KILOBOTS – Shape Formation

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Original Objectives

- Understand the operation of Kilobots
- Rerun the multilateration code for localization from 2017-2018 (hard-coded to use 3 neighboring bots with known locations) and from 2018-2019 (generalized to use more than 3 neighboring bots)
- Once multilateration is done, try shape formation
- Examine the seemingly limited memory issue appeared in 2018-2019 capstone and find a solution

Requirements

- Minor Alterations (OK)
- Shape Formation
  - Not done due to Covid-19
- Compact Design (OK)
- Microprocessor Memory (OK)
- Build new Kilobots
  - Not done due to Covid-19

Concepts

Concept 1: Simplify code
- Simplify the code so that the processor does not run out of memory with large numbers of bots

Concept 2: Find alternative processor
- Design a board with a new processor with more memory to be able to handle the communication with more bots

Problem Statement

In order to scale up the task of shape formation, we need find the solution to potentially limited memory issue, as well as implementing the algorithm and debugging the code.

Final Design/Results *

Tested output radius values (r) from bots and calculated in Arduino to find that the radius measurement error was messing up the multilateration.

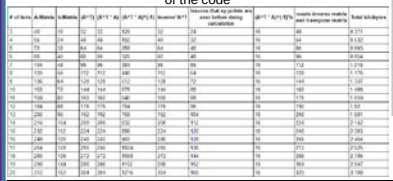
Using the true r

```
b
7200.00
b
0.00

A
0.00    120.00
-120.00 120.00

At
0.00    -120.00
120.00  120.00

outx1
14400.00        -14400.00
-14400.00       28800.00

outx2
0.000139        0.000069
0.000069        0.000069

outx3
0.000333        -0.000333
0.000333        0.000000

x=      60.00
y=      60.00
```

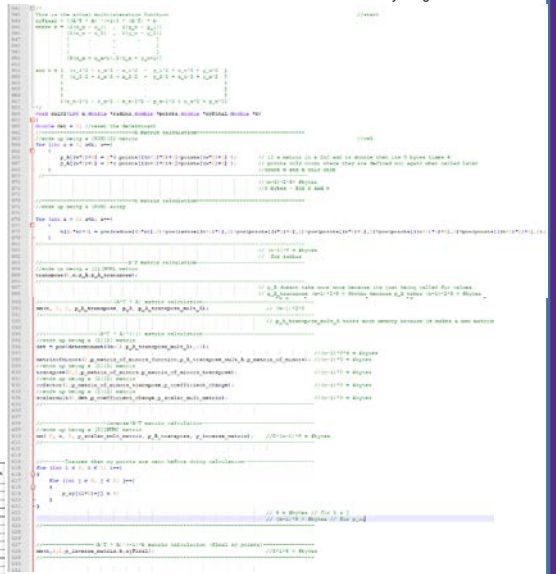
Using the noisy r

```
b
10060.00
b
268.00

A
0.00    120.00
-120.00 120.00

At
0.00    -120.00
120.00  120.00

outx1
14400.00        -14400.00
-14400.00       28800.00

outx2
0.000139        0.000069
0.000069        0.000069

outx3
0.000333        -0.000333
0.000333        0.000000

x=      81.60
y=      83.83
```

This is the calculated Kilobits for the multilateration part of the code



Code commented for multilateration memory usage



* On March 16, 2020 classes and labs were closed to students due to the COVID-19 pandemic. Without access to fabrication and testing equipment, Objectives and deliverables were modified accordingly.

Modified Objectives*

- Worked with the Kilobot system and carried out the benchmark labs
- Verified the multilateration code on the Kilobot using the Arduino board
- Discovered that the distance measurement noise affected the localization accuracy. Distance calibration should've been done on the bots in use
- Overall objective moved from shape formation to code debugging/calculations due to remote working requirements
- Calculated the needed memory for the multilateration portion in the code to understand the memory usage

Summary

- The team has debugged/simplified code as well as performed calculations to further the study and research of swarm robotics/kilobots

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