**SWARM ROBOTICS**

**A MINI PROJECT REPORT**

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**CERTIFICATE**

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as a part of academic curriculum .

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Abstract

Sometimes it is impossible to complete a task by a single person or it becomes quite difficult to that person to complete the work. In such cases, there is need of a team or group of members that can collaboratively work and make the work of the person or the user very much easy.

Swarm intelligence (SI) is an artificial intelligence technique based around the study of collective behaviour in decentralized, self-organized systems. The concept of SWARM ROBOTICS is based on this basis of grouping of multiple robots or devices and perform the desired task .Swarm robotics is a new approach to the coordination of multi-robot systems which consist of large numbers of mostly simple physical robots .This approach emerged on the field of artificial swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behaviour occurs.

Swarm Robotics have varied applications in all fields like communication , military services , civil engineering , building construction etc.

**THE AIM OF OUR PROJECT IS**

To study controlling the bot so assemble themselves, avoid obstacle and synchronisation between bot.

CHAPTER 1 :-

**Introduction**

#### 1.1 Need of Swarm Concept

Sometimes it is impossible to complete a task by a single person or it becomes quite difficult for that person to complete the work. In such cases there is need of a team or group of members that can collaboratively work and make the work of the person or the user easy .The concept of the SWARM ROBOTICS is based on this basis of grouping of multiple robots or devices and performing the desired task.

#### 1.2 Swarm Robotics-The Concept

Swarm robotics is implementation of Swarm intelligence. Swarm Intelligence (SI) is an artificial intelligence technique based around the study of collective behaviour in decentralized, selforganized systems. Swarm robotics is a new approach to the coordination of multi-robot systems which consist of large numbers of mostly simple physical robots. It is supposed that a desired collective behaviour emerges from the interactions between the robots and interactions of robots with the environment. This approach emerged on the field of artificial Swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behaviour occurs. The main objective of Swarm robotics is to reduce the work load and increase the efficiency of the system.

#### 1.3 Swarm Robotics the Idea

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Figure 1.1: Swarm System



Figure 1.2: Swarm Robots performing task.

Swarming Robots Could Be the Servants of the Future. The authoritative ability over swarm robots could prove to be highly beneficial, ranging from military to medical. For military purposes, swarm robots could carry out tasks or missions that may be too dangerous for humans themselves to go on. In the medical field, the swarm robots could play a significant role in micro-medicine, in which they would be considered nanobots who would treat humans non-invasively.

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## CHAPTER 2

## **Literature survey**

The concept of Swarm Intelligence (SI) was first introduced by Gerardo Beni, Suzanne Hack- wood, and Jing Wang[8] when they were investigating the properties of simulated, self-organizing agents in the framework of cellular robotic systems.In Proceedings of the Seventh Annual Meet- ing of the Robotics Society of Japan, Tokyo, Japan.Eric Bonabeau, Marco Dorigo and Guy Theraulaz extended the restrictive context of this early work to include any attempt to design algorithms or distributed problem-solving devices inspired by the collective behavior of social insect colonies, such as ants, termites, bees, wasps, and other animal societies.Swarm Intelli- gence - From Natural to Artificial Systems. Eric Bonabeau, Marco Dorigo, and Guy Theraulaz. Oxford University Press.

They give the three major advantages of SI Robotic approach, since SI systems have the following properties.

1. Scalable: The control architecture of each robot is same, no matter the number of robots.

1. Flexible: The robots may be inserted or deleted to/from the environment, no requirement for any change in the task operation. 3) Robust: Not only due to unit redundancy but also through minimalist unit design.

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#### 2.1 Bio-Inspired Sensor Swarms

In [3]Joseph Fronczek and Nadipuram Prasad of New Mexico State University have identified the critical need for technologies for quickly locating and repairing pressure leaks in contained environments like the International Space Station. The location, isolation, and repair of atmo- spheric pressure leaks are one of the main emergencies on which the crew of the Space Station

is regularly trained. If the crew fails to address the pressure leak in the allotted time, they are instructed to abandon the station via the escape module. Such leaks can stem from a couple of sources. Errors can occur during the operation of the ISS Environmental Control and Life Support System (ELCSS - a network of valves and piping used to create a vacuum environment within the ISS for the purposes of scientific experiments). In addition, impacts from space de- bris are a threat to the atmospheric integrity of the Station. While failures in the ECLSS are frequently due to a failed component that are easily identified and small in nature, leaks oc- curring due to debris impact are often unpredictable. By using robotic sensor swarms that can quickly locate and repair pressure leaks, critical time can be provided for the crews to make permanent repairs.

Given the task of locating pressure leaks, two questions must be answered: Where is the source of depressurization in the system, and how extensive is the leak [3]? Currently, the crew must search the entire Space Station environment, a time consuming prospect at best. Sudden pressure leaks tend to cause disturbances in the regular airflow patterns inside the Station. Con- sequently, if this shift in airflow patterns can be detected quickly, all on-board air circulation systems can be secured and the new patterns caused by the leak can be isolated.

Researchers often turn to the natural world for inspiration for solving problems by novel methods. The common cockroach uses a small appendage covered with thousands of tiny hairs to detect disturbances in the surrounding air alerting it to possible threats. The cockroach in- stinctively runs in the direction of the wind source [3]. This behavior is referred to as a posi- tive taxis (directed movement towards a stimulus). Additionally, when the hive is threatened, bees have the ability to gather and exert defensive measures against the disturbing element [3]. Through communication, the bees contribute to the collective intelligence and enable fast re- sponse to the threat. Studies show that bees and other insects can locate food sources by sensing the odor of the food and use airflows to navigate toward the source. By mimicking these natural systems, a swarm of bee-like sensors that can detect disturbances in the surrounding atmosphere can be deployed in a loss of pressure event to locate the leak source, converge on that source, and affect repairs.

#### 2.2 Under-Sea Sensor Networks

Although the use of manned and unmanned systems in remote ocean exploration has yielded a wealth of knowledge about heretofore-unknown oceanic processes [4], the authors have identi- fied a lack of technologies to observe organisms and processes without disturbing them as they move with the natural motion of the oceans [4]. They propose this can be accomplished through the development of an autonomous, free-floating underwater device that can collaborate or in- teract with other such devices through an acoustic underwater network. [4,5]. They hope this will provide insights into the interactions between ocean currents and underwater ecosystems and our impact on them [4]. Current ocean sensing technologies use sensors that are either stationary or guided. However, the natural dynamics such as waves, tides, and currents play a major part in oceanic interactions [4]. Truly complete observation of these interactions cannot be achieved with sensors that are not subject to those dynamics.

Networked swarms of the proposed free-floating sensors could create three-dimensional maps coastal circulation. These maps could give researchers better understanding of various phenomena such as the spread of pollutants and the evolution of planktonic communities.

#### 2.3 Satellite Swarms

Owen Brown of Defense Advanced Research Projects Agency (DARPA) and Paul Eremenko of Booz Allen Hamilton have put forth a vision for what they term responsive space. They define this as the speed with which a space system can be made to react to various forms of uncertainty, ranging from geopolitical operational requirements to technical failures to fluctu- ations in the acquisition funding stream or more simply, the capability of space systems to respond rapidly to uncertainty [8]. As the authors view is that large, monolithic spacecraft are notoriously unresponsive, they are proposing the adoption of a fractionated architecture where a satellite is decomposed into a set of similar or dissimilar components linked wirelessly while in cluster orbits [8]. These homogenous or heterogeneous satellite swarms would work together to provide equivalent or, in most cases, expanded capabilities. DARPAs demonstrator system for this architecture is called F6 (Future, Fast, Flexible, Free-Flying, Fractionated Spacecraft united by Information eXchange) [8].

The reason for proposing this architecture is to produce a system that can mitigate, to a certain degree, the uncertainty that is present throughout the lifecycle of a space system [8].

In the authors view, this uncertainty can be decomposed into six sub-categories. Technical un- certainty involves risks from systems internal to the spacecraft). Environmental uncertainty is due to transients beyond the normally expected range of environmental conditions [8]. Launch uncertainty stems from risks associated with the spacecraft reaching orbit. Demand uncertainty due to changes in the need for services or capabilities provided by the spacecraft. Require- ments uncertainty involves risks related to uncertainty in requirements from the design phase and is caused by the interaction of unrelated requirements on separate systems on the space- craft. Funding Stream uncertainty stems from risk due to competing programs and expense prioritization [8].

The solution put forth in this paper involves the use of free-flying modules in cluster orbits sharing power and data through a wireless network. This creates a virtual satellite [8]. This would enable a swarm of satellites where a failed (or improved) component can be replaced without the need for complex rendezvous or docking. Imagine augmenting processor resources, power generation, or payload capabilities on the fly on a temporary or permanent basis simply by adding modules to the swarm. A satellite swarm could disperse to avoid other satellites or enemy munitions.

This fractionated architecture addresses each of the categories of uncertainty. Technical uncertainty is reducing by minimizing risk due to failed or outdated components with its ease of module replacement. Environmental risks due to space junk or other objects can be avoided by dispersing the swarm. Launch uncertainty is addressed by allowing modules to be placed into orbit by separate launch sources. Payload and swarm composition flexibility mitigate risks due to Demand and Requirements uncertainty. Finally, funding uncertainty is reduced using incremental development of the satellite swarm.

#### 2.4 Some Observations

Swarm robots were used to construct a 20 ft. high tower, composed of 15,000 bricks that weighed 1.1 lbs each, providing a window into the possible future of architecture and construc- tion.A job that would’ve taken humans several weeks to complete, the little guys completed it in a mere three days.The robots were controlled by computers with complex algorithms and motion sensors. They were able to detect and adapt to any natural disturbances as well, such as turbulence, and either adjust to the issues or abort the task completely.

This is a rather basic experiment, but one that shows the possibilities and prospects of swarm robotics.Researchers throughout Sheffield institutions created robots whose job was to simply push an object across the floor, from one side to another. They could also organize themselves by priority after being scattered in a room. They can do this by sensing if there is a robot in front of them, and if there is, turning immediately. If not, then the robot keeps moving around until it finds one.Dr. Roderich Gross, head of the Natural Robotics Lab, in the Department of Automatic Control and Systems Engineering at the University of Sheffield, says that swarm robots could be utilized in military search-and-rescue missions in areas unfit for humans, in micro-medicine while utilizing nanobots, and in industry to make it more efficient and safe.

”Swarming Robots Could Be the Servants of the Future.The authoritative ability over swarm robots could prove to be highly beneficial, ranging from military to medical. For mil- itary purposes, swarm robots could carry out tasks or missions that may be too dangerous for humans themselves to go on.In the medical field, the swarm robots could play a significant role in micro-medicine, in which they would be considered nanobots who would treat humans non-invasively. This miniature swarm of robots could deliver medicine to the body by traveling through ones veins.

Kent, Leo. ”Swarm Robots: The Droid Workforce of the Future.” Humans Invent.A single robot can detect obstacles in a room, since their knowledge is based on locality, upon gathering the information needed, it is shared with the rest of the swarm so that they are aware of where to go and where to avoid obstacles.Swarm robots can also be used to help out in disastrous situations, for instance after a recent natural disaster, the swarm could communicate with each other and humans by sharing what they observe[9]. A project of swarm robots called Symbrion (Symbiotic Evolutionary Robot Organisms) is currently being worked on to join the robots together as one. This could be beneficial for a natural disaster such as a flood, in which the swarm robots join together to make a raft. Though the malfunction rate of swarm robots is high, it is not much of a threat, since numbers are high, if one robot malfunctions it does not affect the rest.

CHAPTER 3

## **System Design**

3.1 **BLOCK diagram(EDIT)**

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###### 3.1.1 Motor Driving IC L293d

* Wide Supply-Voltage Range: 4.5 V to 36 V.

* This IC is typically used to drive the DC motors rated upto 12v.

* It consists of two H-bridges that can drive one dc motor each.

* It receives the control signals from the micro-controller and accordingly the motors are con- trolled.

###### 3.1.2 Regulator IC’s

(a) LM7805

* Input Voltage : upto 35 V

* Output Voltage :5 V

* This IC is used in order to provide constant 5v power supply to the micro-controller and Motor driver.

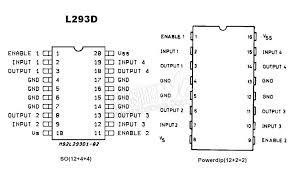


Figure 4.4: Motor Driver

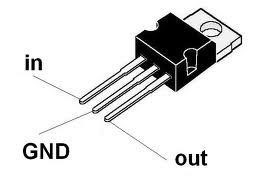


Figure 4.5: 5V Regulator

(b) LM1117.3.3

* Input Voltage (VIN to GND) : upto 15 V.

* Output Voltage is 3.3 V.

* This IC is mainly used for providing the power supply to the Zigbee.

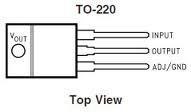


Figure 4.6: 3.3 V Regulator

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###### 3.1.3 Crystal Oscillator

* A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency.
* In our circuit we are using a 16MHz crystal.

* This crystal not only provides the proper frequency to the controller for its operation but also supports the boot loader program to program the micro-controller.

###### 3.1.4 Capacitors

* A capacitor (originally known as a condenser) is a passive two-terminal electrical component used to store energy electrostatically in an electric field.
* The nonconducting dielectric acts to increase the capacitor’s charge capacity. A dielectric can be glass, ceramic, plastic film, air, paper, mica, etc.
* Capacitors are widely used as parts of electrical circuits in many common electrical devices.

* Unlike a resistor, a capacitor does not dissipate energy. Instead, a capacitor stores energy in the form of an electrostatic field between its plates.
* In our project we have used capacitors for the following functions:

##### 3.1.5 Module (**EDIT PLZ**)

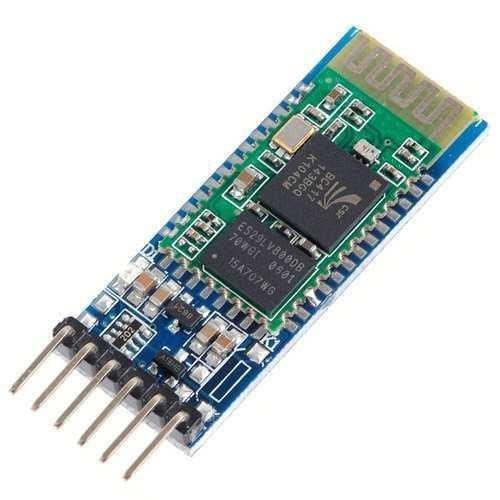
3.5.1 ultrasonic

3.5.2 iir

3.52. nrf

##### 3.1.6 Other Components

* REGULATOR IC7805 and IC1117 3.3 - For Power Supply.



**3.2 Hardware design**

##### 1. Wheel

*•* The Wheels are considered according to the size of the robot.

##### 2. Design of the chassis

* In our project MDF is used to made chassis.
* Size of the chassis considered is 13\*13 .

(EDIT DIAGRAM PLZ)

# 

# **3.3** Printed Circuit Board (PCB) Design

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# 

# **3.4 SOFTWARE DESIGN**

### \* Software tool

##### 3.4.1 Open source software

Open-source software (OSS) is computer software with its source code made available and li- censed with a license in which the copyright holder provides the rights to study, change and distribute the software to anyone and for any purpose. Open-source software is very often de- veloped in a public, collaborative manner. Open-source software is the most prominent example of open-source development and often compared to (technically defined) user-generated content or (legally defined) open-content movements.

##### 3.4.2 Arduino

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It’s an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer.

##### 3.4.3 Arduino Development Environment

The Arduino development environment contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware such as AtMega 2560 to upload programs and communicate with them.

##### **WHY ARDUINO ?**

The advantages that Arduino offers over other systems are:

* Inexpensive - Arduino boards are relatively inexpensive compared to other micro-controller platforms.
* Cross-platform - The Arduino software runs on Windows, Macintosh OSX, and Linux oper- ating systems. Most micro-controller systems are limited to Windows.
* Simple, clear programming environment - The Arduino programming environment is easy- to-use for beginners, yet flexible enough for advanced users to take advantage of as well.
* Open source and extensible software- The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it’s based.

Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

##### 3.4.4 Motor Control

* STEP1 :- M11,M12,M21,M22 are motor pins.

* STEP2 :- For Left motor

1. If M1 and M2 are low, Left motor stops.

1. If M2 is high and M1 is low, Left motor goes forward.

(iii)If M2 is low and M1 is high, Left motor goes reverse.

*•* STEP3 :- For Right motor

1. If M3 and M4 are low, Right motor stops.
2. If M4 is high and M3 is low, Right motor goes forward.

(iii)If M4 is low and M3 is high, Right motor goes reverse.

CHAPTER 4

**Working**

(EDIT)

## 

## CHAPTER 5

**PROJECT MAKING OF SYSTEM**

## Cost of the Project

CHAPTER 6

**EXPERIMENTATION AND RESULT**

## 

## 6.1 Future Scope

# **Swarming robots could be the servants of the future.**

Swarms of robots acting together to carry out jobs could provide new opportunities for humans to harness the power of machines.

Researchers in the Sheffield Centre for Robotics, jointly established by the University of Sheffield and Sheffield Hallam University, have been working to program a group of 40 robots, and say the ability to control robot swarms could prove hugely beneficial in a range of contexts, from military to medical.

The researchers have demonstrated that the swarm can carry out simple fetching and carrying tasks, by grouping around an object and working together to push it across a surface.

The robots can also group themselves together into a single cluster after being scattered across a room, and organize themselves by order of priority.

## 

## 6.2 Conclusion

After studying different research papers and scientific journals we found that our project Swarm robotics had many advantages over the other conventional robotics techniques. Firstly, the small size of the client robot helps us to carry the robots conveniently to any given location to perform work. Secondly, the android application which is developed makes the task of the user to assign work to the robots easy.

This concept has various applications in huge industries like Automobile Industry and Warehousing. At present, while performing a particular task as one robot is performing its work the rest of the robots are idle waiting for the first robot to complete its work which results in slow processing of the assigned task.Using the concept of ’Swarm Robotics’ less number of robots can complete the assigned task collectively in less amount of time which also in turn increases the efficiency and the output at same time reducing the cost.

The turn cost plays a vital role in the functioning of the client robot. Efficient use of the zigbee buffer must be done. Collision avoidance is the most important task that must be worked upon.

Swarm Robots, because of their extreme plasticity, can find interesting applications wher- ever it is required a high level of physical adaptation and a low level of human intervention or monitoring. Tasks which fall in this category might be space explorations of harsh and humanly dangerous environments, assembly of space modules, handling of dangerous materials, mining and even ’harvesting’ material or goods from a physically constrained location. Given such a multi-purpose nature, Swarm robots might also find further applications in future which are presently even unthinkable.

**APPENDIX**:

BILL

DATASHEET

PCB SCREEN

WORKING DOCUMENT

REFRENCES AND BIBLIOLOGY.