# Automated Camera Tracking System in Gait Analysis

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## Introduction

People have numerous walking abnormalities due to the certain illness or medical condition. The main reason is due to the muscle or neurological issues. Hence, the scope of Clinical Gait Analysis (CGA) arises to measure and estimate the gait biomechanics, which makes it easier to recognize the abnormal appearances during the Gait Analysis and it also helps to make the accurate clinical decision regarding orthopedic surgery and rehabilitation for the clinician.

Figure 1: Clinical Gait Lab
*Photo adapted from https://www.youtube.com/watch?v=g_yowc8jSD8*

Automated Camera Tracking System in Gait Analysis is related to the movement of the video recording camera along with the patient so that it could capture the patient's gait in different time interval. This project is the advancement of the current system in a Gait Lab of Repartition General Hospital, South Australia. The present system is the still camera that has been used to capture the video of the walking patient from the side and front in the walkway. This camera is not able to record more than a stride of a patient during the process which is not sufficient to make an accurate clinical decision.

## Background

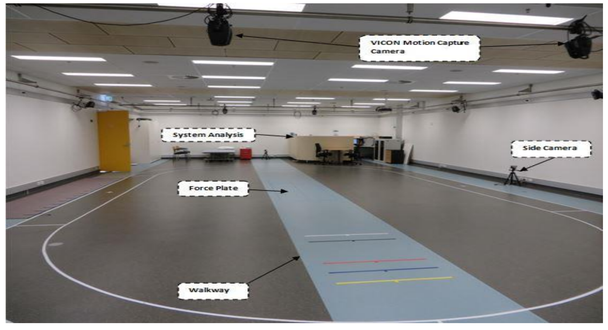


Figure 2: Current system in Repatriation General Hospital, Adelaide, SA
*Photo adapted from: Benjamin Patritti , Repatriation General Hospital, South Australia*

**Problem :**

1. The current system is able to capture only one gait cycle of the patient, which is on its focus or Field Of View (FOV).
2. When the patient moves towards or away from its focus, there would be the change in angle of view so the Parallax error also occurs.

## Automated Camera Tracking System

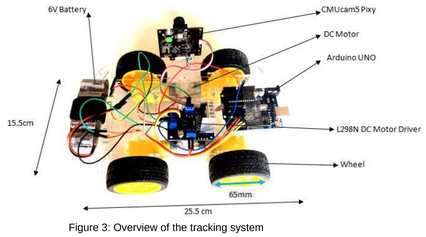


Figure 3: Overview of the tracking system

## Object Detection & Tracking Methods

### Color Object Detection & Tracking Method

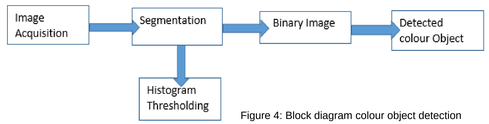


Figure 4: Block diagram colour object detection

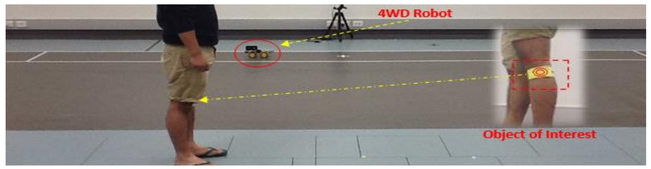


Figure 5: Colour object detection & tracking

### Object Detection and Tracking with Histogram of Oriented Gradients(HOGs) Method

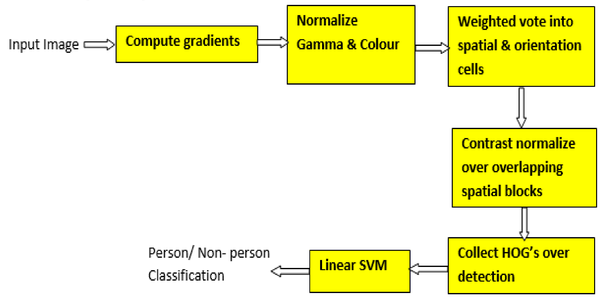


Figure 6: Block diagram of HOGs features detection method

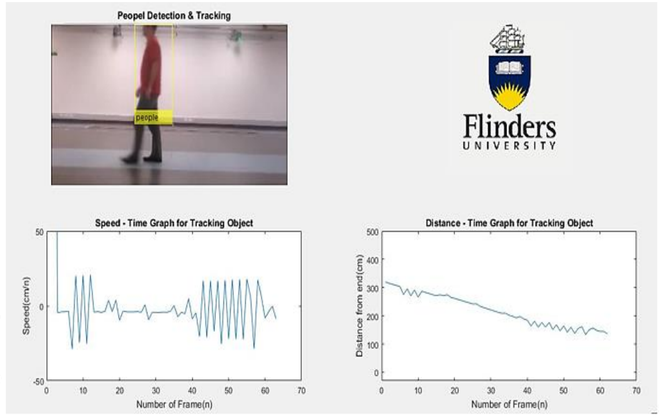


Figure 7: Implementation and analysis of object detection method

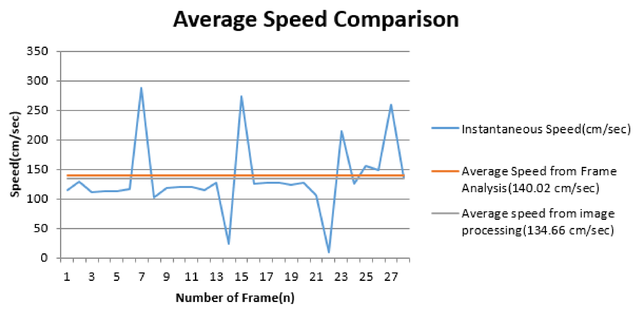


Figure 8: Graphical analysis of Histogram of Oriented Gradient method for object detection

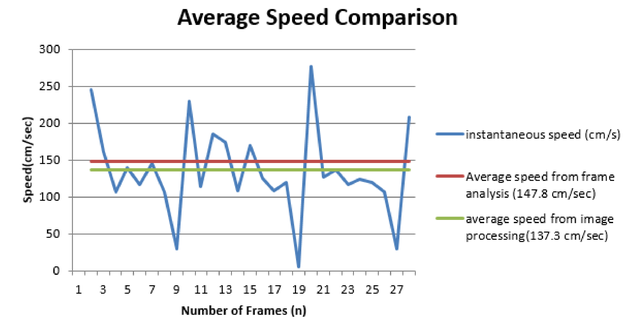


Figure 9: Graphical analysis of Colour object detection method

| | ERROR (%) | |
|---|---|---|
| | HOGs Method | COLOR Detection Method |
| Average speed | 3.82 | 7.10 |

Figure 9: Comparison of error in both the detection method

## Control System & Software

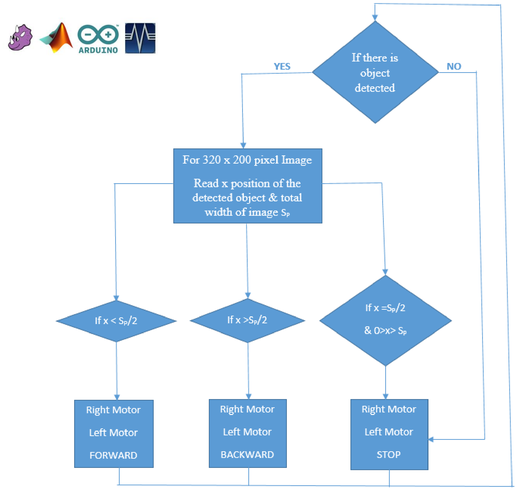


Figure 10: Flow chart of control algorithm for tracking system & Software application (Top Left)

## Result

1. Colour object detection method is not able to give accurate location of an object due to the change of light condition because of which the image sensor can not provide complete information of object in an image.
2. It still can be use because of the low computational cost but it is recommended to improve the brightness of the light source.
3. In HOGs method, the locally normalized histogram of gradient orientation features of an object is invariant which is not affected by illumination variation and low quality resolution of an Image Sensor.

## Conclusion

1. Automated Camera Tracking System is designed and tested successfully with Colour Object Detection and Tracking Method in improve light condition because of fast implementation time.
2. HOGs features extraction method is recommended due to high rate of accuracy on detection of object.
3. Total cost of the system is 182 Australian Dollar out of Total Budget 600 Australian Dollar. Hence the system is inexpensive (Commercial System cost more than 30,000 AUD) and successfully able to replace the previous system.

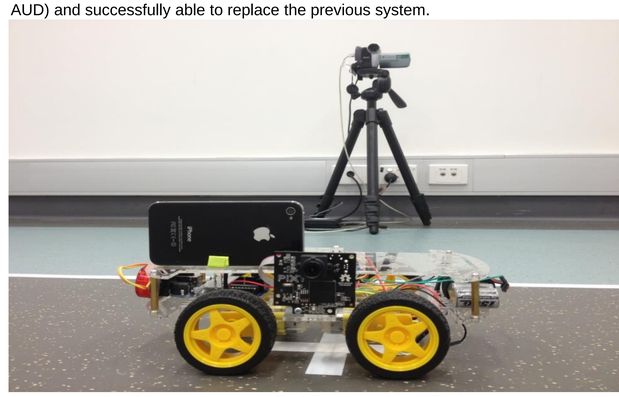

Figure 11: Automated camera system (Front), Previous camera system (Back)

## Future Work

1. Skin colour detection and tracking under time varying illumination.(L. Sigal, 2004).
2. HOGs along with Kalman Filter for detection and tracking accuracy(C. Li, Li. Guo, Y. Hu, 2010).
3. PID controller to improve speed of the robot
4. Modification of Pixy Firmware with HOGs
5. Smart mobile phone control system
6. Tracking of person from both sides of the walkway

## Reference

1. Ratna Raju, P. and Neelima, G. (2012). Image Segmentation by using Histogram Thresholding. *IJCSET*, 2(1), pp.776-779.
2. N. Dalal and B. Triggs. Histograms of oriented gradients for human detection. In CVPR, 2005.

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