Mottier Challenge: Rough Draft **University of Illinois at Urbana-Champaign**
Fall 2020

ThinkBot: Using Brainwaves to Help the Elderly

Siwen Wang and Lucas Buccafusca

Contents

1.1 Executive Summary

Problems:

- Expensive and inaccessible care for elderly and paralysis patients
- The price of hiring experienced nursing home care ranges between $42,000 and $90,000 per year [1].
- Current advancements in technology can be unintuitive to elderly users with limited experience working with it

Objectives:

- The purpose of this project is to design and implement an assistive care robot to better the quality of life for ability-impaired or elderly individuals.
- To better the quality of life for ability-impaired or elderly individuals by significantly reducing the cost of hiring a full-time caretaker.

Current Approach and Limitations:

- Hiring a human professional caretaker is extremely costly.
- Current robots are either controlled by a phone, laptop, or other external controller. State-of-the-art models may include other alternatives, such as voice commands. For those with paralysis or older adults with limited mobility, even simple commands can prove cumbersome or impossible to use.
- Most current brain-sensing technology controls either a robot arm or prosthetics [2].
- While there has been academic research exploring the control of a robot using brainwaves, there has been little to no development in the industry regime [3].

Our Approach and Competitive Advantage:

- Designing an assistive robot that could be guided with users' brainwaves to perform preprogrammed tasks, thereby significantly reducing the cost of hiring a full time caretaker, accessible to all users with no brain injuries.
- Our novel approach—controlling robots with brain signals, will make the interaction with our product easier and intuitive than anything commercially available today.
- Robot training is custom to each user and as simple as placing the sensor on and thinking commands, thereby lowering the barrier to use and expanding the available market.

Impact:

- Approximately 5.4 million persons live with paralysis.
- 110 million people over the age of 80 worldwide; projected to reach 400 billion by 2050.
- In the short term, this innovation can improve the quality of life for millions of affected individuals. In addition to allowing for more independent autonomy, this project can also ease the strain on their families.

- In the long term, our product can revolutionize the care of elderly and disabled persons: reducing the cost of hiring an elder care assistant by easing their own burdens, and eventually replace the need of a human assistant altogether.

Payoffs:

- The market for both assistive care is a burgeoning industry, and our market model fills a niche role that is currently unexplored.
- Data Bridge Market Research analyses that the elder care market is growing with a compound annual growth rate (CAGR) of 7.0% in the forecast period of 2020 to 2027 and expected to reach 2 trillion by 2027; even just a small fraction of that available market can lead to massive profit.

Risks:

- Societal: A successful product would lead to accelerating job loss in elder care industry.
- Business: Lack of funding and experience in the field when compared to preexisting companies (e.g., Neuralink). As such, we are a step behind what may be cutting-edge in terms of sensors or wheeled robots.

Tentative Expectation and Timeline:

Preliminary Research and Prototype Design (9/15/2020-10/18/2020)

Discuss with mentors any key hurdles that they foresee. (Thank you to Professor Wildblood and Professor Norris for their time and guidance throughout the process). Survey a subset of affected individuals to help guide key task assignments; awaiting response. Design and code simple EEG control using preexisting technology.

Prototype Testing and Refinement (10/18/2020-12/1/2020)

Develop a working prototype for both the EEG brain signal measurements, and simple robot commands.

Angel Investing: $80,000 (12/01/2020-8/01/2021)

This will mainly be used to reserve the workspace and be used to pay the cost for materials, R&D expense, and salaries of team members.

Round A: $1 million (8/02/2021-8/01/2022)

More people will be hire and more resources will be spent on R&D as well as marketing and business strategies. Initial products will be made at this stage and sold to users.

Round B: $10 million (8/02/2022-8/01/2024)

This stage will be used to expand this size of the company, increase the level of supplies and users. We expect the profits to be positive at this stage.

Round C: $50 million (8/02/2024-8/01/2027)

This stage will be global expansion. We should have now have a sustaining business model and have continuous income stream. Next, we will be setting up and implementing an IPO (Initial Public Offering).

IPO (2028+)

1.2 Product/Prototype Description

Our prototype consists of using existing technology as a proof-of-concept to demonstrate short-term validity of the idea as a baseline. From there we seek to use any available funding to design and implement a version using components, thereby not tying ourselves to the technology of any given company.
In order to read brainwaves, we use the EMOTIV INSIGHT 5 channel EEG system [5]. Containing 5 semi-dry polymer EEG sensors, and communicating via Bluetooth it provides a relatively inexpensive way to help validate that the commands are uniquely identifiable. A screenshot of the brainwaves being observed can be seen in Figure 1.1.

Figure 1.1: Interface demonstrating the brainwaves being read by the EMOTIV INSIGHT. Each plot represents a different sensor. At 1, 5, 7 and 9.5 seconds the user blinked to clearly indicate sensor response. The same behavior has been seen for thought commands.

The robot used for the prototype is the Sphero RVR Programmable Robot. The RVR robot is mounted with a Raspberry Pi to allow for Bluetooth Communication with a laptop. Onboard sensors include a small GPS board which provides position information to the micro-controller. The board has the accuracy and capability to work for a small object within a household. Additionally, in order to prevent any damage being done to the chassis, there is an onboard time-of-flight sensor that overrides user commands to ensure there is no collisions with walls, furniture, or other obstacles. As a final proof-of-concept, there will be a buzzer: when a user thinks of a command to get attention, the buzzer will activate.

1.3 Market Research

1.3.1 Elder Care Industry

1.3.1.1 Current Status

Home healthcare provides services of both nursing homes and home care facilities. Home care is more beneficial for the elder people as it can be done at home itself; hence its demand is higher amongst the elderly population worldwide. The elder care service industry consists of skilled nursing facilities, home healthcare agencies, social services agencies, continuing care facilities, and assisted living facilities. The US eldercare market reached $381.6 billion in 2014 and nearly $417 billion in 2015. The market is expected to reach $512.7 billion in 2020 [4]. In 2013, skilled nursing facilities accounted for the largest share of elder care service revenues with 42 percent of the total. However, home healthcare agencies are projected to see the fastest growth, accounting for 35 percent of total additional elder care revenues through 2018 [6]. Gains will be driven by the shift in preference among the older population to age at home, as well as by regulatory changes that improve access to home-based care. Furthermore, the burden of chronic disease such as diabetes, obesity, cancer, osteoporosis, and dental diseases has increased worldwide.

1.3.1.2 Demand Projection

Geriatric population, rising chronic illness in aging population and rising awareness of home care services are the major factors for the market growth. Increase in population worldwide will require more elder care and hence the market growth should increase in future. Expected to be 2 trillion dollars by 2050.

1.3.2 Brain-Controlled Robotics

1.3.2.1 Current Status

The current exploration of robots controlled by brain signals is exclusively found in academia. Practical or cost-efficient models, either for our target audience or another regime, have not been explored as viable. The only current implementation is the use of brain-controlled prosthetics. However, these interface with either the actual limb or implant electrodes in areas of the brain that control muscle. Both of these current applications are different enough that we feel there exists room to explore an alternative space.

1.4 Business Model

Our business model is a traditional B2C (Business to Customer) model. There will be 2 revenue streams: selling pre-built bundles, and selling customized bundles.

There are 2 types of pre-built bundle customers can purchase (Shown in Fig. 1). The basic bundle ($799) and the king bundle ($4298). The basic bundle includes: a 5-channel EEG headset, a standard robot and access to limited commands. The king bundle includes: a 32-channel EEG headset, an advanced robot and access to the library of all commands. Another option for customers is to purchase individual components based on their needs and preferences.

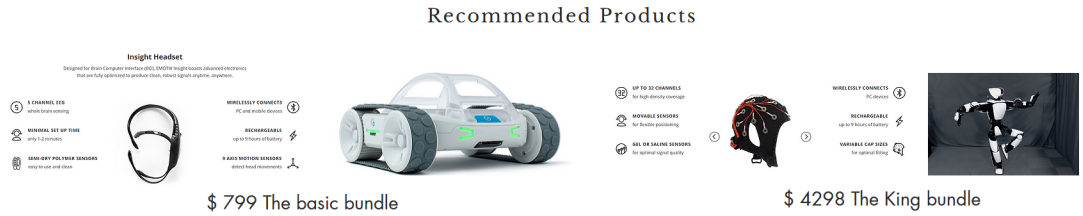

Figure 1.2: Screenshot of website demonstrating recommended products for users seeking brainwave controlled robots.

(Fig 2.) Moreover, if the pre-existing robot model cannot satisfy customers' needs, they can contact us and order customized robot models.

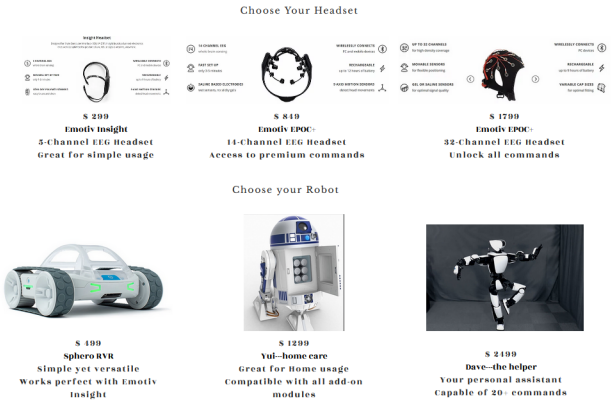

Figure 1.3: Screenshot of website demonstrating recommended products for users seeking brainwave controlled robots.

References

[1] "Senior Care Costs / Aging Care Calculator" Available at: www.payingforseniorcare.com/costs (Accessed: 17 October 2020).

[2] M. Wood. "Researchers help paralyzed man regain sense of touch through a robotic arm" University of Chicago: Medicine. October 13, 2016.

[3] D. Taylor, S. Tillery, and A. Schwartz. "Information Conveyed Through Brain-Control: Cursor Versus Robot" IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol. 11, No. 2, June 2003.

[4] "BCC Research The Elder Care Market: Products and Services" Available at: www.bccresearch.com/market-research/healthcare/elder-care-market-report.html (Accessed: 17 October 2020).

[5] "Emotiv Insight Product Specifications" Available at: https://www.emotiv.com/insight/ (Accessed: 17 October 2020).

[6] "Freedonia Industry Study: Elder Care Services" Available at: https://www.freedoniagroup.com/industry-study/elder-care-services-3214.htm (Accessed: 17 October 2020).

[7] B. Armour, E. Courtney-Long, M. Fox, H. Fredine, and A. Cahill. "Prevalence and Causes of Paralysis—United States, 2013" Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5024361/ (Accessed: 17 October 2020).

[8] "SilverEco: The aging population : Numbers and Statistics" Available at: http://www.silvereco.org/en/statistics/ (Accessed: 17 October 2020).