for improving episodic and semantic memories. Based on this, we focused on the users' own narratives and also support visual trigger using a slide show.

Design Guidelines for Dementia

Through interviews and other research, Mayer and Zach[5] presented several guidelines on designing for patients with dementia. The seven elements provided some valuable insights on designing Mementen as well. First of all, it suggests to use familiarity and emotions, that is, using the physical items towards which patients have a strong sense of familiarity can evoke meaningful associations. The main concept of Mementen is exactly this idea of using the objects that users own. The study also emphasizes the importance of clarity and simplicity of user interface. For example, too many buttons or metaphors that are abstract or modern would lead to confusion and frustration for the dementia patients. Therefore, we tried to make our user interface as simple as possible; it plays when the object is placed, stops when not.

Knome : Name Recall by Adam Preiner

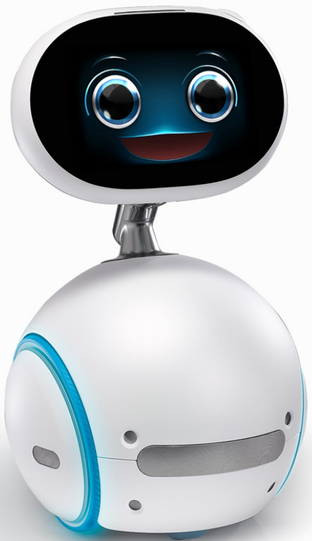
This is a free app which helps people to recall names by relationships. The most interesting part of it is the sorting system: a user can go to different sub topics, such as „Family“, „Work“, „Sports“, etc. to recall a person in connection of where they met.

Although an app could use a better design, it is still user-friendly and not stigmatising, as not only seniors have a problem with names, but even students could use such an app.

NRS Healthcare Memo Minder Reminder Aid by NRS Healthcare

This is a small and easy machine with motion sensor, capable of playing pre-recorded audio messages. Its functions are pretty simple: it just plays a message, if the sensor is triggered. For example, one can attach the sensor next to the door and tailor the message to remind the user to take the keys when leaving.

Although the function of it is extremely simple and effective at the same time, one could also ask, if it is stigmatising. Does using such a machine mean that a person cannot remember the most important things anymore or doesn‘t have anybody to help him with reminding?



Zenbo by Asus

Zenbo is a smart entertainment robot for home, a winner of Red Dot Design Award 2017 and a iF Design Award 2018.

We had the most interest in the functions which could be important for senior users, such as video or phone calls with family, and reminder function. Also the robot could detect emergencies and notify family members, sending them a proving photo or even starting a video call with them.

Of course these functions are great, but this robot of high technology would cost around 600$, what makes him not practical and available, therefore unsuitable solution for the most seniors.

Shadow research

On May 25th, we could have a close look into how the morning starts at one senior care home in Weimar. We were accompanied by caregivers along their working processes, and sometimes given a chance to ask questions. These are some of the insights that we got from the observation.

Medication:

The day started with the medication. Caregivers check the pills that are needed by each senior for the specific time of the day. Upon visiting each room, they make sure that everyone takes the pills. Often some seniors resisted on taking medication, which then resulted in ‘a gentle push’ by a caregiver.

A clever organisation of the pills containers also caught our eye. The medicine is sorted by the pharmacy in small plastic boxes for each of the senior and packed in individual pockets with label showing the name of the medicine and time to take it.

Dementia in senior care home:

It was also important for us to see, how persons with dementia are treated. From what we saw, most of them were spending majority of their time in common rooms, where they could have a feeling of participation in everyday routines and watch other people going past them. Sometimes they would get irritated and disoriented, but other seniors around them would react on it and talk with them trying to calm them down, or call the caregivers.

Hygiene:

One lady was having a morning shower, with the help of a caregiver from start to finish.

The shower chair played an integral role in the process, along with the quickness of caregiver. After a seemingly pleasant shower, the lady went through a little skin care routine, followed by hair combing. During that, one other senior lady came to request a more thorough hair combing on the back. Beauty matters!

Sunday Pullover:

An interesting conversation while the lady was being dressed up,

Lady: *"Is it Sunday?"*
Caregiver: *"No, Friday."*
Lady: *"But this pullover is for sunday!"*

gave an idea how objects might help cognition.

Activeness upon Table:

There were two tables at the breakfast. One small table was for the people who had dementia and couldn't eat themselves, and the bigger one was for those who could.

While the big table had an active atmosphere, people having conversations and helping each other, seniors on another table were mostly quiet, and often observed to glimpse over the other table.

We found this separation very stigmatizing. It could be possible to make few smaller tables, so it wouldn't be so obvious how isolated the seniors are with bigger physical or cognitive issues.

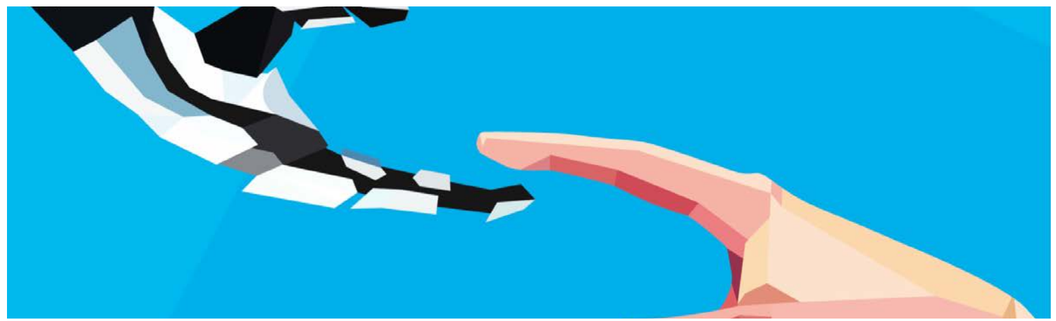
Dokumentation:

There are a lot of paperwork going on behind the scenes. Caregivers had to put up a variety of detailed information on the desktop documentation program.

This includes medication, water intake, vitality check, visitors, or even frequency of going to the toilet, all important later for doctors, families, and insurance company. As we learned, filling these forms would take between one and three hours per workday, depending on the position and responsibilities of caregiver.

Conference insight

At the beginning of June, we had a great opportunity to visit a „Future of Nursing Care“ cluster conference in Oldenburg. It was our chance not only to hear about newest inventions in care and robotic design, but also to speak with inventors and have an insight into the processes and challenges.
As we already decided to design a robot which would help people with dementia, it was particularly interesting how other inventors approached the memory loss problem or disorientation issue. Especially helpful was to see presentations of inventions “I-Care” and “InterMem”, both about helping people with dementia.



I-Care:

I-Care is a project from a Bremen University to develop a tablet application for dementia patients and their families to help improve their mental and social abilities, by bringing more joy in lives.

The app includes activities such as puzzle games, singing with videos, and photographs of their own memory. The core function of the system is the personalized and dynamic adaptation of the contents. This is done daily by automatically evaluating the reactions, particularly emotions of the users.

Also the app can spontaneously creates an activation group with the voluntary help of neighbors.

We feel that the fact that this system changes and adapts to the each individual’s own traits is interesting and adequate way of dealing with memory or cognition illnesses.

In Mementen, we also tried to adapt this personal way of forming the contents, along with the possibility to get input from any people that shared the memory with the individual.

InterMem:

InterMem is a research project exploring new possibilities of interactive memory exercises for people with dementia. Experts from different universities, companies and organisations were working together, using modern technologies and research information to figure out the best way to deal with memory issues. Six different devices were concepted altogether, but most of them were based on the idea that memories could be triggered by right pictures and music. This theory was also proved by testing.

We were glad to see how effective this way could be, as it gave us the reason to bring visual functions along with personal narrative in concept of Mementen.

idea development

First Idea:

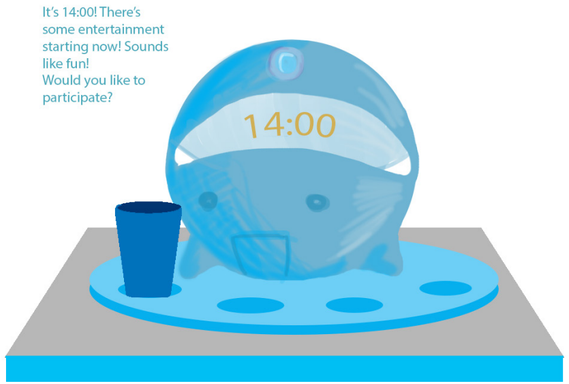
We thought it was a good idea to make a concept of a robot which could play the role of the secretary for seniors and be especially user friendly for people with dementia.

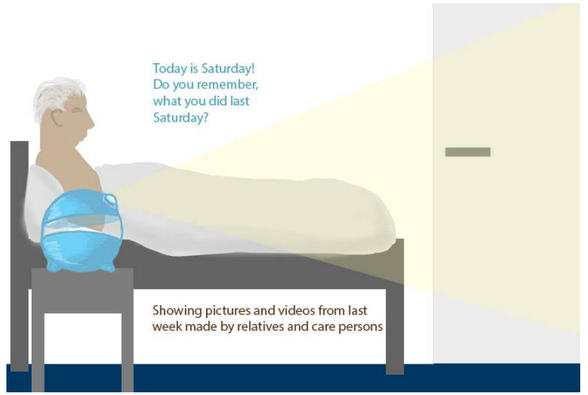
We imagined having a lot of different functions which would be especially handy in the senior care facility: reminder for the medicine and collective activities to spare the time of caregivers; entertainment and communication; detection of emergencies.

Evaluation:

After some detailed research and analysis of our possibilities and technical options, this idea appeared to be too complicated.

Also the user experience was problematic. To solve the problem with dementia patients having difficulty using it, there were a lot of self-initiation integrated in the design; the robot asking questions like „Do you want to listen to some musik?“. However, the sense of disturbance and surveillance the users would feel appeared as a major problem.





Helping with memory:

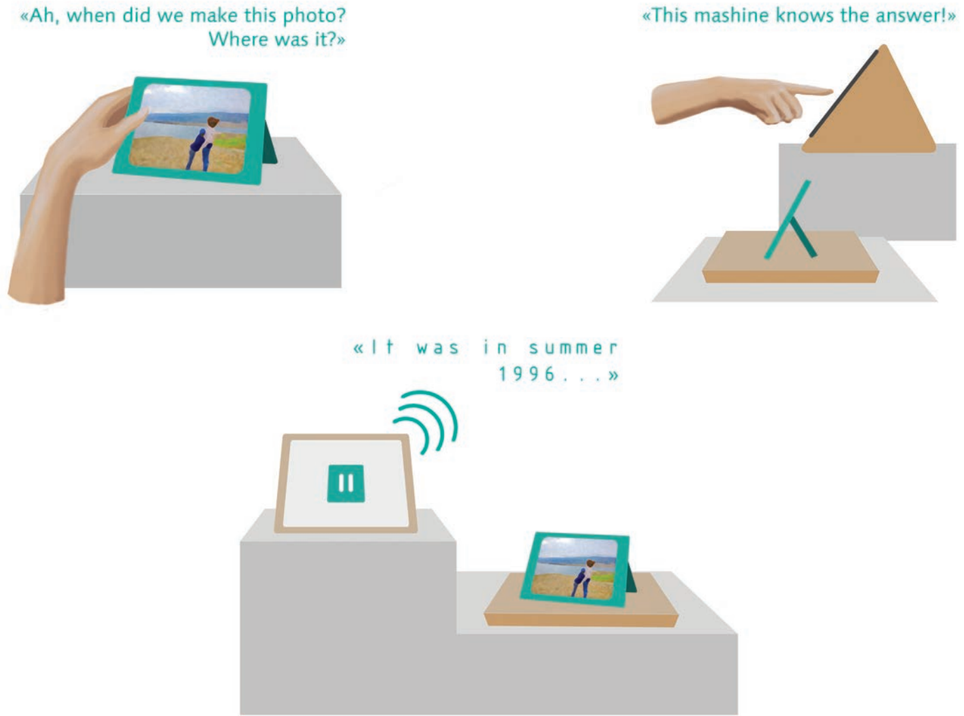
We needed to choose our main topic and base the functions on it. As we wanted to help people with dementia from the beginning, we concentrated ourselves on helping people with memory loss.

We were thinking: how do we keep our memories? We are telling stories to other people, making photos, writing diaries, buying souvenirs. This brought us to our final idea.

Mementen:

This is what Mementen does: it keeps memories safe by recording the user telling a story about some object he placed on the detector. The user can also create his personal slideshow from personal photos or pictures from the Internet.

After recording, memories could easily be played by only placing an object on the detector. No matter what, if big or small, but always with a story to tell.



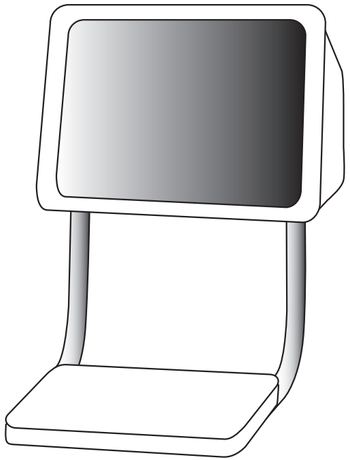
Work in progress:

So we had our concept and probable user scenario, but there was still a lot of work to do and decisions to make.

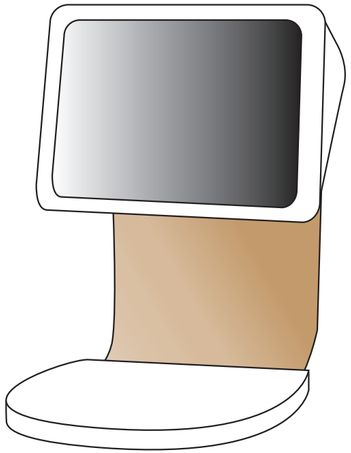
From then on each of us had his own task to do: Hiyeon was creating a software to guide the usage of our machine and Valeriia was responsible for building a model and bringing the hardware to work.

Construction&Material variations:

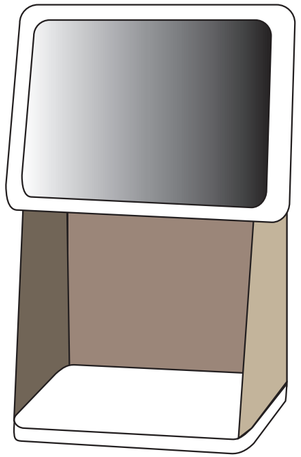
Our first question to the form was: how should it look like? Which materials do we want to use and why? What is the most efficient and elegant way to build our model?



Metal tubes would be easy to build and practical to use, also quick to clean.



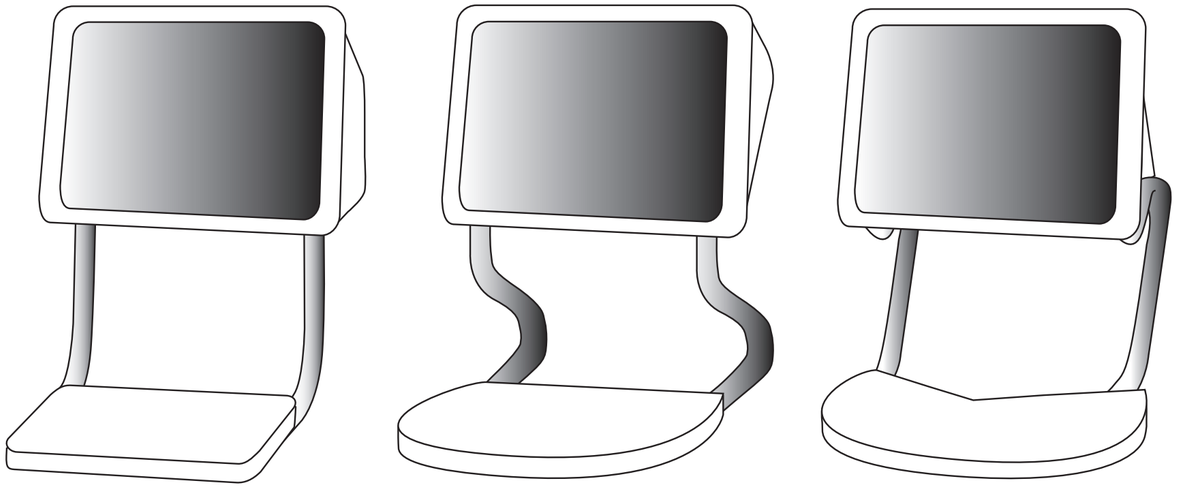
A foot of the bended wood would look very elite, but complicated to manufacture.



A wooden box is a simple and quick decision, but not practical or inviting.

Form variations:

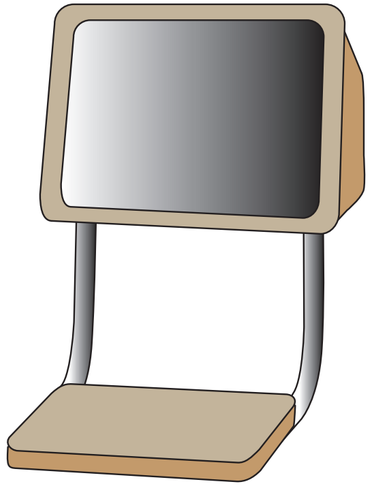
We decided to use metallic tubes. But how exactly do we shape them?



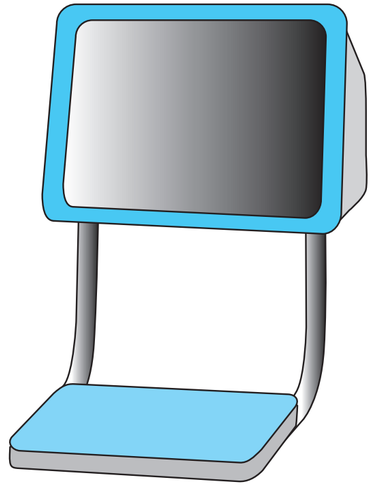
We needed to use a machine in order to bring our metal tubes into shape. Unfortunaly, we weren‘t able to bend the tubes in the form of such a small radius and short length. Sadly, we had to stick to the easiest form.
But perhaps, it was also the most practical decision?

Color variations:

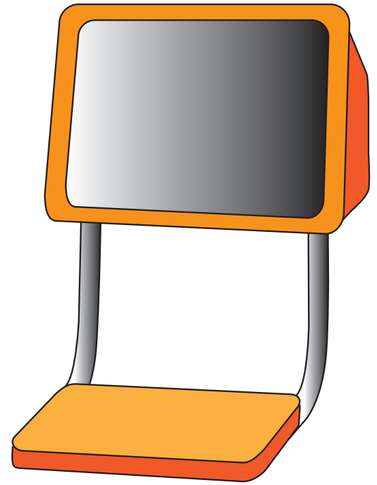
The last question was, which colors do we use? Which material would serve as a holder for our technic and which possibilities fo we have in coloring it?



We could use the wooden plates and let them as they are.



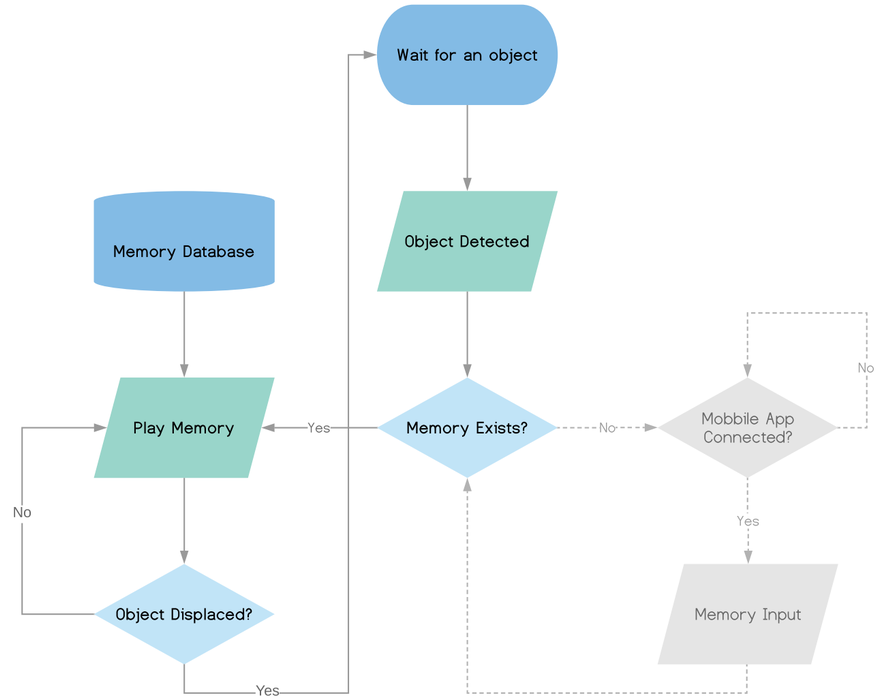
Using plexiglass, we could have calm pastel colours and show the inner structure of electronics.



Of course, we could paint the wooden construction whatever color we find the most apropriate.

Implementation

MEMENTEN APPLICATION ALGORITHM



Mementen was implemented as a desktop app, written in Java. Additional modules used were arduino, jSerialComm, and RXTXComm. arduino and jSerialComm together comprise the Java-Arduino Communication Library to provide the Arduino class as well as serial read and write functions. RXTX library was added to enable serial and parallel communication for Java Development Toolkit(JDK). Especially, WeightSensorApp class in arduino library was used to specify the connection and communicate with the weight sensor.

Sensor Connection

When the app starts, it finds the port where arduino is connected. The serial port number is then used to start the WeightSensorApp class and open the connection. The thread waits for 1000 milliseconds to ensure the connection is done. The opened connection is maintained until the app is terminated. We initially designed it to be reconnected each time the app changes the scene, but later found it to slow down the process.

Value Correction

The app originally reads the value from the weight sensor as a string. Since one incoming string comes with one or more line feeds, it splits the input and takes only the first one. This value is then parsed as double so that it can be calculated. Any exceptions when reading the value would result in the weight value to be zero.

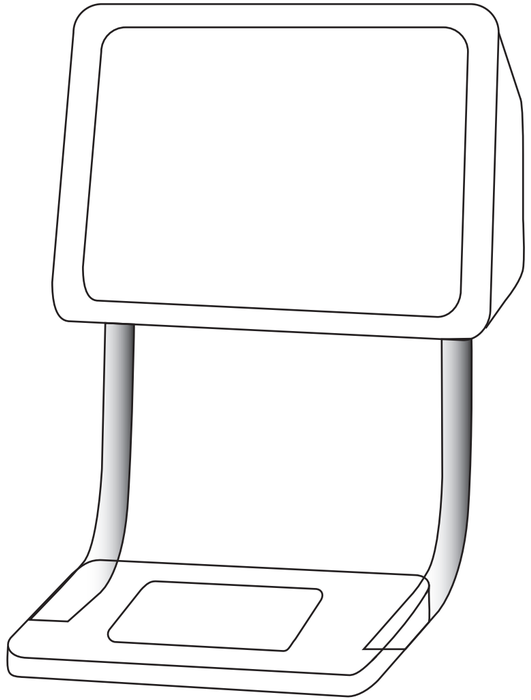
Weight Detection

Since the values from the weight sensor isn't always consistent, they should be processed accordingly. For the both modes of the app - object on and off - the sensor is tared; it becomes zero. This is because the baseline of the weight sensor changes slightly without taring for a long time. At the same time, the first value is discarded. After that, the weight is detected differently according to the mode. When the object isn't placed and the screen is black, it checks whether the absolute weight is more than 20g, and the difference between the current and the previous value is less than 5. If this condition is met twice in a row, the value is passed to find the item and play the corresponding memory. When the object is already placed and the memory is playing, the condition for the weight is less than -20. This is because after taring, the value becomes negative when the object is put off. In this case, especially, when the difference of the current and previous value is more than 20, it detects that something is put, and tare again when nothing is detected next time.

Playing Memory

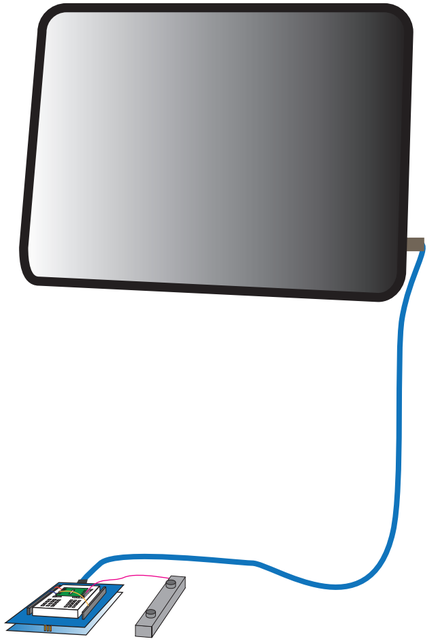
As soon as the app detects and recognizes the object, it plays the audio and a slideshow of photos. The audio and slideshow are auto-replayed until the object is put off. The files were already saved locally and simply retrieved each time the object is specified. One problem we found was that the retrieval time of photos gets noticeably long, especially when they are in high resolution and of relative large quantity from around 10. For this reason, we limited the number of photos for each memory, for the presentation of the prototype.

It was important for us to make our model inviting, but still clean and simple at the same time, presenting just a few functions. We didn‘t want to overwhelm anybody!



We also didn‘t want users to be annoyed by whole cables hanging around, so we hid them.

The Arduino board is required to receive and process the data the sensor sends to it. It is connected to the tablet through a long cable.

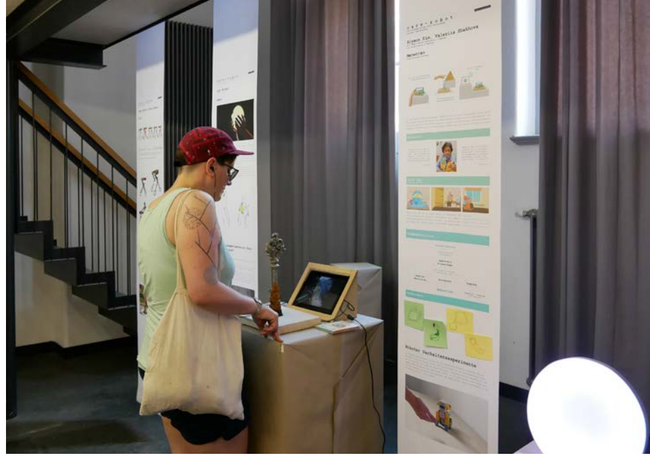


The app installed on the tablet reads data that the Arduino boards sends and acts depending on it.

To convert electronic signals from the sensor to the actual numbers, we used 24 High Präzision A/D Converter Chip HX711, which is normally used for the devices requiring high precision.

The weight sensor is the most important part of the circuit, allowing us to detect and recognise the objects in the easiest way. We‘ve got the tiniest one with capability only for 1 kg, so we could detect even a smallest difference between objects’ weights.

Summaery



Sadly, Summaery exhibition came way before we finished designing our object. We just managed to make a function prototype to show the idea we were thinking of.

But we were very happy to see how interested and open visitors were towards exhibited works. Our functions needed a bit of explanation, but once it worked, a lot of people enjoyed hearing to the stories what our machine would tell them. The feedback we received on Summaery gave us motivation to build our project even further.

Final look


Mucha
ЭЛЕМЕНТЫ ВЫСШЕЙ МАТЕМАТИКИ
А.Г.ЦЫПКИН, А.И.ПИНСКИЙ
НАЧЕРТАТЕЛЬНАЯ ГЕОМЕТРИЯ

Mementen is a narrative memory player, which helps users to recall their stories behind objects. It records and plays a user's voice telling a story about an object placed on the platform. The narration is supported by visual materials related to the story being told, picked by the user. The materials may include photos, drawings, or videos. Our intention was to integrate the tangibility of a physical object with the abstractness of a story to create a tactile memory.

The presented prototype does not yet have the functionality to record memories at the moment. The technique for object recognition should be improved as well as the development of an app to record and save memories.

Evaluation

What could be better?

There are a lot of possibilities to develop the function of object recognition with the help of software and different sensors. Unfortunately we only had our student resources, such as Arduino-sensors and open-source software and codes, but we can see a big potential in developing our machine.

One obvious improvement to be done is, of course, the object recognition method. Due to the lack of time and experience, we chose weight sensing to recognize different objects. However, this was just used for the sake of making a working prototype, because different objects can have the same weight. The most promising solution is to use the weight sensing and the image detection at the same time.

To be specific, image detection uses a camera to capture the color and the shape of the object. This idea couldn't easily be initiated, because the scenarios of users putting the object in many different ways with respect to the fixed camera angle was the problem on which we couldn't come up with any plausible solutions.

The other thing is design. Design of an object is very important for creating a connection between the machine and the user. We wish, our shape would be more organic or cosy, perhaps creating the associations with retro-television, radios or phones. There are endless possibilities, and although we chose the most functional one, it doesn't mean it's the best choice.

What did we learn?

This semester gave us a lot of insight in medicinal and supportive design and ways to solve problems in these fields. These ways are also not always optimal for the users, and by criticizing them we took our baby steps in the direction of improvement.

For example, in our Secretary Robot, which was our initial idea, we tried to include several functions targeting different problems. This ambition over-complicated the user interface. Since our target users are the elderly with cognitive issues, this was not a good approach. At the end of the day, users should be able to use it.

And not just use it, but also be comfortable in using it. Avoiding stigmatising and creating a certain image for the product was also important in our project.

We learned to think about the risks function and design could carry with them: the risks of isolating, creating a stigma, killing the hope and positivity.

That's why we've been asking ourselves "can we use it too?". So we didn't just make an object for seniors with dementia: we created a narrative notebook for every person, who has a story to tell.

Sources

Internet Links

Literature Research:

„Soziale Maschine bauen“, Andreas Bischof: all the informations taken from Google Play Library (https://play.google.com/store/books/details/Andreas_Bischof_Soziale_Maschinen_bauen?id=7ZsvDwAAQBAJ)
„Fürsorge-Relationen“, Soziologie Magazin: all the informations taken from the website „issue.com“: https://issuu.com/soziologiemagazin/docs/care-final

Market Research:

Knome : Name Recall by Adam Preiner**:** all the informations taken from App Store (https://itunes.apple.com/au/app/knome-name-recall/id602197981?mt=8)
NRS Healthcare Memo Minder Reminder Aid: all the informations taken from the Amazon (https://www.amazon.co.uk/NRS-Healthcare-Memo-Minder-Reminder/dp/B006H4RR54)
Zenbo - Asus: all the informations taken from the website (https://zenbo.asus.com/)

Conference Insight:

Clusterconference „Future of Care“:
picture taken from the official website (http://pflegeinnovationszentrum.de/clusterkonferenz).
I-Care: https://www.uni-bremen.de/csl/projekte/laufende-projekte/i-care/
InterMem: the picture taken from official website (www.intermem.org).

References

[1] OECD (2018), „Health spending“ (indicator), https://doi.org/10.1787/8643de7e-en (accessed on 12 October 2018).

[2] Preeyam K. Parikh, Angela K. Troyer, Andrea M. Maione, Kelly J. Murphy; The Impact of Memory Change on Daily Life in Normal Aging and Mild Cognitive Impairment, The Gerontologist, Volume 56, Issue 5, 1 October 2016, Pages 877–885, https://doi.org/10.1093/geront/gnv030

[3] Lena Rosenberg, Anders Kottorp, Bengt Winblad & Louise Nygård (2009) Perceived difficulty in everyday technology use among older adults with or without cognitive deficits, Scandinavian Journal of Occupational Therapy, 16:4, 216–226, DOI: 10.3109/11038120802684299

[4] Esther Y. C. Tiong, David M. W. Powers, and Anthony J. Maeder. 2018. Dementia virtual assistant as trainer and therapist: identifying significant memories and interventions of dementia patients. In Proceedings of the Australasian Computer Science Week Multiconference (ACSW ,18). ACM, New York, NY, USA, Article 36, 9 pages. DOI: https://doi.org/10.1145/3167918.3167953

[5] Julia M. Mayer and Jelena Zach. 2013. Lessons learned from participatory design with and for people with dementia. In Proceedings of the 15th international conference on Human-computer interaction with mobile devices and services (MobileHCI ,13). ACM, New York, NY, USA, 540–545. DOI: https://doi.org/10.1145/2493190.2494436

Libraries

jSerialComm. http://fazecast.github.io/jSerialComm/.
Arduino Library. https://sourceforge.net/projects/javaarduinolibrary/files/.
RXTXComm. http://rxtx.qbang.org/wiki/index.php/Main_Page.

Literature

Bischof, Andreas: „Soziale Maschinen bauen : epistemische Praktiken der Sozialrobotik“, Bielefeld : transcript , 2017

Braitenberg, Valentin: „Vehikel : Experimente mit kybernetischen Wesen“, Reinbek bei Hamburg : Rowohlt , 1993

Meyer, Sibylle: „ Mein Freund der Roboter : Servicerobotik für ältere Menschen - eine Antwort auf den demographischen Wandel? ; Studie im Auftrag von VDE“, Berlin [u.a.] : VDE-Verl. , 2011

A documentation for the project „care - robot“

Under Prof. Wolfgang Sattler
Prof. Eva Hornecker
Dipl.-Des. Timm Burkhardt

Students: Hiyeon Kim,
Valeriia Shakhova.