Automated rearfoot angle tracking on video images

Reflection

Bachelor's degree in Applied Computer Science
field of AI development

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1 INTRODUCTION

This reflection report contains a reflection on the project execution and a personal reflection on my development during the internship, titled *Automated rearfoot angle tracking on video images*, conducted at Materialise Motion. The goal of the internship was to develop a proof-of-concept AI solution capable of identifying the rearfoot angle from videos or images.

2 REFLECTION ON COMPLETION

During the internship, I developed and evaluated two main approaches for rearfoot angle prediction. One using the pretrained Detectron2 model and one fully custom model built using PyTorch. Ultimately, the custom model outperformed the pretrained in performance speed but not accuracy.

Deliverables included:

- Create a development workflow to create a working AI model capable of predicting rearfoot angles from video/images.
- Create an operational workflow for a test application to visualize predictions and angles.
- Write documentation on dataset preparation, model evaluation, and training processes.

These outputs provide Materialise with a strong starting point for integrating AI-driven analysis into their clinical workflows.

2.1 Completion status

Over the course of the internship, I developed two key approaches to solve the rearfoot tracking task and compared them. Additionally, I developed a test application using Streamlit that allowed for easy visualization of the results, angle calculation between keypoints, and user interaction through a simple UI. The project objectives were largely met. The models were reasonably well predicting the keypoints which were then calculated in rearfoot angle, and a visual testing environment has been delivered as well. However, there is room for further development.

2.2 Future recommendations

To improve the performance and robustness of the keypoint detection model, several enhancements can be explored. On the model architecture side, incorporating Long Short-Term Memory (LSTM) or Transformer models may enhance spatial feature learning, especially for tasks involving motion with simple patterns. Additionally, adopting Float16 mixed precision training can optimize computational efficiency by reducing memory usage and speeding up training without compromising accuracy.

Improvements in data collection are also crucial. Gathering a more diverse dataset featuring varied lighting conditions, camera perspectives, and subjects from different racial backgrounds can enhance the model’s generalization and reduce bias. This broader representation would support better real-world performance and inclusivity.

In terms of data augmentation, while color shift techniques have been tested, their effectiveness in improving inclusivity was unclear. Further evaluation is needed to determine its impact. Moreover, incorporating image tilt augmentation could improve the model’s robustness to perspective distortions, making it more effective when input images are misaligned.

Lastly, better data preprocessing through background subtraction can help isolate subjects from distracting environments. Traditional approaches such as Gaussian Mixture Models are suitable for removing static backgrounds. For more complex situations, deep learning techniques like U-Net or semantic segmentation can offer greater accuracy, though at a higher computational cost.

3 PERSONAL REFLECTION

On a personal level, this internship was a valuable and transformative experience. It allowed me to put theoretical knowledge into practice and navigate the real-world complexities of AI development.

3.1 Learning experience

I gained substantial hands-on experience with deep learning, specifically in designing and evaluating custom architectures, hyperparameter tuning, and understanding company motivations. My skills in using PyTorch have improved significantly, and I learned more about tools like Streamlit and Plotly.

3.2 Professional and personal development

Beyond technical skills, I developed several key professional competencies. I improved in project management by organizing my workload and meeting deadlines quite consistently. Weekly planning, regular progress check-ins, and reviews taught me how to structure a long-term research and development effort. Communication was also a major area of growth, as I had to clearly report findings to coworkers during meetings and presentations. Analytical thinking and problem solving were central to the entire process, especially when facing issues such as model underperformance, remote desktop setup issues, and data inconsistencies.

3.3 Challenges faced

Of course, the experience was not without its challenges. Technical problems, such as CUDA compatibility issues with Detectron2 and model performance discrepancies, consumed significant time and energy. At times, progress felt slow and frustrating. Nonetheless, I learned how to address these setbacks through problem solving, continuous feedback from my mentor, and a flexible mindset. When one approach failed, I was able to pivot, explore alternatives, and keep the project moving forward. I also experienced moments of low motivation, especially when bugs or inconsistencies slowed my work, but I overcame these by breaking down tasks and finding workarounds.

4 CONCLUSION

In conclusion, this internship has been both a technical and personal success. I was able to deliver both core but also additional objectives of the project while simultaneously growing into a more competent and thoughtful developer. The opportunity to contribute meaningfully to Materialise Motion's goals while expanding my own skill set has been great. I am confident that the experience has prepared me well for future challenges in AI development and research, and I am proud of what was accomplished over the course of the internship.