

## EE / CprE / SE 492 - sdmay21-40

### Dancing Swarm of Robots

#### Bi-Weekly Report 5

Mar. 15 - 28

Client: Dr. Akhilesh Tyagi

Faculty Advisor: Dr. Akhilesh Tyagi, Dr. Diane Rover

#### Team Members

Abdalla Abdelrahman — Meeting Facilitator, Software Engineer

Daniel Nikolic — Test Engineer

Benjamin Schneider — Report Manager, Hardware Engineer

Noah Thompson — Chief Hardware Engineer

Mason Walls — Chief Software Engineer

Cole Weitzel — Meeting Scribe, Software Engineer

#### Weekly Summary

During this cycle, our focus turned to optimizing the simulation and controller setup to reduce the potential error margin of our followers' movement algorithm. We started with continuing our investigation of time step synchronizing from the previous 2-week cycle. Through this, we found out how to synchronize the controllers' instruction execution with the simulation's time step to ensure that their execution rates remain constant. This allows us to set the exact amount of time required to run a certain code block. If either the simulation's physic engine or the robots' controller hosts begin running behind, the simulation will slow the other down to maintain synchronization.

With a synchronized controller set, we were then able to decrease the simulation's time step, thus increasing the processing and operating speed of all three robots to be more in-line with the capabilities of the CyBot platform. This allows each follower to complete a full sensor sweep in 1/8th the time previously needed, reducing their position error margins.

Lastly, We started looking ahead to the final potential component of our project: integrating the leader's movements with a song to make the swarm dance. We still don't know the full viability of this functionality given the limitations of the WeBots program, but we came up with two potential implementations. The first has us build an external program that reads through a song file, choreograph a swarm dance pattern from the beat of the song, and encode this dance in a series of TCP packets. Then, using WeBots's TCP/IP interface, the lead robot will receive this packet stream, decode it, and dance along to the audio file which it will play through a new speaker module that we would mount to its body. The second approach is very similar to the first, except the dance pattern is encoded in a file read by the leader rather than a network packet stream.

## Past Week Accomplishments

- Found ways to optimize the processing speed of the simulation to reduce the time needed to complete a sensor sweep
- Synchronized processing speed of robot controllers with the simulation's time scale
- Fit servo properties to match those of the physical motors being modelled
- Investigated media player solutions to synchronize the leader's movements with a song
- Finished preliminary simulation optimizations

## Pending Issues

- Currently, our algorithm can cause followers to lag behind the leader when beginning or ending a turn. A more sophisticated turn control for the followers and/or a reduction in sensor sweep time will be needed to reduce this position error margin.
- A potential issue within WeBots when switching between repo branches was identified. In some cases, device node IDs between a robot's child nodes and the robot's controller become unlinked. The issue seems to occur every time different branches are checked out locally. We have modified our repo usage to effectively reduce the number of times this issue occurs.
- Our follower algorithm is still somewhat generalized. We have been working on specializing it more for our given use case, but it will require further adjustments in order to reduce error margins to within our desired bounds.

## Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Abdalla	<ul style="list-style-type: none"><li>- Identified that building a sensor to listen to sound is not needed</li><li>- Started learning how to parse .midi files</li><li>- Started learning how to parse .aiff files</li></ul>	6	20
Daniel	<ul style="list-style-type: none"><li>- Researched appropriate methods for parsing audio file</li><li>- Learned how to parse .midi files</li></ul>	6	17
Benjamin	<ul style="list-style-type: none"><li>- Investigated the time synchronizing functionalities of WeBots's controller API</li><li>- Synchronized all controller operations on all robot participants with the simulation's</li></ul>	8.5	37

	<p>time step</p> <ul style="list-style-type: none"> <li>– Maximized the simulation time step scale to perform calculations and servo operations at the speed of the CyBot hardware platform</li> <li>– Helped brainstorm a possible TCP/IP connection to deliver movement instructions to the lead robot from an external program</li> </ul>		
Noah	Worked with Mason on improvements to follower algorithm	2	18
Mason	<p>Continued to improve the follower algorithm.</p> <p>Worked with Ben to see if we can make things run faster.</p> <p>Researched possible audio files for parsing</p>		
Cole	Worked on the follower algorithm, I tried implementing a new strategy where the speed of the followers changes based on how far away they are from the leader	3	21

### Plans for Coming Week

- Abdalla
  - Identify whether to use .aiff or .midi files
  - Continue to parse selected file type
  - Choose a song to parse
- Daniel
  - Find a song to parse using .midi (or .aiff) files for the Webot simulation
  - Integrate audio within simulation
- Benjamin
  - Prototype a proportional speed and steering addition to the movement algorithm
  - Continue optimizing the hardware & physics engine processing speed of the simulation
- Noah
  - Help with distance-based follower speed
  - Help with music playback
- Mason
  - Assist in development of distance-based follower speed.

- Help create a speaker controller to allow for a music file to be heard while the robots are “dancing”
- Cole
  - Continue working on the follower movement
  - Help with encoding and decoding music and programming the leader to follow the instructions

## Summary of Advisor Meeting

--Meeting on 3/18/2021:

Attendees: Cole, Ben, Mason, Tyagi, Daniel, Abdalla

Missing: Noah

General Notes:

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Status Updates:

- Abdalla
  -
- Ben
  - Findings
    - Able to introduce noise to distance sensor if we want
    - Could make the distance sensor curve non-linear to filter out really close or really far values easier
    - Synchronous controllers, TimeStep, duration
      - <https://cyberbotics.com/doc/reference/robot#synchronous-versus-asynchronous-controllers>
    - Can do synchronous motor position
      - [https://cyberbotics.com/doc/reference/motor#wb\\_motor\\_set\\_position](https://cyberbotics.com/doc/reference/motor#wb_motor_set_position)
    - Battery & power consumption are a thing, not needed to model
      - Would need to specify consumption factors for everything
    - Motor max velocity in rad/s, torque in Nm
    - Can make the servo make a sound if we want
    - Motor specs
      - 38 oz-in (0.269 Nm) torque
      - 14.661 rad/s max speed
    - Distance sensor should be inside normal 32 ms time step envelope
- Cole
  - Starting to work on modifying the follower algorithm to adjust speed of the followers so that they don't start and stop as much.
- Daniel
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- Mason
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- Noah
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--Meeting on 3/25/2021:

Attendees: Cole, Ben, Mason, Abdalla, Daniel

Missing: Noah, Tyagi

General Notes:

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Status Updates:

- Abdalla
  -
- Ben
  - Findings
    - TCP/IP connection for sending sound instructions
    - leader gets instructions, opens sound file, starts playing it & moving
    - could probably just encode instructions in a file and read that too instead of network connection
    - Cranked up simulation time
    - Kind of works better, increasing follower speed helps too
    - Want a blocking function for the servo?
    - Trying to get time to do full sweep, issue with finding function
    - Issue moving backward, see bottom images
    - Proportional movement?
- Cole
  -
- Daniel
  -
- Mason
  -
- Noah
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