Human Activity Monitoring for Mental Health Assessment

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# 1 Introduction

# 2 Prior Work

# 3 Product Design Specification

## 3.1 Problem Statement

Many neurodevelopmental disorders are accompanied by various behavioral traits. Autism spectrum disorder, for example, is typically accompanied by repetitive physical behaviors such as hand flapping or rocking [1]. The physical nature of these behavioral attributes allows us to see and detect abnormalities. This task however, can be difficult in rural areas with little access to health resources. Computer Vision could be used to bridge this gap, allowing software aided diagnosis or recommendations for patients who may express physical traits of a neurodevelopmental disorder. The goal of this project is to develop a system to process real-time video for tracking human movement and behavior. This system shall connect medical professionals to patients via smartphone or computer video and could be improved to analyze and detect the physical attributes associated with common neuro-disorders.

## 3.2 Customer/Client Needs

|  |  |  |
| --- | --- | --- |
| **#** | **Need** | **Importance (5 is high)** |
| 1 | Program shall be able to provide user feedback in real time | 4 |
| 2 | Program shall be able to monitor human behaviors through common smartphone video. | 3 |
| 3 | Program must be able to distinguish a human in an uncluttered environment | 5 |
| 4 | Program must be robust to identify both stationary and moving targets | 5 |
| 5 | Program shall track humans fully visible and near a fixed camera | 5 |
| 6 | System shall identify symptoms associated with disorders to aid clinicians in monitoring human behavior | 5 |
| 7 | System shall provide a user interface that is accessible to medical professionals without a computer science background. | 3 |

## 3.3 Design Specifications

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **#** | **Need #s** | **Metric** | **Units** | **Ideal Value** | **Acceptable Range** | **Importance (5 is high)** |
| 1 | 3,4,5 | Tracking accuracy | pixels | 10 | ±2 | 3 |
| 2 | 2,3,4,5 | Tracking distance | meters | 3 | 3-4 | 4 |
| 3 | 2 | Image quality | Megapixels | 12 | 8-12 | 5 |
| 4 | 2 | Camera focal length | millimeters | 4.3 | 4-6 | 5 |
| 5 | 1 | Response time | milliseconds | 4 | 3-5 | 4 |
| 6 | 4 | Movement speed | meters/s | 2 | ±10% | 4 |
| 7 | 3,4,5,6,7 | Success Rate | % | 80 | 75-100 | 5 |

# 4. Proposed Design

## 4.1 Overview

The purpose of this document is to propose the solution to develop a software algorithm which can analyze video in real time and extract distinct, human like features. Once extracted, these features would be identified and tracked by visually indicating what objects the software identified as human in the video frame. Because of the interactive nature of this program in aiding diagnosis of neurodevelopmental disorders, the design solution will interface with common smartphone and computer hardware to obtain video and display result to the user.

## 4.2 Design Description

The proposed software algorithm can be broken down into essentially five distinct components which work together to meet design requirements:

1. Video processing
2. OpenPose Keypoint Extraction
3. Keypoint Pre-processing
4. Time Delay Neural Network Classification
5. Neurodevelopmental Disorder Recommendation

Together, these functional components will allow tracking and identification of human objects within video frames and provide a recommendation to licensed clinicians (fig. 1).

### 4.2.1 Video Processing

To meet video requirements of the design specification, the software solution will import smartphone video and convert it to individual frames. This will be done using either the OpenPose library or other available C++ libraries. Video pre-processing may be required to remove people if there are more than one person in a frame.

### 4.2.2 OpenPose Keypoint Extraction

Once a video is processed into individual frames, each frame will need to be analyzed to detect human figures present. OpenPose provides an API library which will analyze frames and return keypoint vectors will help to achieve a tracking accuracy of movement within ten pixels.

### 4.2.3 Object Identification

The data obtained from edge detection will be used to form groups of conjoining edges and identify objects. Specifically, the solution will identify humans within each frame. This can be achieved by using line following to find objects or neural networks to identify human like features.

### 4.2.4 Object Tracking

After identifying humans in a frame, the system will use size and location data using coordinates of pixels within a frame to compare movement of the tracked person. This will provide information such as frequency, direction, and speed of motion which could be used, if time permits, to identify neurodevelopmental disorders by behaviors.

This design was chosen as it will provide a modular development for an iterative process. This allows for better optimization, if time permits, to improve the solution’s accuracy. This solution will require lots of testing to hone in on the best edge detectors and video analysis techniques to meet performance requirements of real time video processing and the accuracy required to be a useful solution.

*Fig. 1 Diagram depiction of input user video to software recommendation using OpenPose and Time Delay Neural Network.*

# References

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| [1] | United States Environmental Protection Agency, "Neurodevelopmental Disorders," America's Children and the Environment, 2015. |