

SWARM ROBOTICS IMPLEMENTATION FOR LOAD SHARING

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ABSTRACT

In the modern day, where technology is reaching its pinnacle, there is no need for humans to perform every menial task that aids in his life. Humans are not need to handle big objects or deal with their effects, like as back ailments, etc. These little tasks can be carried out by robots, who are extraterrestrials. Swarm robots are a new technology in development. Working together as a team is referred to as swarming. There are a master robot and three more robots among our four robots. In general, there are two types of robots: explorer robots and carrier robots. In the beginning, the explorer robots travel the complete route from the source to the goal. The carrier robots get the terrain information from them and respond appropriately. As a result, the slave carries out the master's instructions. They are constructed so that they can go across difficult terrain. As a result, the duties are completed quickly and considerably more effectively.

Key Words: *Swarm Robots, Explorer Robots, Carrier Robots, Master Robots, Slave Robots, Rough Terrains.*

1.INTRODUCTION

Over the past ten years, everyone's life has seen a significant transformation. In the existing situation, it is impossible for a human to perform menial tasks like moving a piece of equipment automatically from one location to another or from its source to its destination [1]. There is no requirement that these locomotion actions be carried out by people in locations like factories where lifting big weights is required. In such circumstances, our robots can be useful. Our paper's major goal is to make the person feel at ease by doing the job of locomotion.

This apart from reducing the burden of human, it also reduces the threat post by a human of handling of any with reducing the burden.

Fig-1: Group of Robots



Our study focuses on the idea that there are two different types of robots. The first type of robot is called an Explorer Robot, and it primarily focuses on a leader's actions. The carrier robot, which obeys the explorer robot's directives, is the second kind of robot [1] [9]. In other words, a Carrier Robot can be referred to as a Slave and an Explorer Robot as a Master. Hence the Swarm Robots work on Master Slave Concept like the colony of an ant or the bees in a beehive. This makes for the Swarm Intelligence [3]. These Swarm Robots have the characteristics of

Sturdiness, scalability, effectiveness in operation, fault tolerance, adaptability to the terrain etc.[4]. Apart from load sharing they are designed for other applications like firefighting, agriculture and also data sharing. It prevents over-exploitation of resources. Apart from load sharing they are designed for other applications like firefighting, agriculture and also data sharing.

2.BIOLOGICAL BASIS

According to what was previously said, the word "swarm" represents collective labour. The idea of a swarm was taken from the formic from a biological perspective [20]. The formic often symbolises ants. An ant swarm is referred to as a swarm [23]. Every creature, whether it is unicellular or multicellular, operates in groups from the lowest point in the taxonomy of categorization. So here is where the idea of swarm robots really started.

These ants work as a group mainly to gather food and also protect themselves from the predators [1]. We generally know that ants all work under a common captain who is called Queen Ant [17] [14]. The queen ant is the one that commands all other worker ants.



Fig-2: Swarm of Ants



Fig-3: Swarm of Bees

The same is applicable for a beehive. The bees don't act without the command of the queen bee [18] [19]. So like an ant colony a beehive has the necessity to have a queen. We use this concept of Swarm in ants and the swarm of bees [15] as the main flow on the backdrop.

The absence of the queen ant would halt the work of all the worker ants [1] [7]. So it is right to conclude that the worker ants are inactive with the queen ant. They would have a mayday without the queen; these worker ants have no thinking capability [21] [16]. So a Queen is required to keep them active.



Fig-4: Swarm of Robots

3.THE SWARM CONCEPT

Pioneering of the Swarm Robots

If not in the near future, but at least in the days to come, the idea of swarm robots will be a huge aid. Thus, this has benefits of its own. Here, there will be a master robot and three slave robots [24, 25]. The work of the slave is to accomplish the wishes of the master. So we have all four robots work for the fulfillment of a task and hence the task gets completed in time without the use of surplus amount of resources. This is the key asset for the development of Swarm Robots.

The next thing we come to know is that most robots are Omni-directional (i.e.) they have the ability to move in all directions. This is of a major advantage because they have the ability to access remote location which is mainly conquered by their tolerability to any climatic changes and can encounter any wear and tear [26]. This is a technique that also reduces the time as there are various robots searching in various locations the span keeps on increasing.

The concept of master and slave

The block diagram below shows swarm robotics in load sharing and uses the Raspberry Pi 2 as its central processing unit. It is undervalued because of its processing speed, which enables it to carry out more simultaneous commands than Atmel [5]. Additionally, it is connected to cameras, which makes the concept of image processing possible. The only purpose of the ZigBee module is for communication.

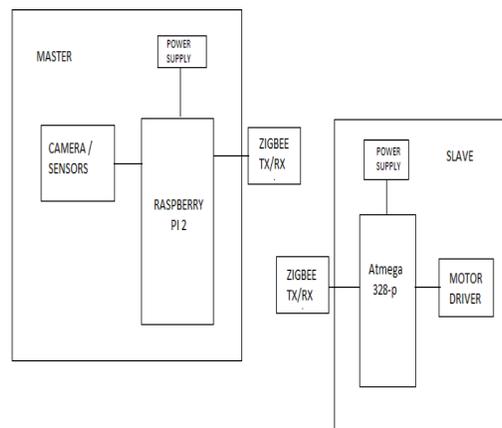


Fig-5: Block Diagram of Master and Slave Alignment of Multiple self-governing robots

As discussed above these robots have the ability to act on their own and don't necessarily require the attention of humans for its operation [22].

The main focus of having this is to minimize the extravagance in the resources [8] being used and to reduce all these [22]. This is a valid reason for the concept of Swarm Robots as this focuses the main concept of this paper.

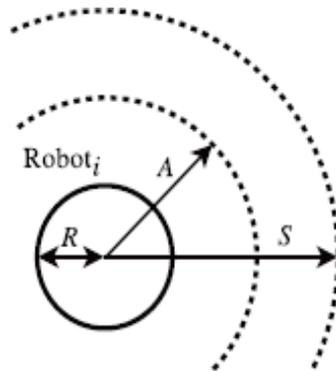


Fig-6: Essential Parameters

○ : Robot ○ : Sight of robot

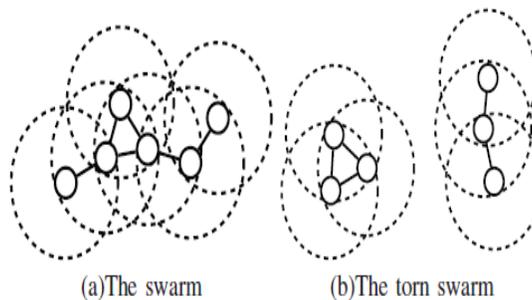


Fig-7: Swarm Structure for Communication

The Swarm Robots are generally said to follow line of Sight means of communication. This mainly helps in the process to a greater extent.

The phases of Transportation

Our swarm concept transforms in four unimportant stages. In this approach, the Master robot seeks for the designation before instructing the Slave robots as to where the assignment has to be completed. The slave robots then carry out the master's instructions and do what they are told. From the above it is evident that there are numerous robots, but here we are taking into consideration only four robots. Out of these four as mentioned above only one will act as a master and the remaining will all act as slaves. Thus the master slave concept is also experimented.

We have four phases of the load being carried from source to destination. In Phase (I) we have the diagrammatic representation of the object at the source. We also have numerous robots surrounding the object. In Phase (II) the diagrammatic representation depicts numerous explorer robots that lead to the preferred destination. It also indicates the carrier robots are about to carry the object to its destination. In Phase (III) illustrates a path has been determined by the explorer robots and the carrier robots follow this path and lead to the destination along with the object to be carried. The explorer robot gives ever obstacle in its path to its destination and hence the

object is moved from one end to another with ease. In case of any hurdle in the path the explorer robots instructs the carrier robots in such a way that its path gets alternated and they are driven to follow a new path. In Phase (IV) we have the object being carried by the carrier robots from its source to its destination through all the hardships.

Communication of the Swarm

In general the word swarm means working as a group. In this we visualize the swarm robots that have to work as a group and for accomplishing this they are supposed to work as a group. In order to work in a group these robots must have intercommunication [6] among them.

We employ a ZigBee module as the communication tool between them to do this [26]. The zigbee technology has advanced [12] to higher heights in the sphere of communication in the modern day and is preferred [13] above other communication methods.



Fig-9: ZigBee Module

The use of ZigBee reduces the amount of space the module occupies on the device and is also easily accessible.

2.PATTERN FORMATION

There are two types of pattern formation in Swarm robotics which include Strip formation and chain formation. Based on the necessity anyone can be implemented. The patterns include i) Chain formation ii) Strip formation.

CHAIN FORMATION

In chain formation the load is carried by a chain of robots [1]. This is mainly followed when the dimension of the load is smaller by length (i.e.,) they are carried by virtue of their breath [11].

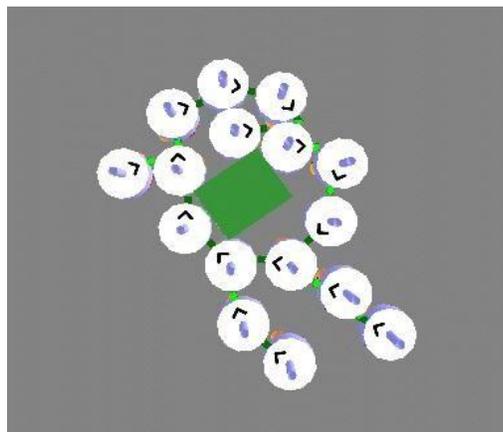


Fig-10: Chain Formation

It sometimes accounts for improper utilization of resources because the robot in some cases in the necessity to accomplish the given task even before the stipulated time speeds up the work process by involving an additional robot [27] [10]. It can be reduced to the maximum extent, but

when there arises a necessity to complete the given task well before this can come in handy [2].

Strip Formation

Strip formation is generally applied in cases where the swarm undergoes a necessity to push a load which is dimensionally longer in its length than it breath [11]. The strip of robots help very much in the concept of load sharing because the weight of the load is calculated and then the load is being pushed by the robots [28].

So strip formation is more suitable because it accounts for proper utilization of resources [1][10]. As it is better than its predecessor it is more formidable and is usually preferred [2].

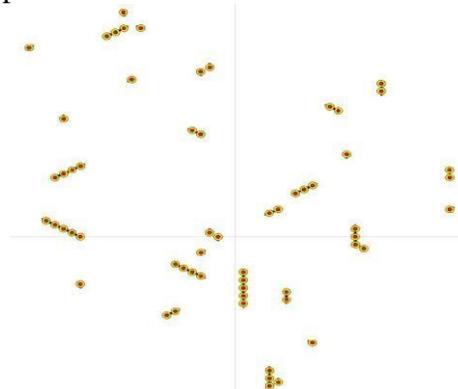


Fig-11: Strip Formation

3.TOPOLOGICAL FORAMTION

It is necessary to create a topology that will govern how the slave robots and the master robot will communicate as well as how the slave robots will communicate with one another. Mesh Topology is the name given to this kind of topology [29]. So, each robot may function as a separate node. The key benefit is that a common node is not necessary. Peer to peer communication allows any node to communicate with any other node.

A mesh topology's primary result is that data may be delivered concurrently, enabling connectivity even when there is traffic [29]. This architecture may be changed without causing any disruption to the neighbouring nodes. A backup parent is available even if a component fails [29]. Consequently, even if a specific robot is impacted, communication is unaffected.

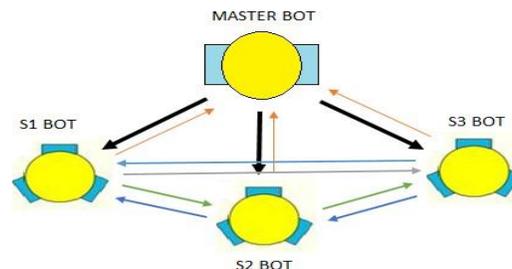


Fig-12: Topological Representation

4.OBJECT RECOGNITION

Open CV refers to the process to doing matrix calculation over an image. It is an image processing library created by Intel. It has diverged number of versions. It is available in various languages which include C, C++ and even the very recently introduced Python.

Object detection which is accomplished by Open CV has the technique called Surf. The premature version of surf is called shift [30]. They form the basics of image detection. The main drawback of SIFT is that it is very slow while processing the output. SURF has an upper hand

because it has a very high speed [32]. It approximates the LOG with the box filter.

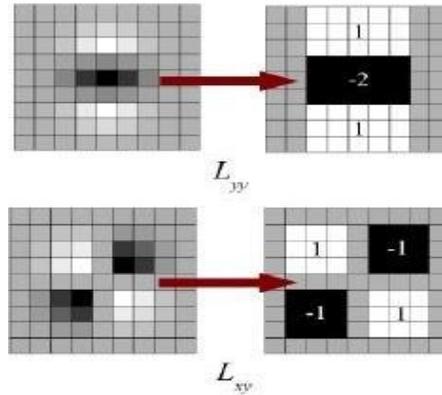


Fig-13: SURF based detection

Another important advancement is the use of Laplacian to find the match and mismatch concept. It distinguishes based on the colour [30] [33]. The sign of Laplacian distinguishes the bright blobs in a dark backgrounds and vice versa. It has lot of advantages than SIFT in the form that it is three times faster in performance [31]. SURF is good handling images with blurring and rotation.

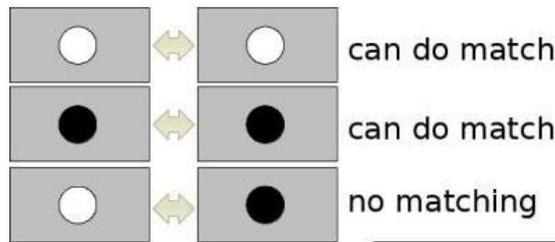


Fig-14: Match and Mismatch in SURF

5.IMPLEMENTATION OF THE ROBOT

The implementation part contains four robots wherein the robots are implemented with a Raspberry Pi2 and an Arduino. The master contains a Raspberry Pi2 which forms the brain of the robot. The slave contains Arduinos which form the core of the slave robots.

The means of communication is by ZigBee which forms the means of interaction. The ZigBee module is implemented in each and every robot and this forms the communication process.



Fig-15: Robot Model

The motor is fixed to the wheels and this enables the locomotion of the swarm. We know that the swarm concept generally works by the master a slave and this enables the type of locomotion.

6.ADVANTAGES OF THE PROPOSED WORK

The primary benefit of the suggested work is that it increases the speed of data [6] and instruction transmission and adjusts for data transfer more quickly [26]. The next thing is pattern formation i.e., in the previous models only patterns were formed but this model helps us to use the pattern formed and makes the sharing and pushing of loads possible.



Fig-16: Raspberry Pi2

7.CONCLUSION

So, to sum up, we can claim that our robotic approach reduces resource waste and, as a result, increases financial savings. In the end, it prolongs the robots' lives. This is possible because the robot is not subject to as much wear and tear.

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