

EE / CprE / SE 492 - sdmay21-40

Dancing Swarm of Robots

Bi-Weekly Report 2

Mar. 29 - Apr. 11

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, we had great progress on developing our follower algorithm. Our version 3 update added a prototype speed control to our followers which varies a follower's forward or backward speed based on its measured distance from the leader. If the follower's measured distance is greater than the target separation, it will set its speed according to the following equation:

$$speed = 20 * (10 * (target - distance)/target + 20 * ((target - distance)/target)^2)$$

If it is closer than the target distance, it will set the speed according to this equation:

$$speed = 20 * (10 * (target - distance)/target - 20 * ((target - distance)/target)^2)$$

The coefficients were tuned after several test maneuvers to balance the linear and quadratic components of the equation. A slightly lower linear component will gradually slow down the follower as it gets closer to the leader, improving slow-speed precision. The greater quadratic component accelerates the follower more as it falls behind the leader, allowing the follower to catch up quicker if it falls behind.

Version 3 also replaced the previous fixed-arc turning circle with in-place turning, allowing followers to change their direction without moving forward. In the previous algorithm version, followers could only turn while moving forward, causing them to gradually creep if the leader stopped moving off center from the followers.

Version 4 of the algorithm was also completed during this cycle, adding an accelerated sensor sweep algorithm which allows followers to update their position data much faster. Rather than sweeping through the full 40-degree arc to find the leader before making a movement decision, followers are now able to skip to the next sensor sweep if they find both edges of the leader's reflector. This effectively makes them constantly zig-zag back and forth over the leader, requiring only 5-10 samples per sweep. The maximum sweep range was increased to 120 degrees, giving followers a

greater search area if they lose lock on the leader. If this occurs, the follower will sweep through this wider frame until they find the leader again, giving them the opportunity to regain their target lock and rejoin the formation.

Version 4 also added constant movement adjustment mid-sweep, rather than making followers wait until the end of a sensor sweep to change direction. This feature performs a movement decision at every single sensor sample, improving the formation's response time to changes in the leader's motion. As part of this update, some enhancements were made to reduce the simulation's computation time as well. With all updates together, our maximum error margin has been reduced to around 7%, though some additional testing will be needed to verify this.

Lastly, we completed and gave our presentation for the second PIRM round and conducted our normal weekly team meetings.

Past Week Accomplishments

- Prototyped and implemented a variable speed control for follower robots
- Completed version 3 of follower algorithm including this speed control, in-place turning, and movement adjustments performed continuously
- Completed version 4 of follower algorithm including accelerated sensor sweeping for followers with a moving sweep window, a widened maximum sensor sweep range, and lock-reacquisition
- Updated follower code to latest version for both followers
- Completed PIRM 2 presentation

Pending Issues

- 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.

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Abdalla	<ul style="list-style-type: none">- Identified music file type that will be using (midi)- Learned what bytes correspond to within data stream- Continued identifying key parts from datastream parsed from midi file	8	28
Daniel	<ul style="list-style-type: none">- Continued progress on music parsing development- Did some complementary research on midi usage within our software	4	21
Ben	<ul style="list-style-type: none">- Finished version 3 & 4 of algorithm- Implemented variable follower speed control- Completed world & physics model optimizations	20	57
Noah	<ul style="list-style-type: none">- Tested follower algorithm- Researched MIDI usage	3	21
Mason	<ul style="list-style-type: none">-Worked with Ben to brainstorm ideas for the follower algorithm-Learning what aspects of Midi files we can use to drive the leader	6	42
Cole	<ul style="list-style-type: none">-- Tested functionality of followers-- Looked into parsing music files	4	25

Plans for Coming Week

- Abdalla
 - Continue identifying datastream information
 - Parse entire song rather than first minute
 - Start on algorithm to move the robot with music
- Daniel
 - Try to finish the music integration
 - Work on presentation, poster, and final report
- Ben
 - Add reflectors to follower models
 - Add additional follower robots
 - Work on presentation, poster, and final report

- Noah
 - Work on MIDI playback
- Mason
 - Implement a file reading system to prepare for parsed music files
 - Test with Ben the scalability of our model
- Cole
 - Work on parsing music files
 - Work on final report documentation
 - Work on final presentation

Summary of Advisor Meeting

4-8-2021

Attendees: Cole, Ben, Mason, Tyagi

Missing: Noah, Abdalla, Daniel,

General Notes:

-

Status Updates:

- Abdalla
 -
- Ben
 - Added macros for commonly used numbers, makes testing and modifying a lot easier
 - Made single function for determining movements, makes modifications easier
 - Allowed followers to back up, WAY better formation now
 - Removed all unused functions
 - Got accelerated sweep scanning working
 - Once follower finds left and right side of reflector, skips to next sweep
 - Basically just zig-zags back & forth over the reflector
 - Constantly changes maneuver with each sample rather than only once per sweep
 - Great position holding, haven't been able to break tracking lock
 - Holds within 0.642m, 7% error on distance
 - Angle is still kind of rough with maneuvers, sometimes flattens formation in direction of turn
 - Don't really need variable speed turning, the accelerated scanning basically fixes this
 - Widened sweep arc to 30 degrees +/- 40 so the follower can find the leader easier if it loses lock in a turn
 - Updated right controller code to left, now both followers run the same algorithm
 - Want to add more robots? Demonstrates scalability
- Cole
 -
- Daniel
 -
- Mason
 -
- Noah
 -

4-1-2021

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

General Notes:

- PIRM next week
- Start working on final poster
- Start working on final report
- Start working on presentation for IRP

Status Updates:

- Abdalla
 - Worked on parsing .midi files and .aiff files to create a byte stream of instructions to be sent to the leader
- Ben
 - Findings
 - Got proportional speed control going straight, working on turning
 - Works on a quadratic scale, keeps within ~ 0.05 m when not turning
 - Got rid of step() calls in movement functions, speeds things up
 - Made turns be in place and for shorter amounts of time, followers hold lock easier now
 - Flag-based scanning implementation
 - Would let us skip to the next scan sweep
 - Implementation
 - Have a flag get set once the leader is found on a sweep
 - If the leader has been found & distance > 1 , start next sweep now
 - Reset flag on new sweep
 - Sliding sweep window ideas?
 - Diagram of node class tree for documents?
 - Get rid of cliff & bump sensor code since we won't use it?
 - Right follower (old controller) tends to lag & creep forward
- Cole
 - Continued working on follower movement
- Daniel
 - Worked with Abdalla
- Mason
 -
- Noah
 -