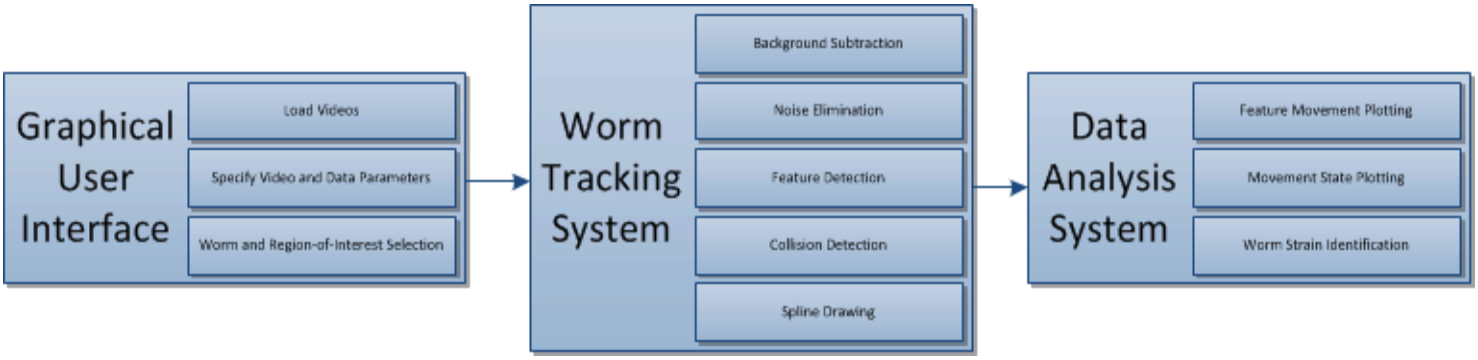
Intelligent Pattern Recognition of Moving Organisms

Project Plan

Team 03/ dec1203

Introduction

In recent years, the recognition of *Caenorhabditis Elegans*–commonly referred to as *C. Elegans*–as a model organism has attracted the attention of the scientific community. Extensive research has been conducted in order to better understand similarities between the complex human genome and that of the much simpler *C. Elegans*, and how these similarities can fuel advancements in next-gen pharmaceuticals. However, it is taxing on the researcher to gather large amounts of data through observation of these microscopic worms. Our goal is to develop a software platform which facilitates data capture through automated image processing, thereby enabling the researchers to spend more of their time interpreting results.



Operating Environment

Experiment

All worms are stored on NGM plates in an incubator at 22.5 degrees Celsius. The experiment will be done under a stereo microscope with a QImaging camera attached to it. The worms are placed on microfluidic chips designed around the current experiment. During the experiment QCapture will take a video of the experiment that will serve as input for our tracking software.

Software

All of the computers in the lab run Windows 7, therefore we will target the software to the Windows operating system environment. The specific computer on which the software will be run is using a 2.4 GHz Intel Core 2 Duo processor with 2 GB of Ram and a 1 TB external hard drive to hold the recorded videos.

User Interface Description

We aim to develop a simple user interface from which the user can import and process videos, either individually or as a batch. The interface will allow the user to select video and

data parameters, as well as view the processed frames and plot data.

Functional Requirements

Video Support

- The software shall support the following video compression codecs:
  - Microsoft Video 1
  - Intel Indeo
- The software shall support input video frame rates between 1 and 30 frames-per-second.

Interface

- The software shall provide a graphical user interface that allows the user to select worms and track only data for the selected worm(s).
- The interface shall prompt the user to enter video parameters.
  - This feature shall be easily scalable to accept a wide range of parameters.
- The interface shall support batch processing of multiple video files.

Tracking

- The tracking system shall identify *C. Elegans* in pre-recorded videos with a 99% success rate, as confirmed by human judgment of the video.
- The tracking system shall filter out background noise that could be incorrectly identified as a worm, including, but not limited to, walls and shadows.
- The software shall provide a confidence interval for worm identification after the event of a worm collision based on the frame rate.

Frame rate	Confidence Interval
1-5	50%
6-10	75%
11-20	90%
21-30	99%

Data

- The analysis system shall provide X-Y coordinates of worm centroid, head, and tail over the duration of a given video.
- The analysis system shall be able to derive velocity and acceleration from the mentioned worm data.
- The analysis position shall be extrapolated as a spline vector for each frame, with interpolations given between frames.
- The analysis system shall draw worm location and movement graphically on the video frame after it has been processed.
- The analysis system shall identify each selected worm's state of locomotion over time.

Non-Functional Requirements

- The software shall process video at no less than 1 GB of video data per minute.
- The software and any support files shall be wrapped into a single installer.

Market and Literature Survey

Several worm-tracking software packages already exist on the market, many of them open source. Our research indicates that these programs don't take full advantage of the speed offered by low-level image processing libraries such as OpenCV, and fail to gather high-level behavioral data that researcher's value.

The following links will redirect you to studies that have been made on C. Elegnas and method of tracking the worms. These papers are inspirational to us and understanding the content of these studies was the first step in our project.

Kaletta, T., & Hengartner, M. O. (2006). Finding function in novel targets: C. elegans as a model organism. *Nature Reviews Drug Discovery*.

Swierczek, N. A., Giles, A. C., Rankin, C. H., & Kerr, R. A. (2011). High-throughput behavioral analysis in C. elegans. *Nature America*.

Deliverable

We will deliver to clients a stand-alone piece of software meeting the aforementioned functional requirements for use in a Windows environment. This software package shall contain all of the necessary support files such that the end-user simply needs to run the installer and then execute the program.

Milestones

Prototype A - *Friday, March 2nd, 2012*

- Isolates worms through filters/background removal and identifies bodies.
- Tracks worm centroids.
- Differentiates between worms–no collision detection.
- Be able to handle the requisite codecs.
- Make an executable.
- Focus on what Richard and Jacob have already achieved.

Rethink/Revise Goals/Requirements - *Tuesday, March 6th, 2012*

Prototype B - *Friday, March 30th, 2012*

- Detects collisions and makes educated guess.
- Fits spline to position and interpolates between frames.
- Identifies head and tail.

Rethink/Revise Goals/Requirements - *Tuesday, April 3rd, 2012*

Prototype C - *Friday, April 6th, 2012*

- All the features of prototype B wrapped in a GUI.

Prototype D - Friday, *April 27th, 2012*

- Batch processing.
- Identify state of locomotion.
- Additional revised goals.

Rethink/Revise Goals/Requirements - *Tuesday, May 5th, 2012*