

VirtuEnkel - Multimodal, Familiar-Feeling Assistant for Seniors' Digital Empowerment

Physical Prototyping - Group 4: Project Report

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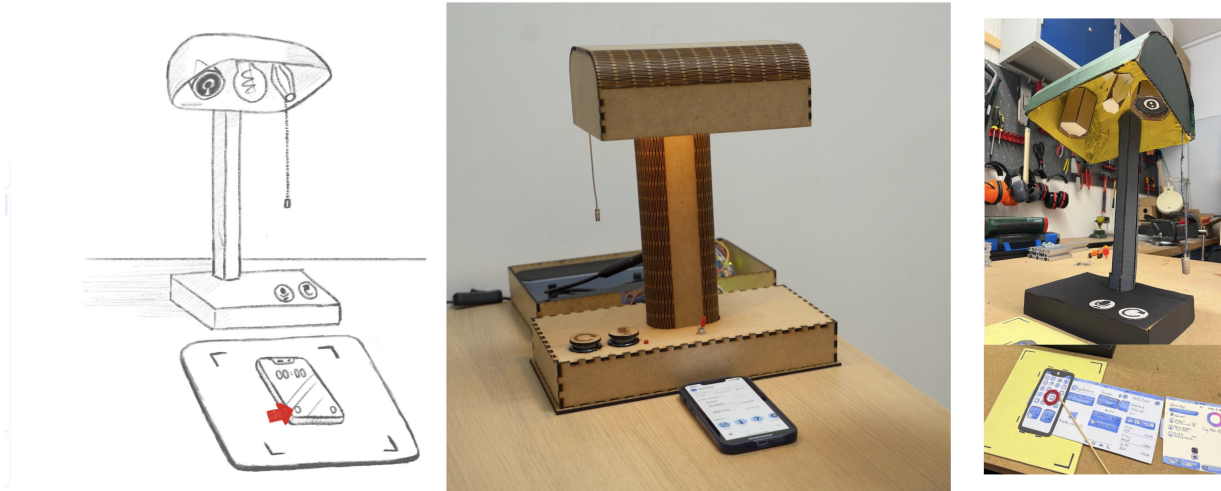


Figure 1: *VirtuEnkel* in different iterations

Abstract

Niko Pallas

This report summarizes the development and design process of the *VirtuEnkel*, an innovative digital assistant that helps senior citizens independently navigate their smartphones and tablets. Understanding that the main challenge for many seniors is not technical ability but the lack of patient support, *VirtuEnkel* employs multimodal interaction through natural language processing and video analysis.

The device is designed as a retro-style table lamp and features an approachable interface that fits seamlessly into home environments. Users engage with the system by placing their device on an input area and verbally describing their issue. The AI interprets the user's question and device screen, providing tailored spoken guidance and visual cues that simplify complex tasks.

Insights from early interviews and low-fidelity (Lo-Fi) prototyping led to key design improvements, focusing on intuitive controls

and a nostalgic aesthetic. Testing highlighted the importance of streamlined features and easy onboarding, setting the stage for a high-fidelity prototype that prioritizes user-centered design. The *VirtuEnkel* aims to boost digital self-efficacy among seniors, promoting greater confidence and independence in the digital world.

CCS Concepts

• **Hardware** → **Sensors and actuators**; *Electro-mechanical devices*.

Keywords

Human-Computer Interaction, Accessibility, Assistive Technology, Digital Literacy, Conversational Agent, Real-Time Guidance

*All authors contributed equally to this research.

1 Introduction and Topic

Maurice Michaeler

Imagine Hannelore, 79 years old, sitting at her kitchen table with her smartphone. She just wants to check a message from her bank. She opens the app but immediately feels overwhelmed. The icons are unclear, the buttons are small, and she's worried that one wrong tap might break something. In the end, she gives up and calls her grandson for help. He usually assists with digital problems but rarely has the time to explain things in a way Hanelore would truly understand.

Situations like this are common. Many elderly people feel overwhelmed by modern digital devices. Not because they're unwilling to learn, but because most technologies aren't designed with their needs in mind. They struggle with unclear interfaces, fast-changing systems, and often rely on family members for support.

This project explores how assistive technology and AI-driven UX design can help lower these barriers. Our concept, the *VirtuEnkel*, is a familiar-looking assistant that uses natural interaction, like voice commands and visual projected symbols, to help seniors navigate digital tasks more independently and confidently.

2 Design Process

Meltem Özdağ

The design process of *VirtuEnkel* was structured following the Double Diamond model, a widely recognized framework in design thinking [5]. This model represents a two-stage iterative process: initially diverging to thoroughly comprehend the problem space through comprehensive user research, and subsequently converging to develop and refine a targeted design solution. This section describes the progression of our team through the four distinct phases of the Double Diamond: *Discover*, *Define*, *Develop*, and *Deliver*.

2.1 Desk Research

Meltem Özdağ

In the *Discover* phase, we conducted an exhaustive investigation into the problem domain, specifically focusing on accessible assistive AI for the elderly. Our objective was to establish a foundational understanding through comprehensive desk research that addressed the following key questions:

- (1) What constitutes the current landscape of academic studies and research reports in this field?
- (2) What trends, developments, or best practices can be identified?
- (3) What assistive AI products are currently available on the market?

2.1.1 Current Literature. Our research revealed a growing body of literature investigating the utility and efficacy of assistive AI in various applications, particularly in healthcare and support of daily routines. For instance, a longitudinal pilot study by Aggar et al. demonstrated how assistive AI integrated into smart home technologies enhanced the quality of life for older adults, especially those living independently, by facilitating everyday tasks

through automated reminders [1]. Furthermore, Shade et al.'s randomized pilot study on older adults' engagement with interactive routines delivered by AI assistants highlighted the potential of these technologies for intuitive daily support, while also noting the inherent challenges in adapting to individual linguistic styles [13]. Complementarily, a narrative review of reviews by Giansanti et al. underscored the capacity of AI assistants to foster independence and autonomy among the elderly. However, this review also identified critical barriers to adaptation, including a lack of digital literacy and a prevailing distrust in modern technologies [7].

2.1.2 Trends, Developments, and Best Practices. Through our research, several trends and best practices emerged. We observed a notable increase in digital participation among the elderly demographic [8]. Organizations such as BAGSO (Bundesarbeitsgemeinschaft der Seniorenorganisationen) exemplify this trend by offering accessible technologies and tailored digital training programs for seniors [4]. Concurrently, there is a discernible trend towards the integration of AI, large language models (LLMs), and natural language interfaces within elderly care solutions [10]. Overall, contemporary technological advancements increasingly prioritize personalized user experiences, robust data security protocols, and fault-tolerant user interface (UI) designs, all contributing to enhanced user-friendliness [11].

2.1.3 Products on the Market. Existing assistive AI products on the market can be assigned to several categories: voice assistants, wearables, social robots, smart home systems, and accessibility-focused applications. Voice assistants are gaining considerable traction, widely employed for personalizing routines and setting reminders [3]. Wearables are instrumental in health monitoring, enabling early detection of health risks and aiding in fall prevention [15]. Social robots are predominantly designed to mitigate loneliness and support mental well-being [9]. Lastly, software, such as SUMM AI, focuses on enhancing digital information accessibility through adjustable fonts, contrast settings, and simplified text presentations [14].

2.2 User Research & Personas

Meltem Özdağ

To gain a deeper understanding of the challenges faced by our target demographic in interacting with modern technologies, we conducted semi-structured interviews with individuals aged 75 years and older. These interviews took place at the *Z'sam Zentrum für Ehrenamt*, facilitated by the *DigitaleHilfe* [6] program in Munich. An interview guideline was developed to ensure comprehensive data collection necessary to determine the pain points of the target group. The guideline focused on the following key thematic areas:

- (1) *Personal Attitudes and Knowledge:* Perceptions and existing knowledge regarding recent technological advancements.
- (2) *Technology Usage Behavior:* The frequency and context of technology utilization in daily life.
- (3) *Device and Technology:* Identification of devices and technologies regularly utilized.
- (4) *Frequent Challenges:* Common difficulties and obstacles encountered during the operation of modern devices and technologies.

- (5) *Social Environment*: Discussions about technology within social circles and primary sources of assistance for technology-related issues.
- (6) *Future Needs and Gaps*: Interviewees' aspirations for technological assistance and identification of areas where current technologies are perceived as insufficient.

For each thematic area, multiple questions were posed, and responses were documented. The collected data was subsequently synthesized to generate three distinct personas, representing archetypal user behaviors and attitudes. These personas were systematically categorized based on their technical affinity, ranging from the lowest to the highest.

In Figure 2, we characterize Hannelore Weiß, an elderly woman living alone who integrates technology into her daily life cautiously and selectively. She exhibits a preference for analog methods, maintains skepticism toward new technologies, and expresses significant concerns regarding data security.

The second persona, Helga Müller, described in Figure 3, represents a pragmatic and purpose-oriented technology user. She frequently seeks technical advice from family members and routinely utilizes common technologies for communication, online banking, and accessing news.

Lastly, Erna Lehmann, detailed in Figure 4, possesses the highest technical affinity among the three personas. She is an independent individual with a positive disposition towards modern technologies, regularly using her smartphone for daily tasks and appreciating voice-activated functions. Despite her engagement with technology, she maintains skepticism toward artificial intelligence and places greater trust in her social network. She values independence from complex digital systems and prefers clear, reliable technological structures.

From the interview results and personas, we were able to extract a set of prevalent user pains. The key pains identified include:

- (1) Dependency on the support of the social environment for technical questions.
- (2) Significant security concerns related to digital interactions.
- (3) Feelings of insecurity and overstimulation stemming from rapid technological advancements.
- (4) A lack of self-confidence in independently operating technologies.
- (5) Difficulties navigating complex user interfaces paired with an inherent fear of making mistakes.

These identified challenges served as a critical foundation for the subsequent ideation phase, guiding our efforts to brainstorm potential solutions focused on generating gains, relieving specific pains, and creating new value for our target users.

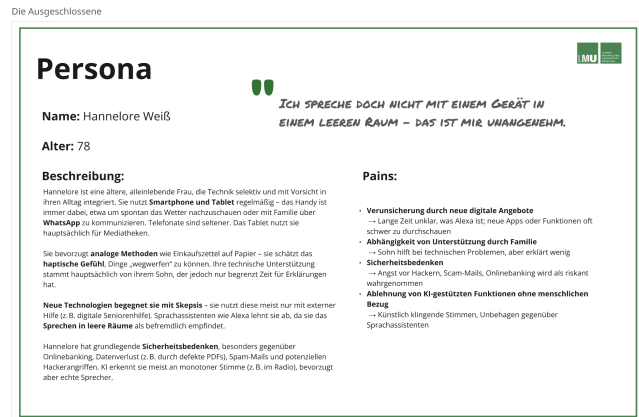


Figure 2: Persona 01: The Excluded



Figure 3: Persona 02: The pure User

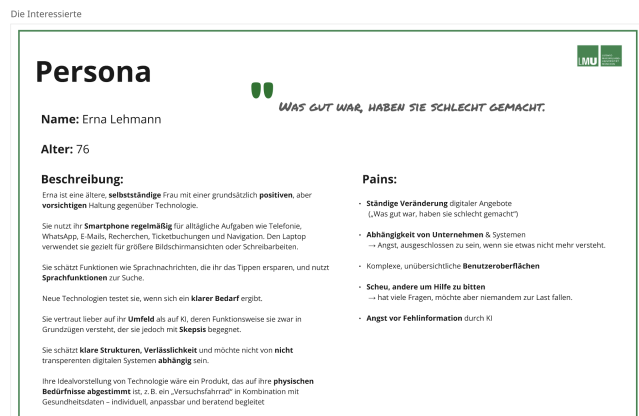


Figure 4: Persona 02: The Interested

2.3 Ideation

Maurice Michaeler

In the Define phase, our team synthesized the insights gathered to identify and frame key design challenges. This phase focused on interpreting the research findings by clustering patterns, identifying user needs, and underlying pain points. To bridge the gap between research and ideation, structured design methods were utilized.

2.3.1 Pains, Gains & Jobs. One such method was the *Value Proposition Canvas*, a framework used to systematically align user needs, pains, and gains with potential product or service offerings.[12] This canvas supported our understanding of what users are trying to achieve (jobs), what difficulties they face (pains) and what benefits they expect (gains). Furthermore, we worked out potential means to alleviate the pains (Pain Relievers), as well as potential means to ensure the established gains (Gain Creators). This was created for every one of our personas as shown in Figure 5. By visualizing these elements, we were able to articulate where meaningful value could be created and which design directions were most promising.

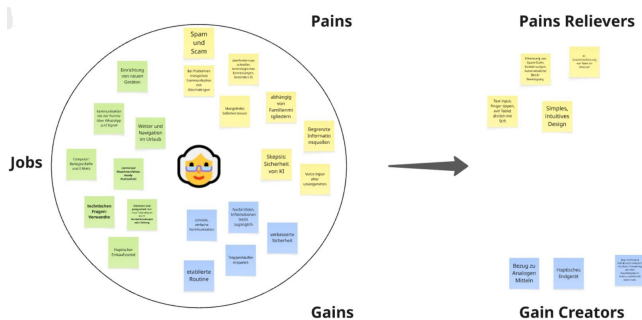


Figure 5: *Value Proposition Canvas*

2.3.2 Asking the Right Questions. Another key technique in this phase was the formulation of *How Might We* (HMW) questions, an established method in design thinking used to translate research insights into actionable prompts. These open-ended questions highlighted specific user pains in a way that encouraged broad exploration without locking in a single solution approach. This effectively encouraged diverse idea generation. Based on our desk research and user interviews, we developed several HMW questions to guide our ideation process. These questions helped us explore a wide range of potential intervention possibilities grounded in real user needs. For example:

- How might we ensure that people over 70 can use online banking independently, without relying on family or friends, while feeling secure and competent?
- How might we empower people over 70 to independently follow and evaluate new technological developments?
- How might we spare older adults from physically demanding tasks such as bending, climbing stairs, or carrying heavy items?

These questions helped bridge the gap between problem space and solution space. Additionally they also enabled us to generate

ideas grounded in real user needs while remaining open to a range of design possibilities. We tried to come up with a diverse range of different ideas to solve every *How Might We* question, exploring various approaches, media, and solution types. As a result, we created a list of potential projects, each addressing different aspects of the users' needs and challenges. All concepts aimed to support the target audience in meaningful ways and laid the foundation for selecting and refining the most promising solutions in the subsequent phases.

2.3.3 From Ideation to Prioritization. To effectively narrow down our extensive pool of ideas, we employed the *How-Wow-Now Matrix*, a structured tool for categorizing concepts based on two key dimensions: *feasibility* and *originality*[16]. Sorting our ideas along these axes enables quick, practical sorting into four quadrants:

- **Now:** ideas that are highly feasible but not necessarily original
- **Wow:** ideas that are both highly feasible and highly original
- **How:** ideas that are highly original but currently difficult to execute
- **NOT:** ideas that are neither feasible nor original, which can typically be set aside

This method helped our team move from a broad ideation phase into a more selective stage, enabling deliberate prioritization. “Now” ideas gave us quick wins and tangible starting points, “Wow” ideas highlighted our most innovative directions, and “How” ideas provided long-term inspiration for potential future work.

2.3.4 Committing to a Concept. To further narrow our focus, we decided to vote on the ideas we considered most promising and interesting from the exercise before. Each team member was given 5 votes, which they had to distribute among the 16 ideas we had generated. This resulted in the following lineup:

- **Bankomat:** A physical interface for online banking tailored to older adults, featuring tactile buttons, enhanced security via a physical card, and direct connection to a bank representative (Figure 6).
- **Virtuenkel:** A device that assists older adults in understanding and operating complex smartphone or digital device functions through a combination of visual projection, voice output, and AI-powered assistance (Figure 7).
- **RemAInder:** A tactile reminder system that helps older adults with memory challenges manage daily tasks and stay on top of to-dos (Figure 8).
- **SOS-Button:** A simple emergency button that can be worn or placed at home, which calls for help during health emergencies or connects users to a patient support agent for helpful assistance with digital devices (Figure 9).

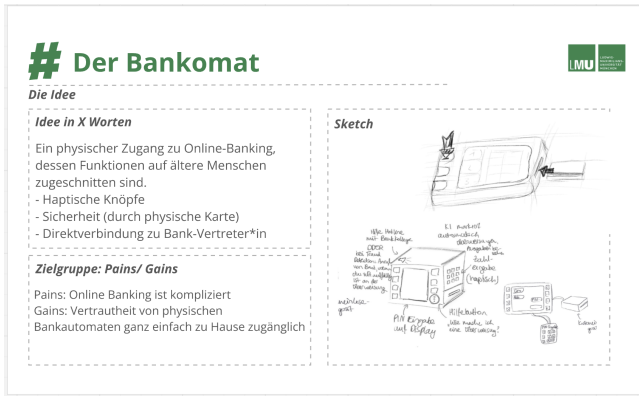


Figure 6: Idea #1: Bankomat



Figure 9: Idea #4: SOS-Button

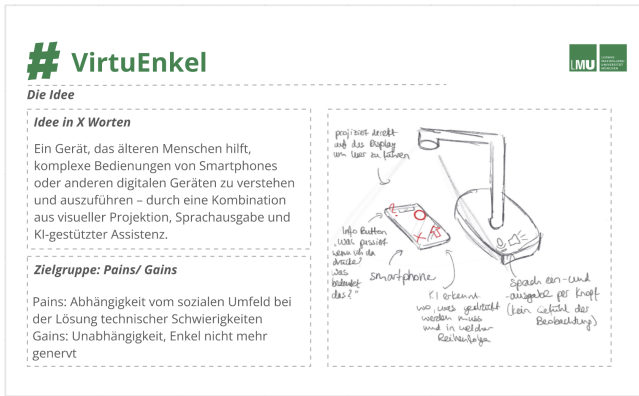


Figure 7: Idea #2: VirtuEnkel

Der VirtuEnkel

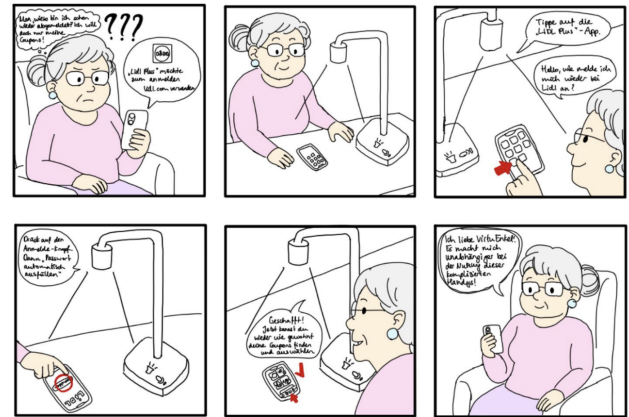


Figure 10: Storyboard VirtuEnkel

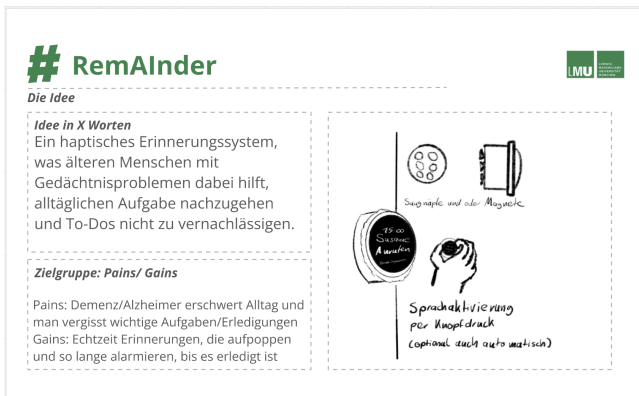


Figure 8: Idea #3: RemAnder

For the final decision, our team collectively chose to pursue the development of **VirtuEnkel**. While other ideas appeared more feasible and straightforward to implement, the VirtuEnkel stood out due to its unique potential and conceptual depth. Despite the technical challenges involved, we believed that successfully realizing

this idea would result in a highly impactful and innovative solution. Having gathered all relevant data from before (pains, gains, HMW questions) we were ready to begin working on our first prototype to bring the VirtuEnkel to life. To ensure we stayed on track, we frequently revisited our previously defined *How Might We* questions, which helped maintain focus while also supporting creative ideation. Additionally, to better understand what interacting with the VirtuEnkel would feel like, we created a storyboard illustrating a potential interaction between device and user (Figure 10).

3 Prototyping & Evaluation (Design Iteration)

3.1 Iteration with Concept Prototype

Meltem Özdağ

After deciding to proceed with the development of *VirtuEnkel*, we created an initial conceptual prototype to illustrate its intended functionalities and appearance. In the *Develop* phase of the Double Diamond framework, we constructed a small-scale version of *VirtuEnkel* with construction paper which served two main purposes: first, to externalise our concept in a tangible form; and second,

to establish a shared vision within the team regarding the intended user interaction.

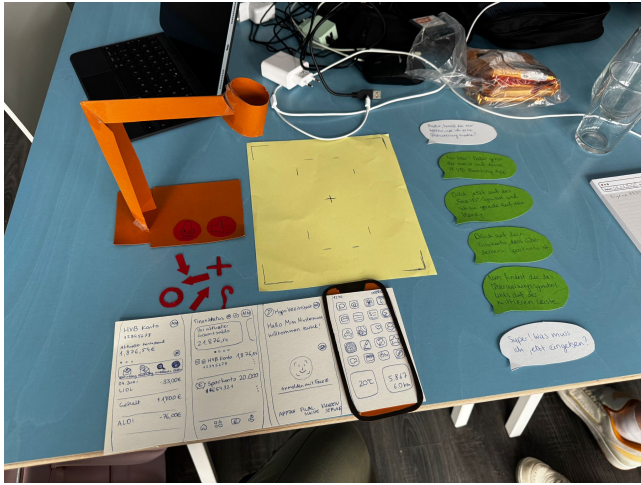


Figure 11: Concept Prototype for Design Iteration

The first iteration of our haptic prototype, shown in Figure 11, consisted of the following components:

- A lamp structure representing the *VirtuEnkel*
- One button for activating voice input (microphone)
- One button for initiating voice output (speaker)
- A flat desk mat with marked indicators showing the correct placement of devices
- A mock-up smartphone positioned under the lamp
- An interchangeable paper slide illustrating a sample transaction in an online banking app
- signs with red circles, crosses, and arrows to indicate required touch points
- Printed dialogue snippets for use in a predefined user scenario

With this prototype, we revisited the *Z'sam* center to gather user feedback before further development. This stage corresponds to the *Deliver* phase of the Double Diamond, during which design iteration took place. We conducted interviews with seniors aged 75 and above, posing the following questions:

- (1) "What do you think of our product?"
- (2) "Would you use it in your daily life?"
- (3) "In what other ways could we integrate this product into everyday life, aside from a desk lamp?"
- (4) "Which additional functionalities could we include?"

After testing our concept prototype with the interviewees, we derived the following key insights:

- The product should feel familiar and not overly "technical."
- The interface must be extremely simple and intuitive.
- The microphone button increased user trust, as it gave the impression that the device was only listening when explicitly activated.
- The speaker button was not intuitive to most users.



Figure 12: Visual Design Inspiration: Vintage Desk Lamp

This feedback directly influenced the subsequent development phase. Specifically, we:

- Replaced the speaker button with a "repeat" button that replays *VirtuEnkel's* most recent response.
- Adopted a retro desk lamp aesthetic to enhance familiarity.
- Focused on improving core functionalities rather than adding numerous new features.

Participants also highlighted that the visual projection on the screen through arrows and circles, indicating where to tap, was particularly helpful when addressing technical difficulties. This feature was therefore retained and further refined in subsequent prototypes.

3.2 Low-Fidelity Prototype

Jacob Finch

Our Low-Fidelity Prototype aimed to create an impression of what the final Device could look like. Here we started taking aspects like visual appeal and practicality into account. The design, which was inspired by the iconic retro Library reading Lamps shown in Figure 12, proved to be the perfect balance between familiarity and functionality. The Large wide "Head" of the Lamp left ample space for the Hardware to be fitted in and giving the laser Pointer a large range of motion. Where the design differs slightly from the Reference is in the "Foot". In Order to ensure stability and enough space to house computing components and the power supply, it was made wider and taller. The "Neck" of the Device was also made slightly bigger to act as a tunnel where cables could run through and be concealed from the user.

3.3 High-Fidelity Prototype

Niko Pallas

To validate our design concept and test core interaction principles, we developed a fully functional high-fidelity prototype of the *VirtuEnkel*. This prototype was designed to test several key hypotheses about elderly users' acceptance and interaction with assistive technology:

- (1) The familiar design of a desk lamp lowers the entry barrier for elderly users.
- (2) Haptic buttons provide intuitive control and build user confidence.

- (3) Manual microphone control (via button) improves trust among users skeptical of always-listening devices.
- (4) Guidance on where to click by a laser is self-explanatory and helpful.
- (5) Speech as primary input and output modality gets adopted by elderly users.
- (6) Using the *VirtuEnkel* improves users' digital self-efficacy.

Ensuring the prototype remained fully functional for independent user testing was a development priority. In order to enable a prototype that is actually usable by users but can be built fast, we decided to create two main user stories, and from those two, fixed flows.

3.3.1 System Architecture and Components. The high-fidelity prototype consists of several integrated components working together to create a seamless multimodal experience:

Physical Components

- **Desk lamp housing:** Laser-cut wooden case designed to resemble a familiar desk lamp
- **Two buttons:** A microphone toggle button (with LED feedback) and a repeat button for cycling through audio explanations
- **2-axis servo system:** Pan-tilt mechanism for laser guidance
- **Laser pointer:** For guidance on screens
- **Audio system:** USB microphone (SF-558) and USB speaker for speech interaction
- **Status LEDs:** Green (system ready mainly for development) and red (microphone active) indicators

Software/ Electronics

The system runs on a Raspberry Pi 5 and the web-based slideshow is hosted on *Vercel*.

- **Speech recognition:** German language processing using Vosk [2] for keyword detection in input-audio
- **Flow management:** TOML-based configuration system for different assistance scenarios
- **Slideshow synchronization:** Web-based interface hosted on *Vercel* for smartphone interaction: <https://remote-ctrlrd-slideshow.vercel.app/>
- **Servo control:** Coordinate mapping system for laser positioning
- **Audio management:** Audio playback with USB devices

3.3.2 User flow. We implemented two primary user scenarios to demonstrate *VirtuEnkel's* capabilities: Both stories include a banking-related issue our user wants to solve, as this topic seemed to be of the most relevance to all users we talked to during the initial interviews. The hope was that this would be a topic where test users could relate the most and would engage.

Flow 1: Banking Transfer Assistance This flow guides users through a complete mobile banking transaction with 13 interactive steps. The system:

- Provides spoken instructions synchronized with visual laser guidance
- Waits for user actions (button presses, screen taps) before advancing

- Responds to user questions and concerns during the process
- Uses both slideshow progression monitoring and speech recognition for interaction

Flow 2: Document Consultation (Bank Letter) This dialogue-focused flow helps the user to understand a letter they received from their bank.

- Uses pure conversational interaction without screen guidance
- Responds to user concerns with contextual explanations
- Adapts responses based on recognized keywords and emotional cues
- Demonstrates the system's ability to handle non-digital assistance tasks

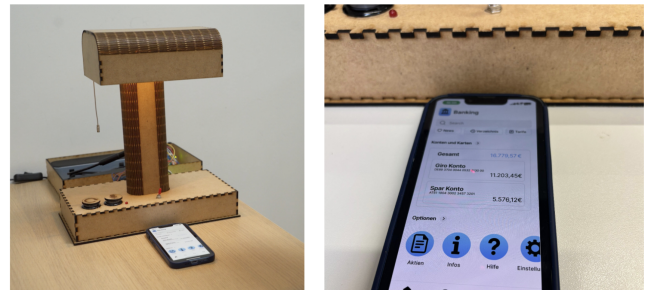


Figure 13: Final High-Fidelity Prototype

3.3.3 Bringing It All Together. The integration of hardware and software within the *VirtuEnkel* high-fidelity prototype allows for authentic user testing under realistic conditions.

Through microphone activation, users can trigger German speech recognition. The web-based slideshow simulates the banking application, responding dynamically (through predefined hitboxes) to user input. The API communication enables real-time responses to those inputs, creating an approximation of the final product's functionality.

The two operational flows—*guided banking app transaction* and *conversation on a document*, allow users to assess the spectrum of possibilities a functional product would pose. The prototype's repeat functionality provides alternative and slower explanations at any step of the flow, thereby illustrating the system's adaptive assistance philosophy.

This prototype serves to evaluate participants' response to the appeal of the lamp, assess the intuitiveness of laser guidance combined with audio, and measure improvements in digital task self-efficacy. The prototype serves both as a proof of concept and a robust testing platform.

4 Outlook

4.1 Future Improvements

Niko Pallas

Our *VirtuEnkel* prototype opens several paths for development. The most immediate improvement would expand beyond fixed flows to help with other common smartphone tasks—taking photos,

using maps, or video calling family members. Therefore, the speech recognition system would need to work. While our keyword-based approach functions reliably for the prototype, the next step would be to use an improved *speech2text* model and connect this to an *LLM*. Additionally, a camera would have to be added as well, connecting its image to a multimodal foundation model.

The servo-2-axis system would also benefit from more robust and qualitative components, as the currently used servo-motors (*SG90*) sometimes pose issues on angle-precision, probably also a voltage-related issue.

The current wooden housing worked well for rapid development, but the next prototype would need better cable management and a more robust and aesthetic case.

4.2 Broader Impact Potential

Niko Pallas

Projects like *VirtuEnkel* could genuinely improve digital literacy among older adults, but success depends on addressing the right problems. Our user interviews showed that seniors often understand technology (at least partially/ conceptually) – they just lack patient, judgment-free support when things go wrong. *VirtuEnkel*'s strength lies in providing on-demand, contextual help that adapts to whatever screen the user faces. This approach builds confidence and self-efficacy rather than just knowledge.

The real challenge lies in rigorous user studies that measure improvements in digital self-efficacy and task completion rates. We designed *VirtuEnkel* based on identified needs, but its effectiveness needs controlled evaluation with target users over time.

These studies would determine if the lamp design reduces technology anxiety and our provided guidance is helpful or distracting. Such insights would be relevant, as assistive technology only succeeds when users integrate it into their daily lives.

5 Conclusion

Jacob Finch

The *VirtuEnkel* turned out to be a very exciting project. To start, speaking directly with elderly people not only broadened our view on the day-to-day struggles of elderly people, but also showed us there is still a lot of variety among their generation. Some already had a decent understanding of modern-day technology others were intimidated. This gave us a unique challenge to design something from a completely different perspective as our own, while also trying to develop something that could aid people of different levels of experience equally. At first, we considered the idea of the *VirtuEnkel* to be too difficult to create, with ideas like assistive projections and Speech recognition, but we were able to find creative solutions to these challenges and were able to create a prototype for a device that could far exceed its initial objectives. What started as an idea to help with Bank transactions and Phone setups, has the potential to expand to areas beyond even the digital space, in areas such as confusing paperwork, organisation or even cooking. That's what makes the *VirtuEnkel* a thrilling example of what future assistive technology could look like.

6 Work Distribution

Maurice Michaeler

- **Jake:** Contributed to initial interviews with elderly adults, compiled persona data, worked on concept development, created sketches for project ideas, worked on the first two low-fidelity prototypes, designed the case for the high-fidelity prototype, oversaw its fabrication and assembly
- **Maurice:** Contributed to initial interviews with elderly adults, worked on concept development, created storyboards for concepts, worked on the first two low-fidelity prototypes, co-conducted iteration interviews with elderly participants, structured and refined demo stories, designed websites and phone desktop mockups for the demo in *Figma*, produced voice lines for the *VirtuEnkel* using *Elevenlabs*
- **Meltem:** Performed essential desk research at the start of the project, worked on concept development, created the initial sketch and storyboard for the *VirtuEnkel*, worked on the first two low-fidelity prototypes, co-conducted iteration interviews with elderly participants, contributed design input, structured and refined demo stories and prepared props
- **Niko:** Conducted initial interviews with elderly adults, worked on concept development, facilitated design process methods, guided the overall design direction, developed the final technical implementation plan, finalized the high-fidelity prototype (hardware, programming and language model integration), established a functional and responsive connection between the demo and the *VirtuEnkel*, recorded and edited project videos

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