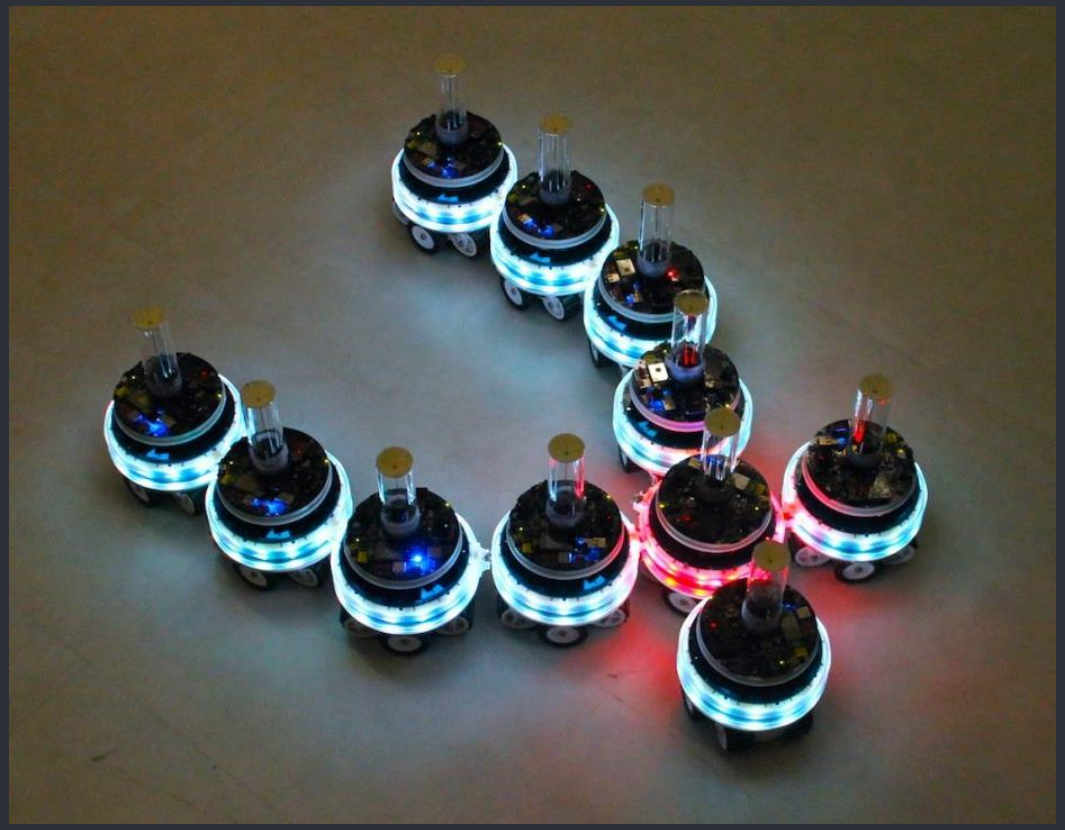
HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)
CHENNAI

CENTRE FOR AUTOMATION & ROBOTICS

DESIGN AND DEVELOPMENT OF HOMOGENEOUS SWARM OF COOPERATIVE ROBOTS IN VIRTUAL ENVIRONMENT

INTRODUCTION



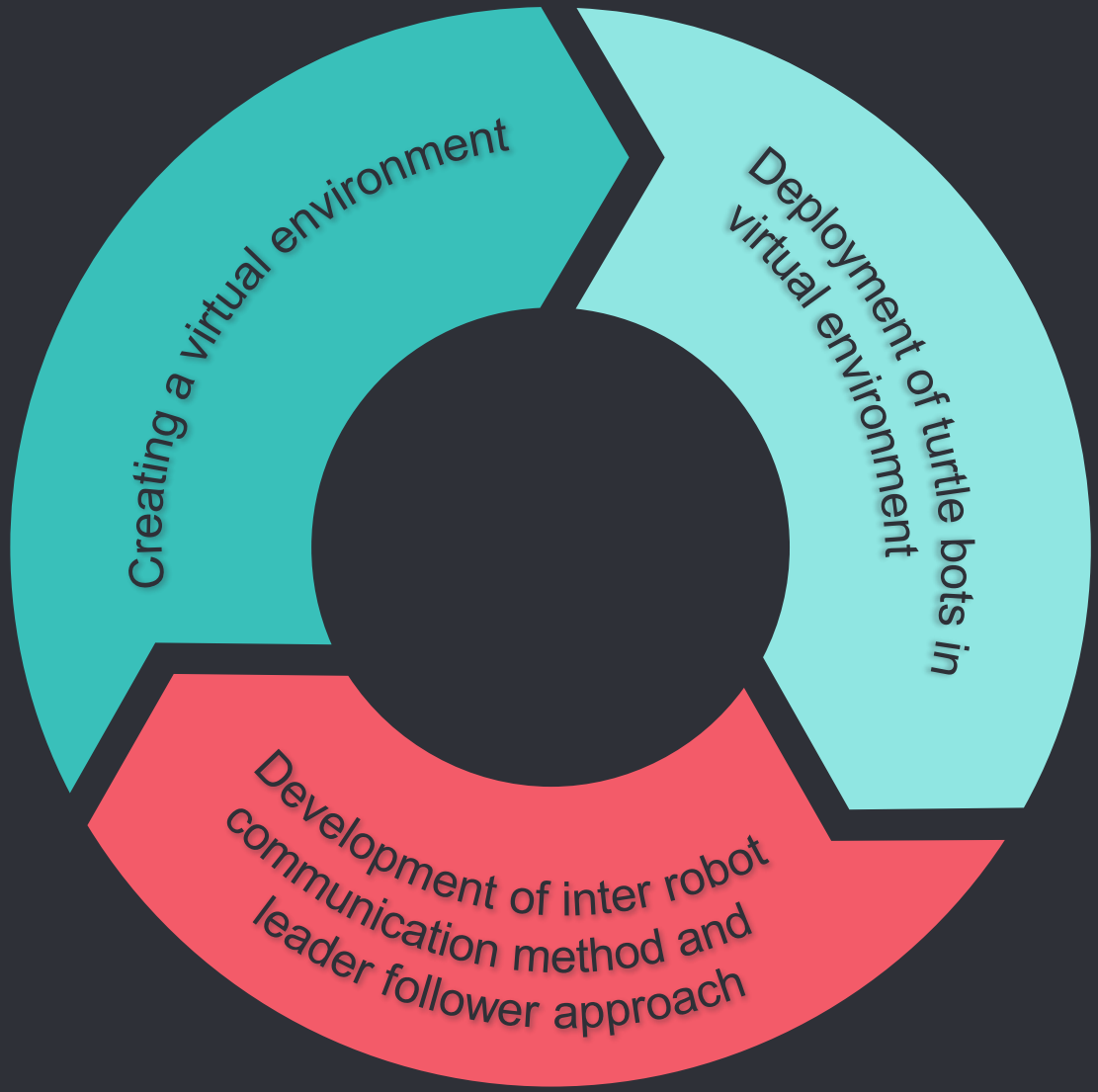
INTRODUCTION

Inspiration

MOTIVATION

- Improved performance: if tasks can be decomposable then by using parallelism, groups can make tasks to be performed more efficiently.
- Task enablement: groups of robots can do certain tasks that are impossible for a single robot.
- Distributed sensing: the range of sensing of a group of robots is wider than the range of a single robot.

OBJECTIVES

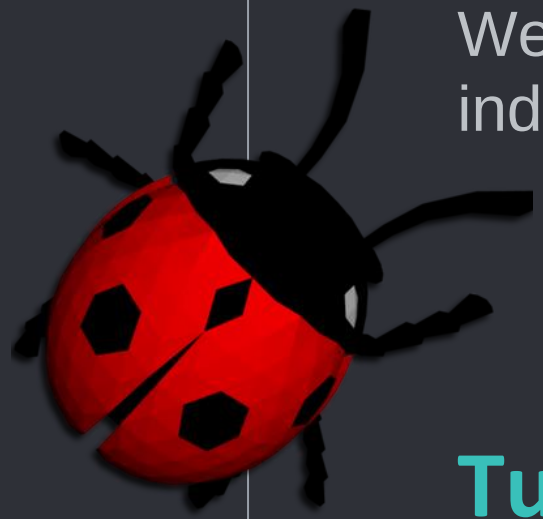

Creating a virtual environment
Deployment of turtle bots in virtual environment
Development of inter robot communication method and leader follower approach

CHALLENGES

- Interference: robots in a group can interfere between them, due to collisions, occlusions, and so forth.

- Uncertainty concerning other robots' intentions: coordination requires to know what other robots are doing.

WEBOTS



Webots is a free and open-source 3D robot simulator used in industry, education and research.

TurtleBot

TurtleBot is a low-cost, personal robot kit with open-source software. The TurtleBot's core technology is SLAM and Navigation, making it suitable for service robots.

Review of literature

TABLE 1

Title	Author	Joural/ publication	Inference
Leader Follower formation for UAV Robot Swarm based on Fuzzy Logic Theory	Wilson O. Quesada, Jonathan I. Rodriguez, Juan C. Murillo, Gustavo A. Cardona, David Yanguas-Rojas, Luis G. Jaimes, and Juan M. Calder´ on	Springer International Publishing AG, part of Springer Nature 2018 L. Rutkowski et al. (Eds.): ICAISC 2018, LNAI 10842, pp. 740–751, 2018	Results depicted a robot swarm showing some bio-inspired behaviors, such as swarm agents surrounding the leader when it is in a static position or when it is traveling from one place to another place.
LINK: https://repository.usta.edu.co/bitstream/handle/11634/18031/127.pdf?sequence=1			

TABLE 2

Title	Author	Joural/ publication	Inference
WebotsTM: Professional Mobile Robot Simulation	Olivier Michel	International Journal of Advanced Robotic Systems, Volume 1 Number 1 (2004)	can equip each robot with a large number of available sensors and actuators. can program these robots using your favorite development environment, simulate them and optionally transfer the resulting programs onto your real robots.
LINK: https://journals.sagepub.com/doi/pdf/10.5772/5618			

TABLE 3

Title	Author	Joural/ publication	Inference
Turtlebot 3 as a robotics education platform	Robin Amsters, Peter Slaets	October 25, 2019	Designing and functioning of turtlebot 3
LINK: https://www.researchgate.net/publication/335023861_Turtlebot_3_as_a_Robotics_Education_Platform			

TABLE 4

Title	Author	Joural/ publication	Inference
An Introduction to Swarm Robotics	Iñaki Navarro and Fernando Matía	Hindawi Publishing Corporation ISRN Robotics Volume 2013, Article ID 608164, 10 pages	The main tasks and experimental results in swarm robotics has been explained with future research platforms and robots mentioned clearly. The major drawbacks and benefits helps in understanding the real world implications.
LINK: http://dx.doi.org/10.5402/2013/608164			

TABLE 5

Title	Author	Joural/ publication	Inference
ADVANCED COMMUNICATION PROTOCOLS FOR SWARM ROBOTICS: A SURVEY	Emaad Mohamed H. Zahugi, S.V.A.V. Prasad and T.V. Prasad	2012	Understood the various modes of transmission of data and under which best possible conditions they are used.

LINK:
https://www.researchgate.net/publication/280112433_Advanced_Communication_Protocols_For_Swarm_Robotics_A_Survey

TABLE 6

Title	Author	Joural/ publication	Inference
Tracking Algorithm Using Leader Follower Approach for Multi Robots	B Madhevan, M Sreekumar	2013	The task flow, path flow and the overall controller process is clear and the algorithm process is successfully explained.
LINK: https://www.sciencedirect.com/science/article/pii/S1877705813017384			

TABLE 7

Title	Author	Joural/ publication	Inference
Robot Swarm Communication Networks:: Architecture, Protocols and Application	Ming Li, Kejie Lu, Hua Zhu, Min Chen, Shiwen Mao, B.Prabhakaran	(Not mentioned)	In this paper, wireless intercommunication between swarm robots was established using ROBOTRAK equipped with wifi as well as GPS.

LINK: https://www.eng.auburn.edu/~szm0001/papers/LiCHINACOM08.pdf

TABLE 8

Title	Author	Joural/ publication	Inference
Collaborative multi-robot exploration	Wolfram Burgrad, Marks Moors, Dieter Fox, Reid Simmons, Sebastian Thrun	IEEE International Conference on Robotics and Automation (ICRA), 2000	This technique for target allocation to multiple robots and determining the cost of reaching the target point in minimum time was successfully implemented.
LINK: https://www.researchgate.net/publication/3847261_Collaborative_multi-robot_exploration			

TABLE 9

Title	Author	Joural/ publication	Inference
Homogeneous Swarm Robot Exploration	W.A.F.W Othman, M.A Rosli, A.A.A. Wahab, S.S.N Alhady	International Journal of Trend in Scientific Research and Development (IJTSRD) ISSN: 2456-6470 | volume 2 | Sept-Oct 2018	This study has succeeded in investigating the exploration technique using homogeneous multi agent system.
LINK: https://www.researchgate.net/publication/333690029_Homogeneous_Swarm_Robots_Exploration			

TABLE 10

Title	Author	Joural/ publication	Inference
Swarm Robots	Erol S¸ahin , Sertan Girgin , Levent Bayındır and Ali Emre Turgut	January , 2008	Brief review of swarm robotics as a new approach to the control and coordination of multi-robot systems is studied,

LINK: https://www.researchgate.net/publication/226173060_Swarm_Robotics

TABLE 11

Title	Author	Joural/ publication	Inference
Swarm Robotics: From Sources of Inspiration to Domains of Application	Erol S¸ahin	January 2005	Define the newly emerging field of swarm robotics as a new approach to the control and coordination of multi-robot systems. Got the knowledge of Biomimicry involved in Swarm Robotics
LINK: https://www.researchgate.net/publication/225703852_Swarm_Robotics_From_Sources_of_Inspiration_to_Domains_of_Application/link/546f5abb0cf24af340c08747/download			

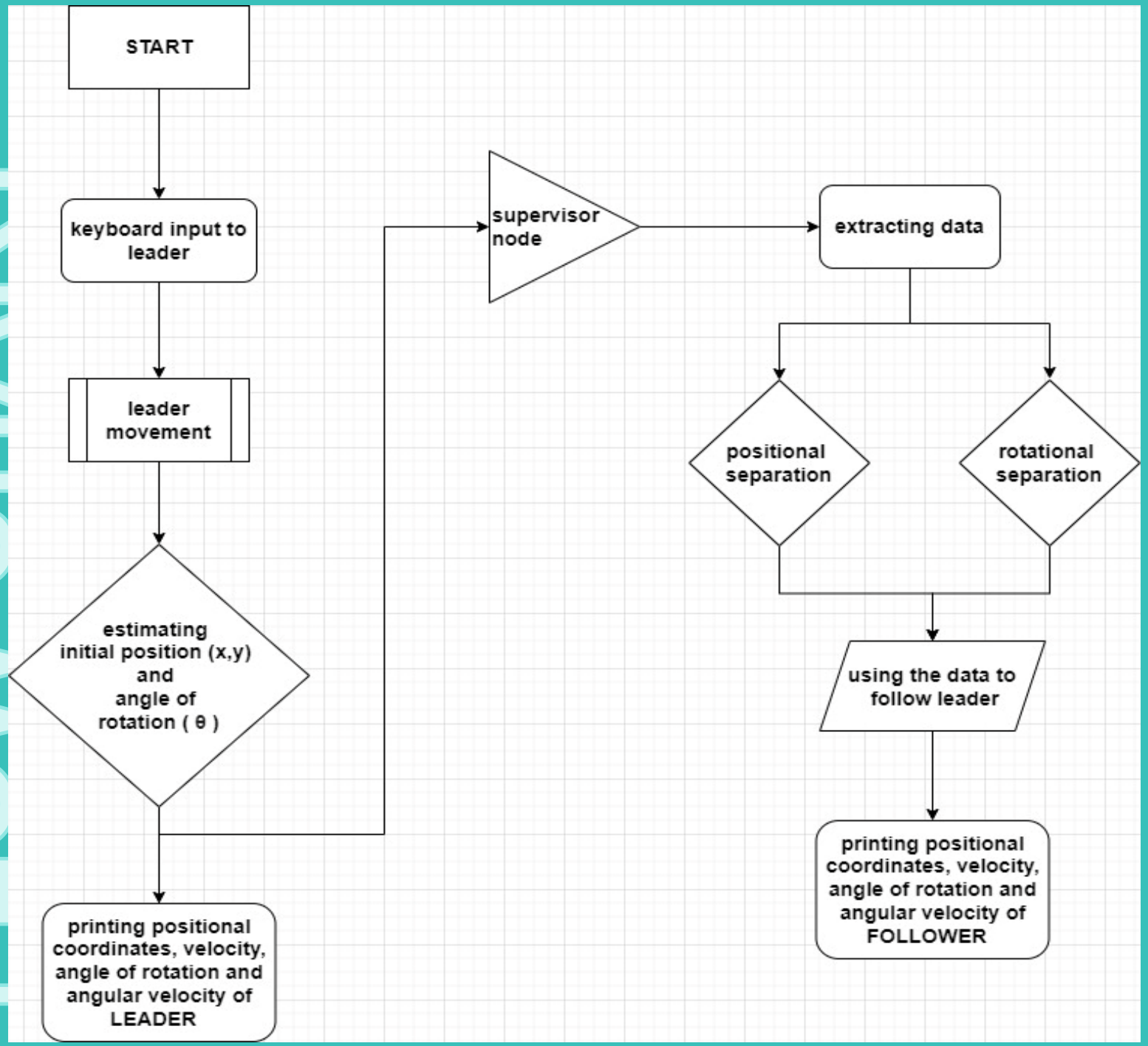
TABLE 12

Title	Author	Joural/ publication	Inference
Swarm robots' communication and cooperation in motion planning	Khiem N.Doan, An T. Le, Than D. Le and Nauth Peter	January 2017	Overlooked Kinematic models and obstacle avoiding algorithms. Overlooked experiments and results on setup, connecting (synchronize),path planning of robots.
LINK: https://www.researchgate.net/publication/306386315_Swarm_Robots'_Communication_and_Cooperation_in_Motion_Planning			

Important points extracted from literature review

- Brief review of swarm robotics as a new approach to the control and coordination of multi-robot systems is studied. - PAPER 10
- Got the knowledge of Biomimicry involved in Swarm Robotics - PAPER 11
- Knowledge on desirable properties and defining characteristics of Swarm robots is gained. PAPER 11
- The task flow, path flow and the overall controller process is clear and the algorithm process is studied. PAPER -6
- Wireless intercommunication between swarm robots was established using ROBOTRAK equipped with wi-fi as well as GPS has been studied. - PAPER 7
- Understood the various modes of transmission of data and under which best possible conditions they are used. - PAPER 5
- Details and specs of turtlebot 3 is gone through. - PAPER 3
- Overlooked Kinematic models and obstacle avoiding algorithms. PAPER - 12
- investigating the exploration technique using homogeneous multi agent system. - PAPER 9

FLOW CHART


START
keyboard input to leader
leader movement
estimating initial position (x,y) and angle of rotation (θ)
printing positional coordinates, velocity, angle of rotation and angular velocity of LEADER
supervisor node
extracting data
positional separation
rotational separation
using the data to follow leader
printing positional coordinates, velocity, angle of rotation and angular velocity of FOLLOWER

CODES

- turtle_node = robot.getFromDef('master’)
  turtle1_node = robot.getFromDef('slave’)
  : *defining master and slave turtle bot respectively*

- translation_field=turtle_node.getField('translation’)
  slave_field=turtle1_node.getField('translation’)
  : *defining translational attribute of master and slave*

CODES

- robot.getName()=='master'

  : *extracting the name of the robot from respective controller*

- (key==Keyboard.CONTROL+ord('W’)

  : *key input for the movement of the bot*

CODES

- position=translation_field.getSFVec3f()

  position2 = turtle1_node.getPosition()

  : *extracting positional details of master as well as slave bot*

- slave_field.setSFVec3f(position2)

  : *setting position for slave bot*

CODES

- rotation = turtle_node.getField('rotation').getSFRotation()

  : *extracting rotational details of master as well as slave bot*

- turtle1_node.getField('rotation').setSFRotation(rotation1)

  : *setting rotational details for slave bot*

CODES

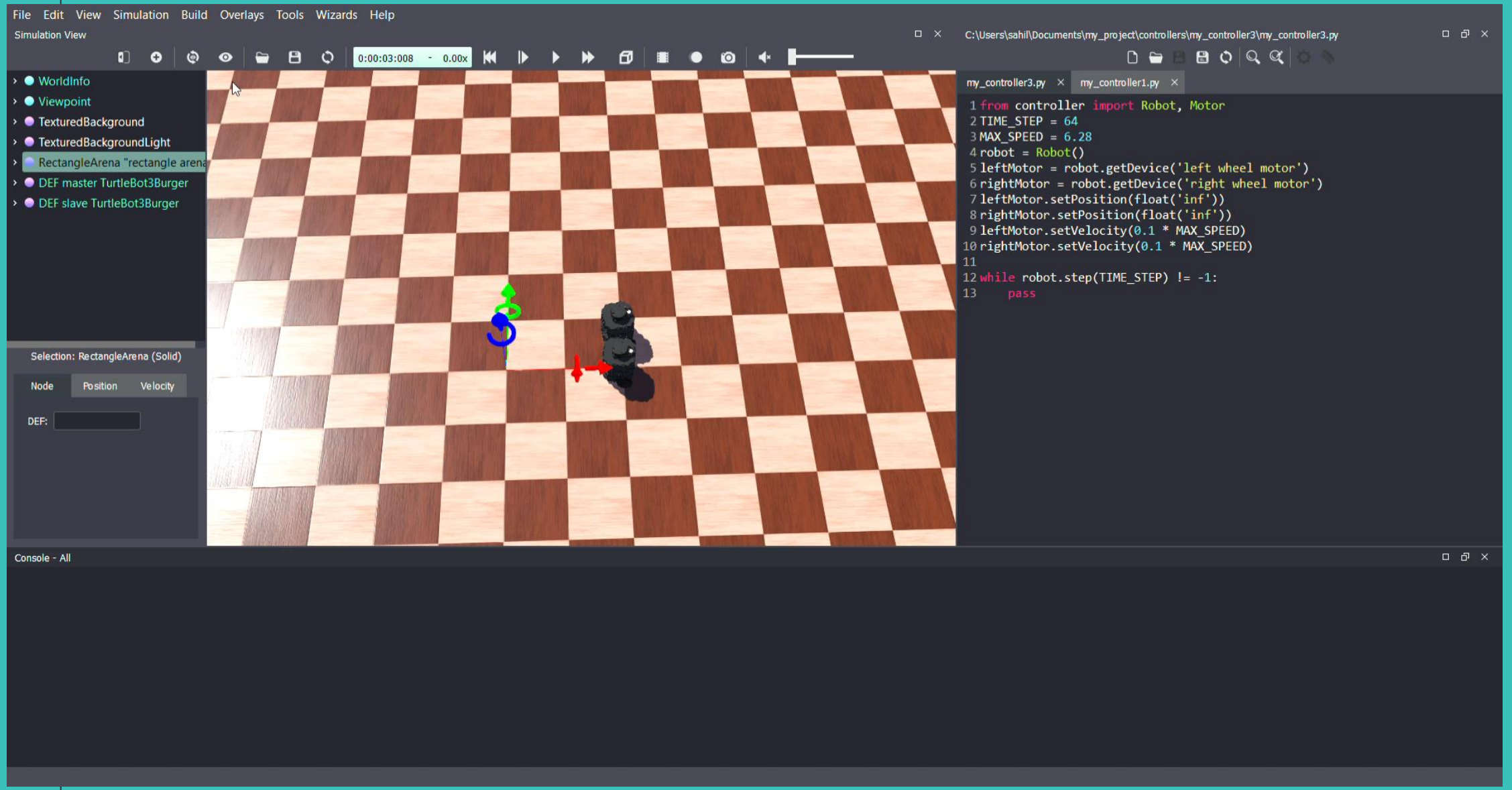
- k=turtle_node.getVelocity()

  : *extracting velocity details of master as well as slave bot*

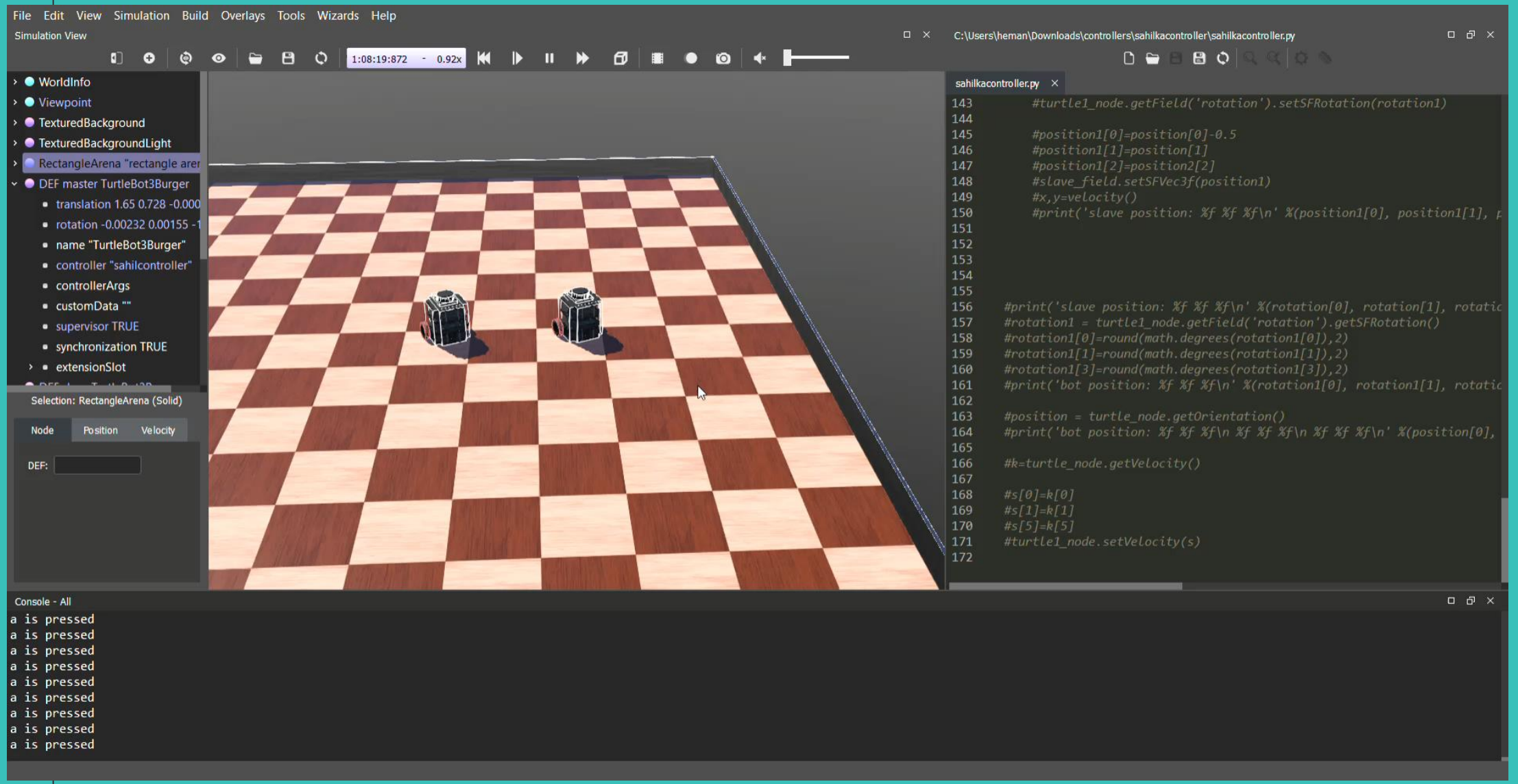
- turtle1_node.setVelocity(s)

  : *setting velocity details for slave bot*

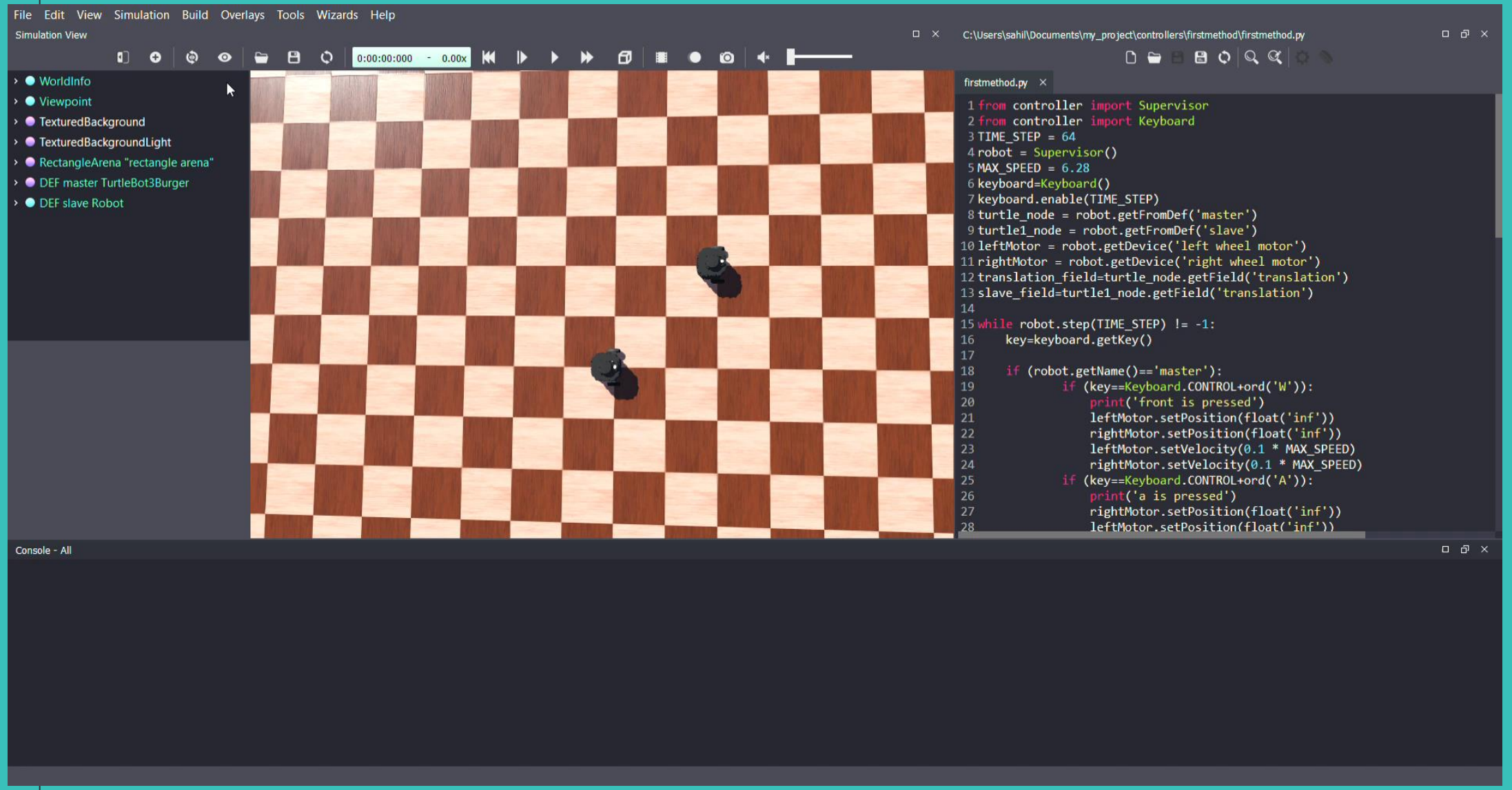
Printing positional details



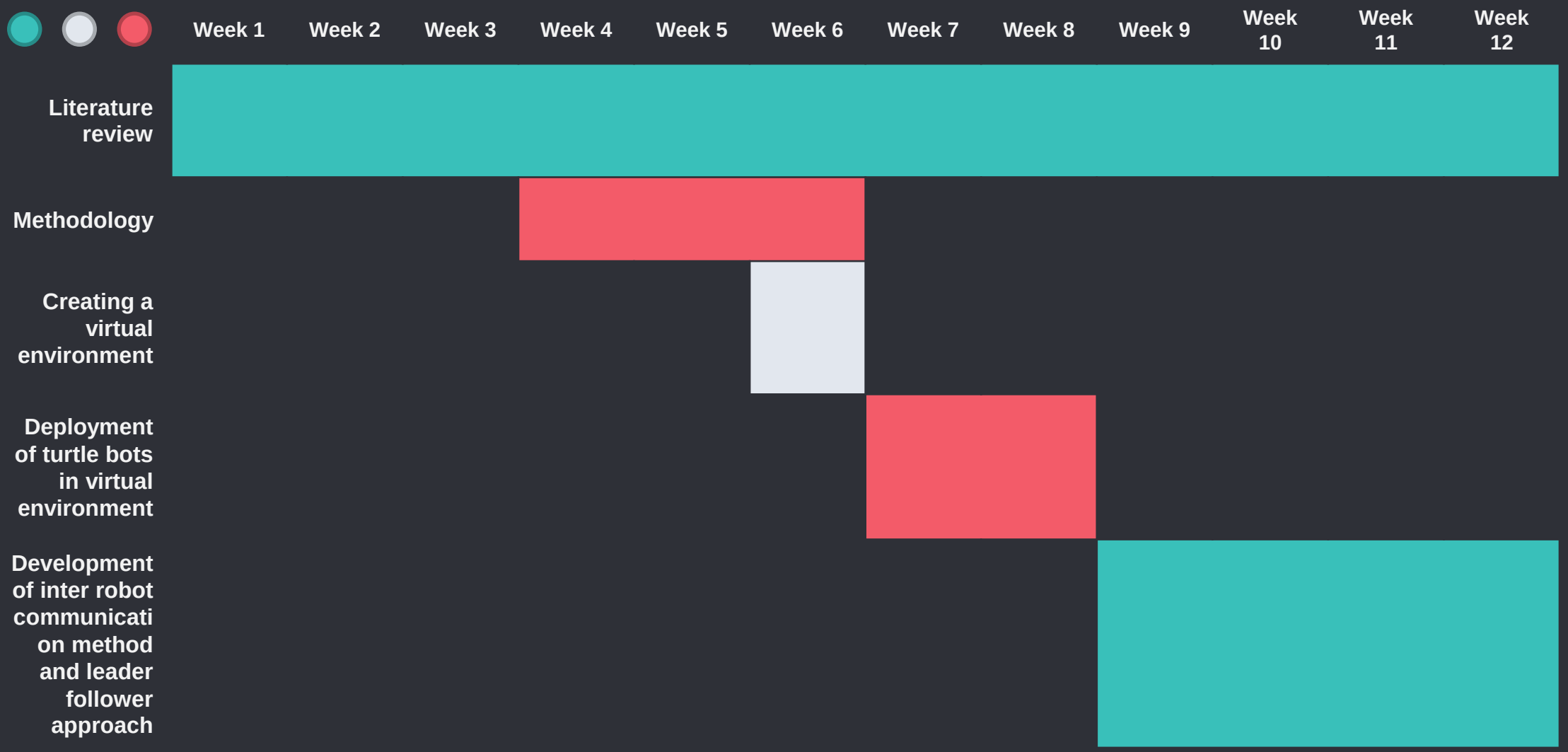
Operating turtle bot using keyboard



Final test run



Gantt chart


Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Week 12
Literature review
Methodology
Creating a virtual environment
Deployment of turtle bots in virtual environment
Development of inter robot communicati on method and leader follower approach

DESIGN AND DEVELOPMENT OF HOMOGENEOUS SWARM OF COOPERATIVE ROBOTS IN VIRTUAL ENVIRONMENT

MHB4244- DESIGN PROJECT-II

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THANKS!

Team: ANDRO WIZARDS