

RESOLVING PHYSICAL INTERFERENCE AMONG THE ROBOT USING RESPONSE THRESHOLD (RTM) IN MULTI ROBOT TASK ALLOCATION (MRTA)

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ABSTRACT:- Undertaking assignment, where errands ought to be executed before due date, might be a noteworthy research space in multi-robot system. For efficient errand portion, physical obstruction between robots ought to be thought about for example when two or a great deal of robots are doled out a comparative undertaking at a proportionate time. Response Threshold (RTH), one of the best Swarm mechanism assignment designation technique, is utilized to break down the influence of impedance in multi-robot system. This paper proposes a fresh out of the box new methodology for goals obstruction as per the need assigned to robots. Central point that are considered for defining need among the mechanisms are remaining vitality of the robot, errand finished by people mechanism and separation to the thing. A default need is utilized to determine impedance when at least two homogenous robots look for same the assignment. Results demonstrate that the arranged technique of impedance goals helps in improving system execution. A scrounging mission has been taken as Ground to check the consequences of our procedure

Keywords:-Physical impedance, multi-robot, assignment allotment, response threshold, kinematic vitality.

1.Introduction:- A helpful multi-robot framework considers the usage of progressively complex techniques, for example, investigation and looking undertakings, over a solitary robot framework. Notwithstanding of these advantages, multi-robot frameworks likewise have a few issues. Errand

portion issue, in multi robot framework, for the most part centres on choosing best robot or a lot of robots for executing assignment. A few errands will be executed by more than one robot. Number of robots has extraordinary effect on the framework execution, exhibited in various investigations [5], due to the physical impedance impact. Obstruction happens when at least two robots need to achieve a similar spot in the meantime. Part of analysts has chipped away at assignment distribution issue to give a powerful arrangement yet it is as yet an open issues. They isolate errand designation issue into two general classifications: 1. Multi robot assignment designation (MRTA) and 2. Swarm robots assignment portion (SRTA).

A MRTA is one where data about asset and undertaking is known to earlier and execution measure is predefined. The point of MRTA is to expand the framework execution by distributing undertaking to the best robot; fit for executing the errand before due date. Closeout instrument is a standout amongst the best techniques; give viable answers for MRTA [3, 4, 6, 7]. Sale component is showcase based coordination approaches in which robot go about as self-interested members whose mean to amplify their individual benefits and limit their

People cost. Assignments are the products which are traded by robots for instalment. A focal salesperson decides the best robot for finishing undertaking [8].

The motivation of Swarm framework originates from common frameworks like creepy crawly provinces, where the functionalities of whole framework as entire, relies upon communication

between littler elements. As a rule, robots in swarm framework are equivalent as far as assignment execution ability. The point of SRTA is to fulfil framework request by enabling individual robots to perform as per its nearby sensation. In SRTA, no correspondence or just nearby correspondence is accessible and the information of the earth is additionally restricted. So the answers for MRTA are once in a while relevant to swarm mechanical framework [9]. It has been demonstrated that sale frameworks in MRTA perform superior to swarm strategies as far as undertaking throughput, as has been appeared in [1].

We think about the effect of obstruction, demonstrating that the framework execution can be improved when it is considered. This paper proposes another strategy for settling obstruction. The closest first swarm technique is one of the most straightforward strategies in SRTA. In this technique every robot chooses accessible assignment, nearest to the robot. The focal chief communicates the data with respect to area and due date, to every one of the robots. In view of this data robots choose, regardless of whether they can execute the undertaking. If not, they will not take up the assignment. To evaluate time of consummation for a given undertaking, robots use separation and kinematics as choice parameters. After the consummation of each errand, the focal specialist imply every one of the robots about it; with the goal that they expel the undertaking from the rundown of incomplete assignments. The assignment choice relies upon the undertaking distribution technique utilized, explicit to swarm-like system. Thus, in the swarm strategies, the designation of errands isn't under the control of focal operator. This makes the framework decentralized. At that point the focal operator goes about as a client who chooses when to flag culmination and age of new errand [1].

The rest of the segments of the paper are depicted as pursues. Segment 2 is the survey of the past work about the errand portion technique in multi-robot framework particularly centres on closest first swarm strategy. Segment 3 clarify, issue in a

nutshell and answer for the issues given by us. Area 4 deciphers the usage of our answer. The exploratory outcomes are displayed and elucidation in area 5. Finally, area 6 present end and future work.

2 Literature review:-

The issue of undertaking distribution has been considered by different specialists in the past for multi robot framework. Arrangements of errand portion issues are classifications in MRTA and SRTA. MRTA techniques are advertise based methodology, gives preferable outcomes over the SRTA strategies as far as assignment throughput [4]. In any case, these market based methodologies are convoluted to actualize as they require collaboration among robots and hold all recourses of the framework all through the assignment execution. This will expand the general all multifaceted nature of framework regarding correspondence and

Calculation [1]. In this way, SRTA strategies are increasingly ideal when framework assets are restricted. In closest first swarm (NFS) strategy, a SRTA approach, every robot chooses the closest accessible undertaking, in this way NFS is the deterministic in nature. An errand is relegated to robot just when the separation among undertaking and robot is not exactly a limit, D . This keeps robot from picking a far off undertaking. The comparable methodology was taken by creators in [4] however without due dates. As robots just need to get message from focal chief, not send, the correspondence cost is incredibly decreased making the method a lot less complex. This straightforwardness accompanies a cost which is acquired in wording obstruction between robots. Impedance happens when different robots endeavour to pick same errand at same time [1]. In this way with increment in impedance, framework execution corrupts. In this paper we utilize a NFS: given a robot r and an errand t , a separation $d(r, t)$ is determined. On the off chance that $d(r,t) \leq D$ then r begin to execute the assignment t . The

acknowledgment of NFS, utilized in this paper, is appeared in calculation 1.

Calculation 1: Nearest First Swarm for the robot r

Require: $T =$ List of unassigned tasks
 1: for all $t \in T$ do
 2: if $d(r, t) \leq D$ then
 3: return t {Start to execute task t }
 4: end if
 5: end for
 6: return null

3Methodologies: Resolving Interference

Lots of solutions were applied to avoid interference in task allocation. But some of those bring about multiplied fee, both communication or computation, and some of these result in decreased task throughput. SRTA is a simple undertaking allocation approach which calls for less communication and computation price. But it results in more interference because robots are free to pick mission autonomously. On the alternative hand auction mechanism is well suited in phrases of venture execution, however calls for greater communication and computation price. These public sale strategies keep away from interference up to some extent however not completely

Sense the total foods in nest zone when staying at home. Robots should go foraging to keep the full foods left at nest greater than zero, so the food consumption can always be satisfied. Robots have equal capability and each robot will deliver one food to home zone during one foraging cycle. Foods are scattered randomly in foraging area. At once after a food is delivered to home zone, another food is randomly placed in foraging area. So the food density is unchanged during the mission [20].

3.1 Proposed technique

We advise a new technique that resolves the interference whilst it occurs. In this methodology, critical supervisor maintain a listing of all available obligations. The list consists of information approximately each undertaking alongside its

region and deadline. This listing is broadcasted to any or all the robots. As soon as a robotic starts exploring the location, it first consults the

List earlier than deciding on any undertaking. At any time, the challenge closest to robotic is selected. In actual time while challenge preference, robot sends a message to the primary manager to look, whether there is interference with this task on not. If there's no interference, imperative manager simply permits the robotic to transport any. However if exceptional robots are looking for same assignment then there may be interference with that assignment. Now, central supervisor has to determine which robot is pleasant positioned for the task execution. Central supervisor takes a few parameters to determine on the fine robotic, specifically, energy of the robotic, undertaking finished via the person robots, distance of robots from the task and default priority of robots. During mission execution, a robotic ought to be in one of the five states, proven beneath.

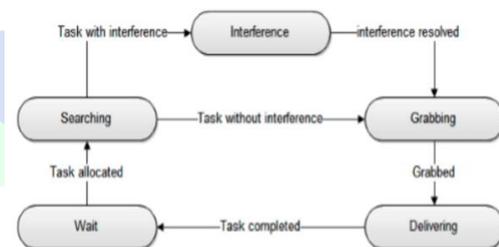


Figure 3.1: Block diagram of task allocation system

Initially, all robots wait in domestic and a important manager continuously display the amount of ingredients. As soon as it goes underneath to sure stage then it's going to announce to all robots for foraging. All robots start exploring vicinity for searching ingredients. If a robot find any food object than it'll sends a message to crucial manager for the determination of the interference. If significant supervisor determined any interference then it will allowed a single robotic have highest precedence, and disallowed all different robots. A priority of the robotic is define on the idea of some parameter discusses underneath-

3.2Parameter for selection great robotic

For resolution interference amongst robots, central manager takes some parameter that are referred to as beneath

3.2.1 Energy of the robotic

Energy consumption of the robots throughout execution of task is given via the power model, defined in [17]. This power version determines the connection between electricity consumption and velocity of the robotic. The movement strength may be modelled as a characteristic of the rate v , the acceleration a , and the mass m :

$$P_m(m,v,a)=p_t+m(a+g\mu)v \quad (3.2.1)$$

Where p_t is the remodelling loss and p_m is motion energy of the robot. Robots will charge themselves throughout searching of venture if electricity degree is going under a positive degree. In [17], authors define the maximum speed V_m , at which robots eat high electricity. They also defines any other velocity V_o at that robotic consumes the minimal electricity to cowl a unit distance such speed is known as maximum power- efficient speed. In actual time eventualities, time and strength constraints are most vital factors that have to be considered. A Speed control module defines the velocity at that a robotic can tour longest distance by means of pleasing those constraints. We are the usage of maximum pace for delivering challenge due to the fact our purpose is to maximize the variety of executing assignment.

3.2.2 Task finished with the aid of the individual robots

This is the second parameter taken by important manager for choosing satisfactory robot. Central manager use this parameter if two or greater robots, includes in interference, have identical quantity of power at any time t . A robot completed more tasks in a particular time t , could be bear in mind as most premiere robotic than other robots. This parameter make certain that device performance would be increase as selected robotic perform higher than other robots, as it completed extra challenge than others in identical amount of time.

3.2.3 Distance between robot and object

If all robots involves in interference have same amount of energy and complete same number of tasks one by one then this parameter comes into the image. A robot nearest to the task will be selected as best robot for executing task. This parameter ensures that a robot with minimum Distance to the object will requires less time than other robots. This can helps in improvement of task throughput of system.

3.2.4 Default priority of the robot

This parameter is used by the central manager if robots looking for same task at the same time are more homogeneous means that all robots have same amount of energy, complete same number of tasks and all are at same distance. Default precedence may be a chain variety assigned to robot, previous to project allocation. Central supervisor lets in a robotic on the premise of FCFS. A robotic request first could be accepted for the execution of task

4 Task Allocation Strategies

Foraging project has been used to test our challenge allocation strategies. Initially all robots reside in domestic and incorporate a few amount of food that decreases at a positive price. Once meals amount goes below a sure level, important manager declares mission. Then, all robots begin foraging. They depart the house and search for meals in dynamic environment. As soon as a robotic detects meals, it sends a message to central supervisor which consists of energy of the robotic, wide variety of assignment completed and distance to the object. Then critical manager calculates the placement of the item and decide whether there may be interference for the object or now not. If no longer, permit the robot to execute the assignment. Robot grabs the meals and returns to the residence. Calculation 2 implements our undertaking allocation strategy.

4.1 Proposed Algorithm

In this approach, given a robotic r and a project t , $d_{r,t}$ represents distance among robot and item

Calculation 2: New RTH algorithm for a robot
 r

Require: $T = \text{List of unassigned tasks}$
 1: for all $t \in T$ do
 2: if $dr,(s) < D$ then
 3: for all $t \in T$ do 4: if $Pr, > \text{ran}(0..1)$ then: end
 for 5 return $t \{ \text{Start to execute task } t \}$
 6: end if
 7: end if
 9 return null

In any other case, if there may be interference, way or greater robots are attempting to find a comparable project then primary supervisor ranks the robotic on the idea of precedence. A robot has highest precedence if it has larger electricity then the opposite robots. We use this parameter due to the fact a robot with excessive strength is maximum efficient and might supply the undertaking to domestic at better pace. This maximizes the system aim. But, if all robots have identical amount of energy, then we use a second parameter E_i . Number of mission finished through the robotic personally. This parameter guarantees that the chosen robotic can carry out higher than others, as it has finished greater obligations then other robots in equal amount of time. Again, if variety of obligations finished is same for all of the robots, then we use a third parameter E_i . Distance to the object. A robotic with shorter distance to the object may be allowed to execute challenge. If, in any case, all parameter are equal, we've assigned a default priority, a sequence variety, to each robotic. A robotic with high sequence number is permitted to execute the mission. E_i is the final energy of the robotic r_i at any time, I_i is the task finished through the robotic r_i , dr,t is the gap of robotic r_i to the project t and P_i is default precedence of the robot. Calculation 3 suggests the implementation of our interference resolving approach.

Calculation 3: Resolving Interference for a robot r_i

1: if robot r_i look for an item then
 2: Send a message to central manager
 3: central manager receive message and evaluate

4: for all j to n (looking for same task) do
 5; ($i \neq j$ and r_i is allowed)
 6: ($E_i > E_j$) then
 7: r_i is allowed
 8: else ($(E_i == E_j) \&\& (I_i > I_j)$) then
 9: r_i is allowed
 10: else ($(E_i == E_j) \&\& (I_i == I_j) \&\& (dr_i,t < dr_j,t)$) then
 11: r_i is allowed
 12: else if ($(E_i == E_j) \&\& (I_i == I_j) \&\& (dr_i,t == dr_j,t) \&\& (P_i > P_j)$) then
 13: r_i is allowed
 14: else
 15: r_i is not allowed
 16: end if
 17: end for
 18: end if
 19: return

4.2 Flowchart

The flowchart of mission allocation is algorithm is given in figure beneath. A robotic ought to be in one of the five country till timer expired. This version implied, firstly, that there are more than one goal region in environment or seek area, where robotic will find ingredients; secondly, that surroundings includes most effective unmarried series factor. The five states are defined as observe

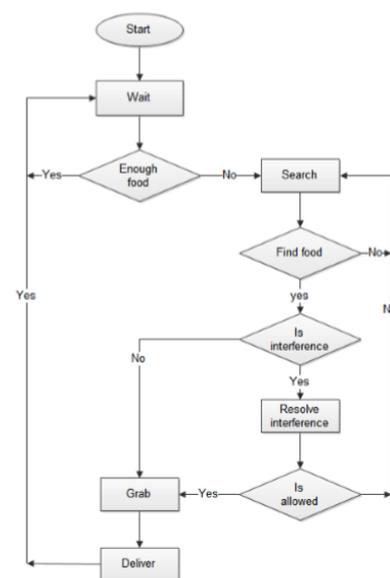


Figure 4.1: Flowchart of task allocation algorithm

Wait:- Robots, in this state, are resides at domestic zone and constantly check the quantities of meals. If food's quantity is going under to a positive stage then robots make transition to go looking kingdom

Search: - Robots will begin discover the surroundings for looking food. If any robotic find food than it send a message to relevant supervisor to decide whether or not there may be interference or now not. If now not, robot transfer to seize kingdom else in clear up interference state.

Resolve interference: important supervisor test for interference. If so, it's going to allow one robotic, having maximum priority and disallowed all other robots. A authorised robot switch into take hold of state and rest of the robots again switch into seek kingdom.

Grab: - in this state, a food item is bodily grabs and captured via the robot and robotic is prepared to can provide it back to the nest. Here we consider that the item is capable of being captured and carried through a robot.

Deliver: robot delivered amassed food to home region and again enter into the wait nation. As we've seen above, no communicate is wanted throughout allocation, communicate is simplest required whilst interference passed off.

5 Experimental Results

We have proposed a hybrid method wherein all robots moving independently. Robots are homogeneously ready with identical variety of measuring tool sensors to find impediment and different robots, in order that they do now not collide with each other and with boundaries. Every robot includes a camera to apprehend project. Four robots in circle are in interference. We expect that there's perfect conversation among central manager and robots. They ship messages to each other without any loss. The preliminary electricity of the robot is defined the usage of the specifications of a chargeable battery. Pioneer3dx makes use of one 12 V lead acid accumulator [17].

We initialize our robots with the base cost of 25920 J. All the robots begin place exploration with the above price as last electricity and are homogeneous i.e. Have equal basic characteristics. We define our arena in shape of grid of length 26*26m. Finally average of all 5 has taken. Then we compare results of both algorithm and find that by using proposed methodology robots executing more task then the using basic RTH. We give two modules. In first module we imagine that all robots have unlimited energy and selection of best robot is depends only on robot's throughput and distance to the object. In second module, robots have limited energy and they are ready to charge themselves during execution of task. Results are as follows:

Table 5.1: Task completed by robots with unlimited energy using RTH

number of robots	2	4	6	8	10	12	14	16
Simulation 1	20	23	23	29	23	50	41	50
Simulation 2	13	16	22	28	33	60	46	43
Simulation 3	13	16	20	30	28	52	36	59
Simulation 4	15	18	19	34	26	40	48	34
Simulation 5	16	19	27	25	31	30	52	36
Av.task completed	16	19	23	29	29	47	45	45

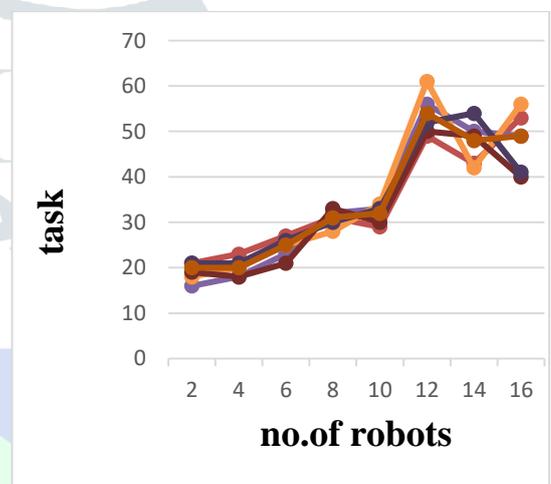
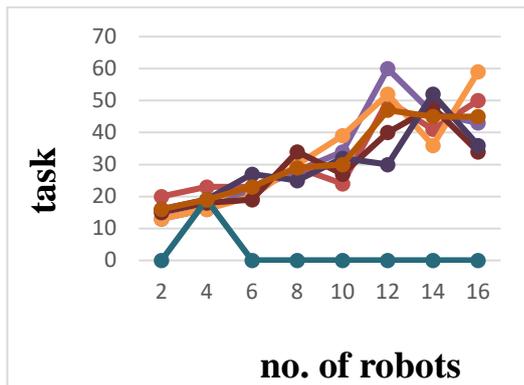
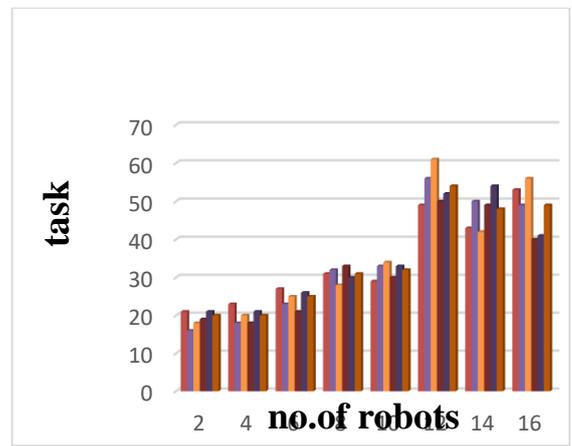
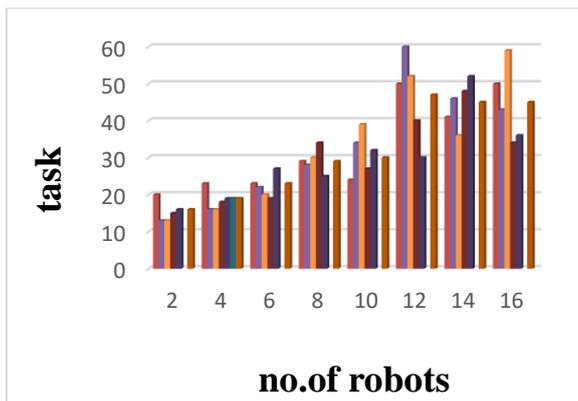


Figure 5.1: Task completed by robots with unlimited energy using RTH

Figure 5.2: Task completed by robots with unlimited energy using proposed method

Table 5.2: Task completed by robots with unlimited energy using proposed method

number of robots	2	4	6	8	10	12	14	16
Simulation 1	21	23	27	31	29	49	43	53
Simulation 2	16	18	23	32	33	56	50	49
Simulation 3	18	20	25	28	34	61	42	56
Simulation 4	19	18	21	33	30	50	49	40
Simulation 5	21	21	26	30	33	52	54	41
Av.task completed	20	20	25	31	32	54	48	49

Table 5.3: Task completed by robots with limited energy using RTH

number of robots	2	4	6	8	10	12	14	16
Simulation 1	8	10	11	21	28	31	44	43
Simulation 2	13	15	22	17	35	29	42	35
Simulation 3	11	13	18	25	26	31	33	34

Simulation 4	9	1 1	2 3	2 8	3 2	2 7	3 2	4 2
Simulation 5	9	1 2	2 1	3 0	3 0	2 9	3 0	4 0
Av.task completed	10	1 4	2 4	3 2	3 9	3 5	3 7	4 1

Table 5.4: Task completed by robots with limited energy using proposed method

number of robots	2	4	6	8	10	12	14	16
Simulation 1	19	2 1	2 1	2 4	3 3	3 5	4 3	5 0
Simulation 2	14	1 6	2 5	3 0	3 4	3 4	3 9	4 6
Simulation 3	17	1 9	2 7	2 9	3 8	3 2	3 7	3 8
Simulation 4	16	1 8	2 1	2 5	3 0	3 3	4 1	4 1
Simulation 5	14	1 5	1 9	2 7	3 2	3 1	3 8	3 9
Av.task completed	16	1 8	2 3	2 8	3 4	3 3	4 0	4 3

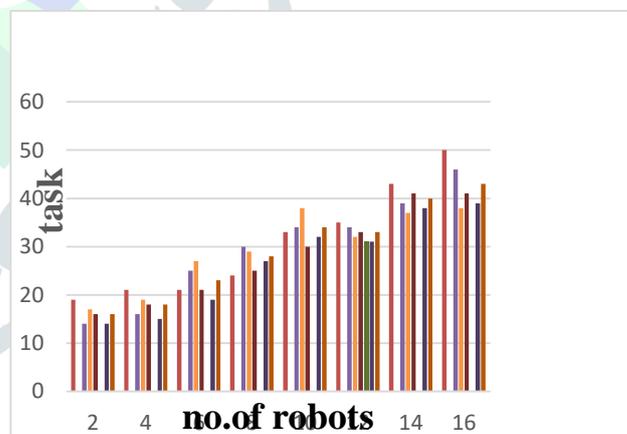
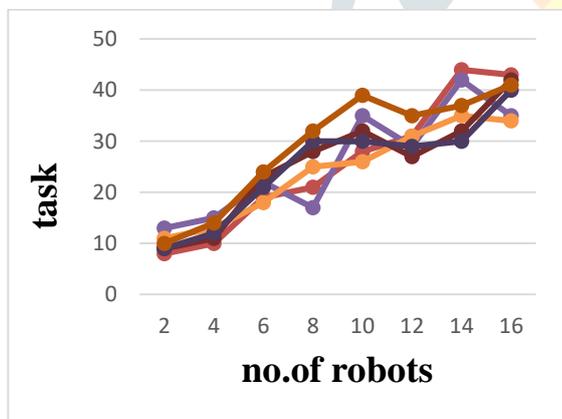
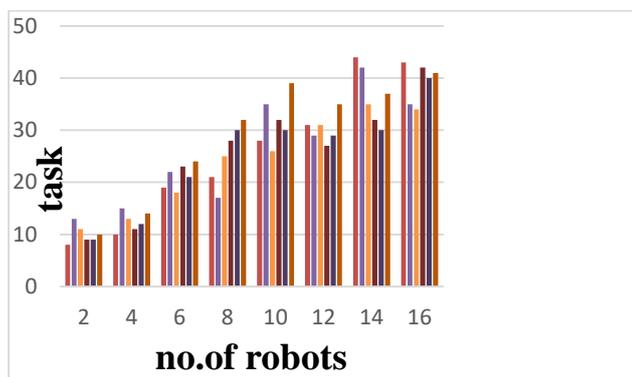


Figure 5.3: Task completed by robots with limited energy using RTH

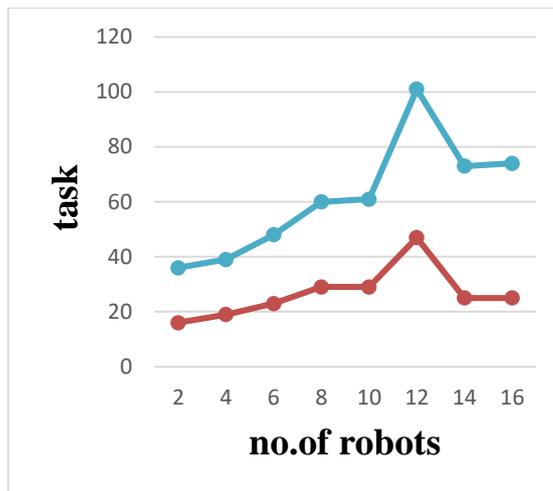
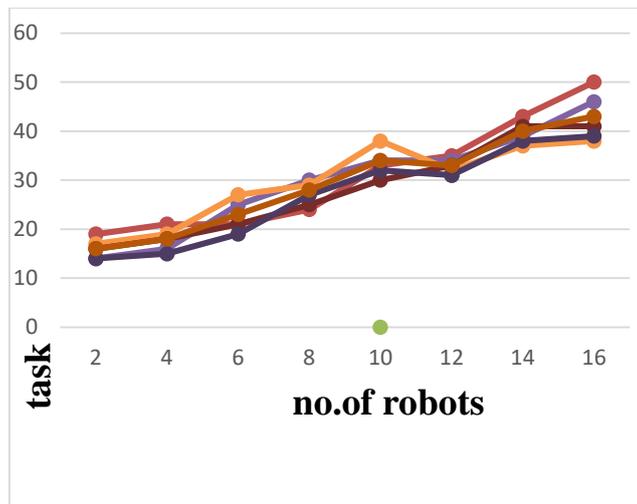
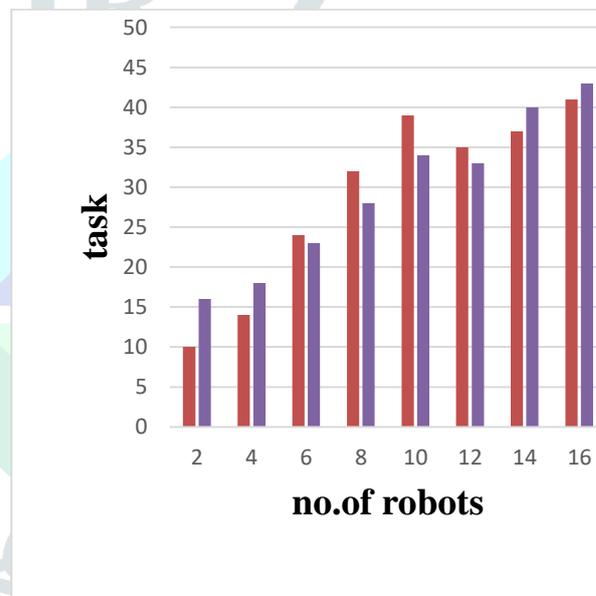
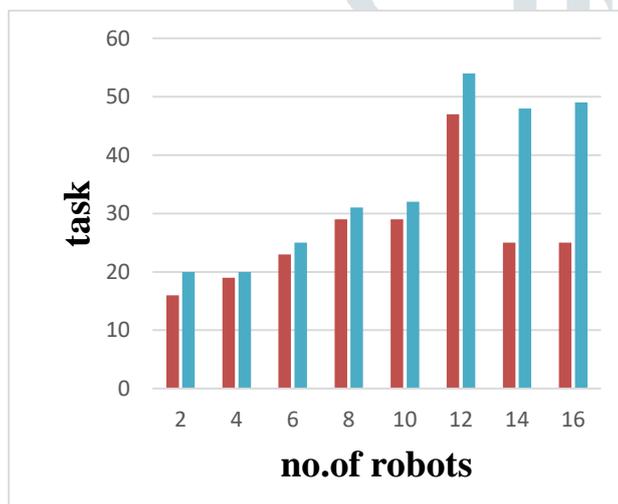


Figure 5.4: Task completed by robots with limited energy using proposed method

Figure 5.5: Comparison of RTH and Proposed method with unlimited energy



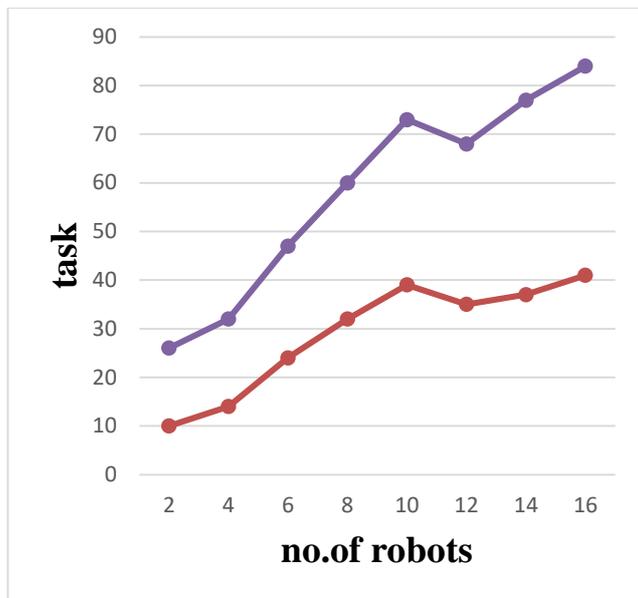


Figure 5.6: Comparison of basic RTH and Priority RTH with Energy function

6 CONCLUSION AND FUTURE WORK

This paper introduces a new technique for resolution interference in swarm robot task allocation methodology, where the tasks must be executed before deadline. Our methodology by taking interference acts into account the robots will better for all the task's deadline. Results prove that number of finished tasks throughput has been increased up to 22% as compared to RTH. This shows that interference is very important issue, it can't be neglected.

The work presented still has some open issues to add and to improve. We are searching for probabilistic response threshold strategy, i.e. a robot is allowed to execute task when a stimuli exceeds a given thresholds, provides better result than RTH, as in [1]. This work can be extend by using real robots and various kind of other tasks like cleaning space, area exploration, mail delivery mission etc.

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