Ergonomic Posture Detection

Business model documentation

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Abstract

test [1]

Contents

Chapter 1

Introduction

During the COVID-19 pandemic, a lot of people startet to work remotely from their homes instead of working in their offices. Their new workplaces were not ergonomically designed for long-term work. This can lead to health problems.

Chapter 2

Solution: How to adress this need?

(by Ari Wahl)
The first goal of this project is to develop a software that helps people to work ergonomically correct. We will develop an application that will be able to detect the user's posture in real-time and give feedback to the user. The feedback should be given in a way that users can correct their posture if necessary. The software should be easy to use and should be able to run on different platforms and devices. It should be available and easily accessible to businesses and private users. Ideally, the user can just use the webcam of their device to use the software. The application will be able to run in the background and give the feedback in a subtle way. We propose a traffic light colored-scheme that will be displayed as a frame around the users screen. This means that the frame will be green if the user's posture is correct, yellow if the posture is not optimal and should be changed soon and red if the posture is bad and should be changed immediately. We will also provide an option to display the feedback as sound. There will be no sound if the posture is correct, a beep from time to time if the posture is not optimal and a continuous sound if the posture is bad. The user can choose if we will also provide a visual feedback in the form of a small window that will be displayed in the corner of the user's screen. This window will show the user's posture in real-time and in case of a bad posture highlights the regions that contribute most to the detection of a bad posture. So the user can know which parts of their posture they should correct. Eventually we will also display arrows in the image on how/which direction to correct the posture next to the highlighted parts.
As data privacy is an important issue with real-time video analysis, we will develop the software in a way that the raw video data will not leave the user's device. It will be processed locally in a first step on the user's device and only the processed data will be sent to the server.
To further develop our application we will (optionally) also analyse the data over time and give the user feedback about their posture in the form of a dashboard. This dashboard will show the user for example how much time they spent in a good, bad or neutral posture and which is their most used bad posture, etc. It will also show the user how much time they spent sitting in total.
As a further step, the application will be extended to optionally also give the user advice on how to compensate for long sitting periods. This will be done by suggesting the user different exercises once in a while after they have been sitting for a long time.
For further development we see the potential to grow into an ergonomic workout application branch. This means that we will have an additional model to detect the user's posture and movements during workout and give them feedback on how to do the exercises correctly.
Another possible area of growth will be physiotherapy applications. This means that we will have an additional model to detect the user's posture and movements during physiotherapy exercises and give them feedback on how to do the exercises correctly.
Since these further developments need additional resources and domain knowledge we will focus on the implementation of the first step of this project.

Chapter 3

Technology: Why is it unique?

by Ari Wahl
For our Ergonomic Pose App "PoseFix" we will use YOLO v8 pose as a base model. It can run on mobile devices (Android and Os) with 6-7 frames per second [1], which is more than enough for our application as well as on laptops or desktop computers. For data protection and privacy we will send only the keypoints from the pose detection the be evaluated online on our classification layer or alternatively run the model as a lightweight application completely on the users devices. Either way, this ensures that there is no threat for businesses or private persons as customers to be victims of spy attacs. Just having keypoints would only allow for an extremely abstract representation and is therefore a perfect measure to protect the data and privacy of our customers. For the adaption of the YOLOv8 pose model for our application, we train a classification layer on basis of the keypoint representation. To evaluate, if a pose is ergonomic or not, we collected a dataset, which uses classification levels from the well established RULA (Rapid Upper Limb Assessment) employee assessment worksheed [2]. Additional implementations that exceed the base model will be a dashboard for monitoring the posture over time and show long term improvements to the customer. Also we plan to optionally leverage Explainable AI methods to indicate which joint positions are problematic and show in which direction an improvement can be achieved most quickly. To establish more trust among our (potential) customers we will also aim to get some certification(s) that prove the health impact of our application, e.g. TÜV. For our applications we use the following modules and packages so far: ultralytics YOLO, openCV, Numpy, Pillow, Cocoa, Quartz, objc, PyObjCTools.
A PEST-analysis was done to evaluate the external factors that might influence our business. Since this includes political, economic, social and technological factors, and we focus on the technological factors in this chapter, we decided to include the PEST-analysis in this chapter. And since we are a startup, we also included a SWOT-analysis, that was informed by the PEST-analysis.

3.1 PEST-analysis

3.1.1 Political Factors

- **Labor Laws**:
  - The Workplace Ordinance ArbStättV outlines employer responsibilities for ergonomic workplaces.
  - Potential benefits from stricter ergonomic regulations for the B2B model [3].
- **Data Privacy**:
  - Compliance with the General Data Protection Regulation (GDPR) is vital for handling employee data [4].
- **AI-Related Regulations**:

  - The EU AI Act could affect the use and cost of third-party AI software [5]. Since movement patterns are as unique as fingerprints, our product may be labeled as a moderate or high-risk AI system, requiring additional certifications and meeting compliance requirements.

- **Copyright Laws**:
  - Importance of using copyright-free or properly licensed third-party software or pretrained models [6] to save money and computantional effort.
- **Environment Laws**:
  - In the future, AI products may be regulated due to their high energy consumption. Using pretrained models [6] helps reducing the environmental cost.
- **Opportunities and Risks**:
  - Labor laws currently favor the B2B model, but future changes in ergonomic regulations pose risks.
  - GDPR compliance offers appeal to privacy-conscious customers but incurs higher initial costs.
  - Evolving AI and copyright laws present ongoing challenges and opportunities.

3.1.2 Economic factors

- **Return to Office Work**:
  - Decreased remote work reduces demand in the B2C segment focused on home offices.
  - Overall demand might diminish as employees working remotely often have dual workplace setups.
- **Shift in Job Distribution**:
  - A shift from desk jobs to manual labor initially challenges the business model.
  - Potential long-term expansion into ergonomic solutions for manual labor sectors, requiring extensive training and data.
  - Close monitoring of job distribution changes due to AI technology impacts is crucial for strategic planning.
- **Economic Climate - Inflation**:
  - High inflation rates could lead to reduced demand as businesses may limit investments.

3.1.3 Social factors

- **Changing Sensibilities Towards AI Monitoring**:
  - Increasing desensitization to data privacy concerns, driven by widespread use of social media.
  - Potential resistance to constant visual monitoring at the workplace, despite anonymized data.
  - A shift towards greater privacy concern could necessitate investments in marketing and certifications for consumer assurance, impacting profitability.
- **Social and Cultural Focus on Health**:
  - Growing societal emphasis on health and quality of life aligns with the product's benefits.
  - This trend supports both B2C and B2B demand, influenced by regulatory changes focusing on workplace health.
  - Potential decline in demand if societal attitudes shift away from health focus.

- **Demographic Considerations**:
  - Aging workforce with existing health issues due to poor workplace ergonomics supports current demand.
  - The impending mass retirement of the boomer generation could reduce long-term demand.
  - Younger generations seeking more flexible work schedules and better work-life balance could also affect demand.

3.1.4 Technological factors

- **State of the Art Technology and Automation**:
  - Current technology is advanced, reducing the immediate impact of technological changes.
  - Ongoing research and development are crucial to stay ahead of emerging technologies that could enhance ergonomic predictions, data privacy, and AI efficiency.
- **Continuous Innovation Strategy**:
  - The goal is to maintain a state-of-the-art position in the market.
  - Proactive adaptation to new developments to ensure they are not a threat to the business.
- **Competition from Large Tech Companies**:
  - Major risk from big tech companies potentially incorporating similar business ideas into their existing products, like operating systems or Microsoft 365 applications.
  - Such integration by large companies could significantly and rapidly decrease the demand for the product.

3.2 SWOT-analysis

STRENGTHS:

- **User Experience**: intuitive and user-friendly user feedback as frame in traffic light scheme
- **Technology Stack**: Advanced and secure technology
- **Strategic Partnerships**: with tech companies, platforms, or health organizations
- **Compliance with Privacy Laws**: Adherence to GDPR, CCPA, etc.
- **Trust and Transparency**: Open communication about data privacy
- **Sophisticated Monitoring**: tracking performance, user behavior, etc.

WEAKNESSES:

- **Lack of business experience**
- **Limited resources**: Budget constraints, small team, etc.
- **Scalability issues unknown**: challenge to handle increased users or data
- **Technical issues unknown**: bugs, slow performance...do more testing
- **Marketing strategy**: Limited reach due to limited resources
- **Dependency on Third-Party Platforms**: reliance on app stores
- **User Concerns about Privacy**: skepticism towards video monitoring

OPPORTUNITIES:

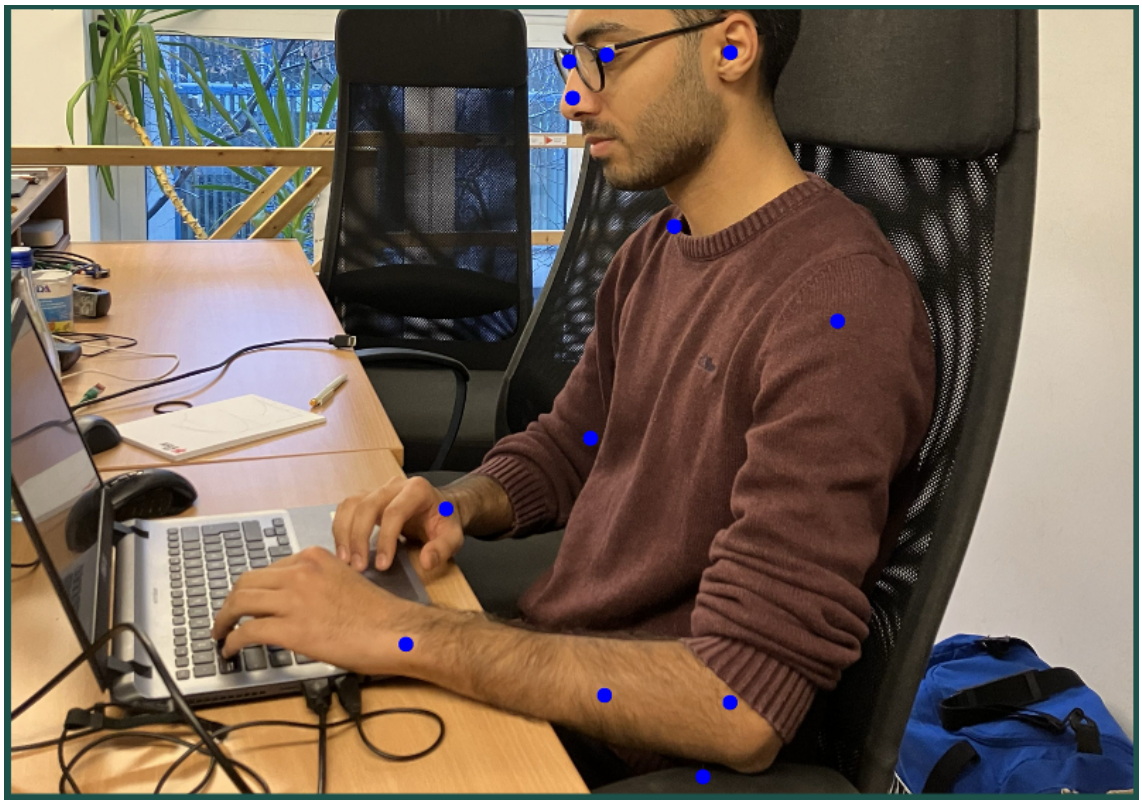
- **Technological advancements**: Leveraging new lightweight models, etc.
- **Regulatory changes**: Stricter workplace regulation laws or policies
- **Partnerships or alliances with health insurances**
- **Integration Possibilities**: Opportunities to integrate with other services
- **Innovative Privacy Solutions**: Constantly improving data privacy
- **Adding new features and growing into other markets:** Manual labor, physiotherapy, and workout

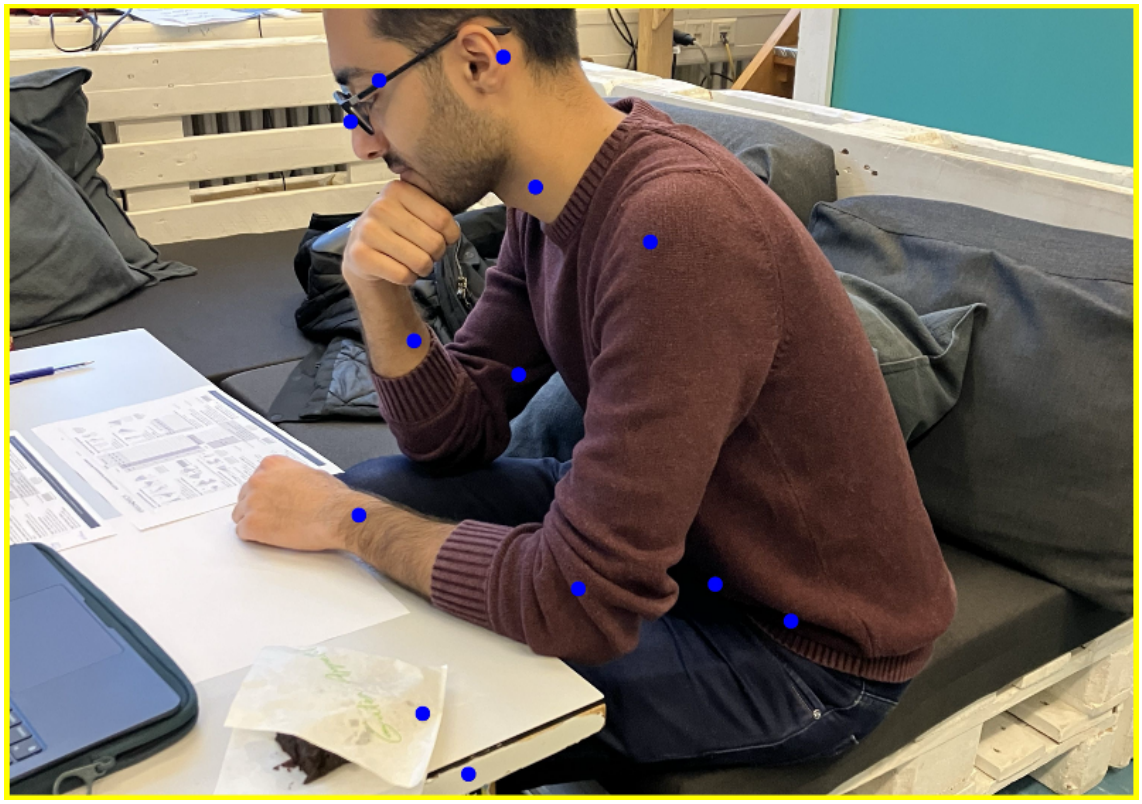
THREATS:

- **Competitive Market**: similar products or big tech companies integrating something like our product on operating system level or into office suites
- **Regulatory Challenges**: EU AI Act could impose restrictions or require costly compliance measures
- **Changes in consumer preferences**: Increasing skepticism towards AI, less remote work or also a cultural development towards less long-term health orientation
- **Economic Downturns**: Which could impact funding or consumer spending
- **Public Perception and Trust Issues**: Perceived (or real) privacy concerns

3.3 Mock-up

For our mock-up we decided to use the traffic light colored-scheme that will be displayed as a frame. The frame will be green if the user's posture is correct, yellow if the posture is not optimal and should be changed soon and red if the posture is bad and should be changed immediately. In the working setup, the user does not see their own image but instead the usul screen content. The feedback-frame will be displayed around the screen content. For the mock-up we will also show the keypoints our base model detected. The keypoints will be displayed as dots in the image. The user can choose if we will also provide a visual feedback in the form of a small window that will be displayed in the corner of the user's screen. There it would then display the keypoint where the user's posture is bad and should be corrected in a different color than the other keypoints. In a more advanced state, we can also output an arrow in the image on how/which direction to correct the posture next to the highlighted parts.





Chapter 4

Business Model: How to capture value?

Chapter 5

Marketing and sales: How to sell it?

Chapter 6

Competition: Who else is in the game?

Chapter 7

Implementation team: Who will implement the plan?

Chapter 8

Status or timeline: Where are we now, what next?

Chapter 9

Executive summary: Concise overview of the opportunity

References

[1] Ultralytics. *YOLOv8 Discussion*. Online; accessed 21 January 2024. 2022. URL: https://github.com/ultralytics/ultralytics/issues/4333.

[2] Fabian Holzgreve et al. "Home office versus ergonomic workstation - is the ergonomic risk increased when working at the dining table? An inertial motion capture based pilot study". In: *BMC Musculoskeletal Disorders* 23.1 (Aug. 2022). ISSN: 1471-2474. DOI: 10.1186/s12891-022-05704-z. URL: http://dx.doi.org/10.1186/s12891-022-05704-z.

[3] *Ergonomie am Arbeitsplatz*. 2024. URL: https://www.arbeitsrechte.de/ergonomie-am-arbeitsplatz/ (visited on 01/22/2024).

[4] *General Data Protection Regulation*. 2024. URL: https://gdpr-info.eu/ (visited on 01/22/2024).

[5] *EU AI Act*. 2024. URL: https://www.credo.ai/eu-ai-act (visited on 01/22/2024).

[6] *Copyright and Licensing in Software*. 2024. URL: https://www.copyright.gov/ (visited on 01/22/2024).