Human Activity Monitoring for Mental Health Assessment

Phuoc Nguyen, Sunny Qin, Xinyi Yan, Virginia Pohl, Meskerem Terega
Advisor: Nikolaos Papanikolopoulos

Abstract

In this project, we intend to provide a technique to monitor human activity automatically and assess mental health in an easier way instead of high-cost manual diagnosis. We approach the problem by using camera and computer vision algorithms, such as Skin Enhancement, Edge Detection, and Edge Following, to detect and track a person's activities. By using this approach, we were able to determine the frequency of a person's hand movements with a faster runtime compared to the previous year's implementation.

Background

Mental disorders like anxiety, OCD (Obsessive Compulsive Disorder), autism, etc., have a significant impact on individual, families, and society. Research has shown that mental disorders can interfere with social functioning and negatively impact physical well-being. Therefore, early diagnosis will always be better for effective treatments. Earlier diagnosing of mental disorders can be made with a system to detect specific symptoms.

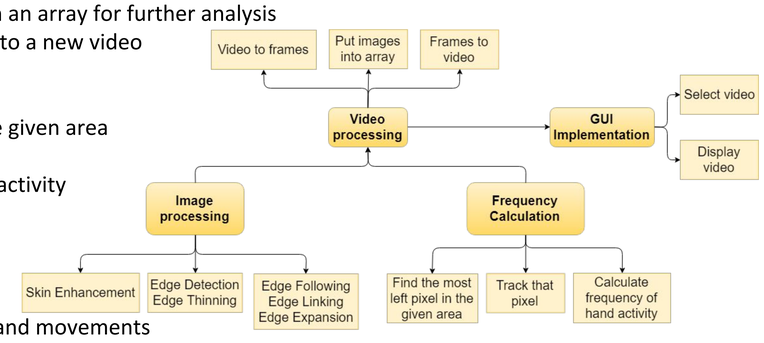
The previous team used a Human Pose detection called OpenPose that is able to detect a human body, hand, facial, and foot keypoints. Using these keypoints, they were able to extrapolate the data from a video and calculate the behavior and frequency of a person's hand movements. However, this type of detection generates too many extra keypoints for our application, making the runtime longer.

Industrial Value

- Main beneficiaries:
  - At risk children/patients and Families
    - Earlier intervention will occur
      - lead to improved long term prognosis
      - create a better life
  - Healthcare providers and Medical professionals
    - provide accurate quantitative measurements
    - Able to move timely and targeted referrals to specialist services

Methods and Materials

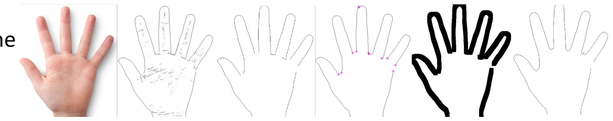
- Image Processing
  1. Skin Enhancement:
     Use HSV colorspace and threshold the value to make skin part (face and hands) enhanced
  2. Edge Detection and Edge Thinning:
     Use Canny detector to get edge image; Thin the edge image to remove noise
  3. Edge Following, Edge Linking and Expansion:
     Connect edge pixels in a sequence; Use this sequence to link and expand the pixels to fill up the gap
- Apply Image Processing to Video Frame
  1. Extract every frame from video and apply the image processing to each frame
  2. Save the processed images in an array for further analysis
  3. Write the analyzed images into a new video
- Frequency Calculation
  1. Find the most left pixel in the given area
  2. Track that pixel
  3. Calculate frequency of hand activity
- GUI Implementation
  1. Select video to analyze
  2. Display video after analysis and calculate frequency of hand movements



- Programming Language Using: Matlab and Python (use for OpenPose)

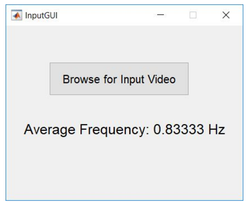
Results

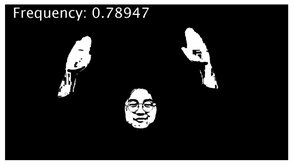
Our product implemented the preprocessing work for image and for video. Also, the skin model can be used to show hands movements and the frequency of it. Moreover, the GUI is implemented to present the average frequency and the analyzed video.



To test the performance of both systems, we ran OpenPose and our implementation on the same machine (a Lenovo Yoga 720), with a 4 seconds video input. Within 30 seconds, our implementation generated the skin enhancement and analyzed the frequency of hand movements.

For OpenPose, it took over an hour but the computational power of the laptop was insufficient to generate the result video. Thus, we used a Jetson TX2 to run OpenPose instead.. This reduced the runtime down to around 4 minutes.





Discussion

Comparison:
One of the big differences between the two implementations is their runtime. OpenPose requires a tremendous amount of compute power for human behavior detection in real-time. Moreover, OpenPose focuses on a whole body analysis, which may cost some useless computation when people only want to analyze activities like hand waving.

Our implementation includes a few filtering and edge detection algorithms. It achieved a lower runtime compared to OpenPose. On a common laptop, the time difference was greater than an hour.

VS

Conclusions

Assessing mental health is related to assessing human activities. Among a lot of human activities, our group focuses on hand-related activities, such as hand waving and hand shaking.

During our project, we implemented calculating frequency for hand movements in video. To achieve this, we involved several preprocessing works to remove noises, including edge detection, edge linking and skin enhancement techniques. We applied these works to video frames to track hand movements and calculate its frequency. We also implemented a Graphical User Interface as an application prototype, which can be used in future application design.

Compared with the OpenPose implementation, our approach has a better run time performance on video, which can easily be applied to real world application.

Future Directions

- Apply Kalman filter to track human body.
- Apply advanced image processing to improve accuracy.
- Improve system to track a single person in any environment.
- Expand solution to other applications.

Contact Information

Virginia Pohl
University of Minnesota
Email: pohlx065@umn.edu

References

1. E. Low, A. Widjaja, M. Johnson, A.-A. Lawati, C. Patterson, "Senior-Design." *GitHub Repository*, 2018.
2. G. Hidalgo, Z. Cao, T. Simon, S.-E. Wei, H. Joo, Y. Sheikh, and Y. Raaj, "Openpose." *GitHub Repository*, 2018.
3. Cao, Zhe, et al. "OpenPose: Realtime Multi-Person 2D Pose Estimation Using Part Affinity Fields." 2018.a

Acknowledgements

University of Minnesota
Electrical and Computer Engineering Department

© Poster Template by Genigraphics® 1.800.790.4001 www.genigraphics.com