ISSN No:-2456-2165

# Swarm Robot Using Arduino

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**Abstract:- Swarm robotics is a way of organising huge num- bers of primarily straightforward physical robots in multi-robot systems. A desired collective behaviour is thought to originate from the interplay between the robot and how it interacts withits surroundings. This project provides applications, im- plementation information, and utilizing various technologies, meet hardware and design requirements. In the swarm robotics problem, cooperation swarm organisation, which emerges from the system itself, and the urge to solve problems are referred to assolution capability. Decentralization is achieved by allowing local contact between individual robots. communicating with Using the inexpensive nRF24L01 wireless transceiver module, which is made for very low power consumption, robots wireless power application Communication between two or more microcontroller platforms makes it possible to Our performance coordination. Weemploy two nRF24L01 modules, each of which contains VCC, CSN, and MOSI and IRQ pins are inexpensive and simple to interact with. One is associated with the transmitter, whereas another There are GND, CE, SCK, and MISO pins on the receiver. nRF24L01 transceiver is attached to a microcontroller. SPI communication protocol is used by the module (which uses master and slave concept).**

## I. INTRODUCTION

Some of the best characteristics of humans include inter- acting, comprehending, and then reacting to the environment. These traits are what define who we are as a species. Humans have always known that we are the most polite social creaturesthat have existed on this planet since it was created because we are designed from birth to live in a social society. Other species of this planet, such as a group of birds, fish, or bees, also exhibit social behaviour and interaction with one another in order to further a common objective. This is a trait thatall of these species share with humans. When birds migrate, it'scommon to see them in groups that are headed by the leader. Despite the fact that birds have no sense of shapes or figures, the lead member of their group directs the others, and everyone follows them. The group is also organised so that the older members are on the edges and the younger members, or the newborns, are in the middle.

The same traits are present in fire ants, which differ slightly from other kinds of ants in that they establish their colonies collectively and define their preys as a group. In other words, they are aware that they can do more when they work as a team. They were discovered to be capable of building sturdy structures if necessary, such as when needed to build a shortbridge to cross, in a recent study on the collective behaviour of these ants. Despite all of their limitations, these social animals and insects accomplish more thanks to their collectivebehaviour. Researchers have shown that members of these groups do not require sophisticated knowledge or represen- tation. Individuals in social insects, mammals, and birds arenot aware of the overall health of the colony. All of the agents share in the swarm's information, so that no one agent can complete their task independently of the rest of the swarm.

The ability to communicate between two or more microcon-troller platforms allow us to carry out interesting projects, suchas automatic control of home appliances, in the fieldof robotics, and game controllers, to name a few. This com- munication can be achieved wireless or over wires. Among other technologies, wireless communication can be conducted utilising WiFi, Bluetooth, RF, GSM/GPRS and LoRaWAN.

## II. LITERATURE SURVEY

### *A. Swarm Robot coordination*

Mondada and Pettinaro introduced the idea of a group of autonomous mobile robots known as S-BOTs, or "swarm-bots." S-BOTs may physically connect to one another becauseto a unique assembling ability. SWARM-BOT, which consistsof 10 to 30 S-BOTs networked together, is far more durable than a single bot and is capable of handling challenging jobs even in challenging environmental circumstances. A K- neighbor restriction was suggested by Poduri and Sukhatme tomaximise the area coverage of a mobile sensor network duringself-deployment. The main goal of the strategy is to coordinate the placement of mobile sensors using two forces: Fcover, which makes nodes reject one another in order to extend their coverage, and Fdegree, which makes nodes attract one anotherin order to have more neighbours. When the two forces are equivalent, an anode stabilises its position.

### *B. Self Assembly*

Jhang Jian Ju, et al., envisioned in order to increase the effectiveness of the swarm robot's self-assembly process and enable dynamic local navigation of random movement in ac- cordance with the distance between the seed robot and dockingrobot, Jhang Jian Ju, et al. devised a self-assembly distributed control method. Additionally, this paper investigated the time efficiency of morphology using line, arrow, T, and star shapes.

ISSN No:-2456-2165

This method boosts the effectiveness of self-assembly. Harish Verlekar, et al.,developed a strategy based on the imitation of the division of labour in bees and the chain creation behaviourof ants was proposed by Harish Verlekar, et al. Swarm robots, which are made to resemble ants, create chains while foraging and employ the division of labour to reduce energy waste.A computer vision-based method is combined with magnetic sensor readings for localization and navigation. Swarm robot technology provides parallelism, robustness, and scalability.

*C. QoS support in wireless ad hoc networks*

Xue and Ganz, proposed a QoS routing protocol with admission control enforced to enable quality of service inmulti-hop ad hoc networks is presented as Ad hoc QoS on-demand routing (AQOR). ad hoc networks By taking into account the competition for fall nodes inside the carrier sensing area, Yang and Kravets suggested to enforce admission control.To get nearby information, nevertheless, requires highpower usage. Additionally, when estimating bandwidth, they did not take link rate and traffic into account. It was suggested by Chen and Heinzelman to determine available bandwidth by local estimation and message exchange among nearby nodes. They then used the Li and Blake result to adjust for intra-flowinterference. However, even with multi-rate enabled, this resultis not precise enough. Due to transmission ata high data rate while using a multi-rate MAC, the link'sdistance maybe significantly reduced, increasing intra-flow interference. When making an admission control decision, Li and Prabhakaran proposed route available bandwidth (RAB) and route reliability (RR) metrics to take into account both mobility, multi-rate feature, and multi-link interference.

*D. Obstacle Avoidance*

Syed IrfanAli Meerza, et al. offered a technique to guidea mobile robot toward a target and navigate across a space without knowing anything about it beforehand. In order to design a robot's course, this work introduces the particle swarmoptimization (PSO) with dynamic obstacle avoidance technique. In the Processing IDE, we simulate and test the various contexts for our proposed solutions. This system's feature is its computational simplicity, and it also uses less memory.

*E. Behaviour*

Harish Verlekar, et al developed an approach based on the imitation of the division of labour in bees and the chain formingbehaviour of ants. Swarm robots, which are madeto resemble ants, create chains while foraging and employ the division of labour to reduce energy waste. A computer vision-based method is combined with magnetic sensor readings for localization and navigation. We achieve parallelism, robustness, and scalability by using swarm robots.

## III. PROPOSED SYSTEM

In this paper, We suggest a brand-new design known as robotswarm communication networks. Robots are clustered into one or more teams or swarms in this architecture, and eachswarm can be monitored and managed by some central serversusing a wireless mesh backbone and the Internet. A self- organizing mobile ad hoc network develops within each swarm such that all robots remain connected to one another despite movement. Mobile users can also keep an eye on swarms using portable gadgets like computers and PDAs, and they canrespond right away based on the data they gather. Location, topology, and other relevant information might be included in the monitoring module. It is also suggested that images and videos be transmitted from robots to servers or mobile usersso that suitable decisions can be made. From the perspectives of both software system development and protocol design, the suggested architecture presents new issues.

On the other hand, it's crucial for the system to be implemented how to create a software system to effectively monitor, coordinate, and operate robot swarms. Additionally, the wireless mesh network backbone must offer quality of service (QoS) for robots streaming video.

## IV. BLOCK DIAGRAM

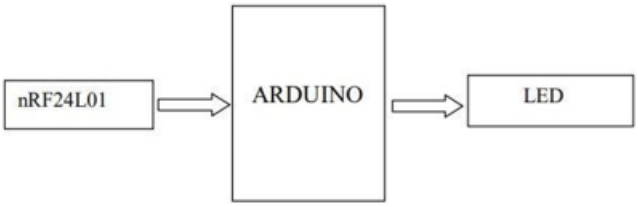


Fig 1

## V. HARDWARE AND SOFTWARE

*A. ARDUINO UNO (ATMEGA 328)*

The Arduino UNO microcontroller was used in our project. The ATmega328P-based Uno is a microcontroller board. It has 14 digital input/output pins, 6 analogue inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. It comes with everything you need to support the microcontroller; simply connect it to a computervia USB or power it via an AC-to-DC adapter or battery toget started. You can tinker with your UNO without fear of doing something incorrectly; in the worst-case scenario, you can replace the chip for a few dollars and restart.


*Fig 2:- Arduino UNO (Atmega 328)*

In this paper, we are using this module to demonstrate how wireless communication between Arduino modules can be achieved using the lowcost RF (radio frequency) based nRF24L01+ transceiver module The first benefit of these modules is their low price. One can be purchased for less than 2 dollars. Using the SPI protocol, nRF24L01+ modules can be easily interfaced to a wide range of microcontrollers including MCU, ARM, PIC, AVR, and STM32. When compared tolower operating frequencies, 2.4GHz allows for higher bit rateusages.The Nrf24L01+ module transmits data using GFSK modulation, so the data transfer rate can be 250kbps, 1Mbps, or2Mbps. The operating voltage for these modules ranges from 1.9 to 3.6V, but the logic pins are 5V tolerant, so they canbe easily connected to any 5V logic microcontroller without the use of a logic level converter. During transmission, the power consumption is approximately 12mA, which is even lower thana single LED therefore making this the best choice for wirelessdevice in low power applications. gallium phosphide, and gallium arsenide (GaAsP) (AlGaAs). As a result of the electroluminescence phenomena, LEDs

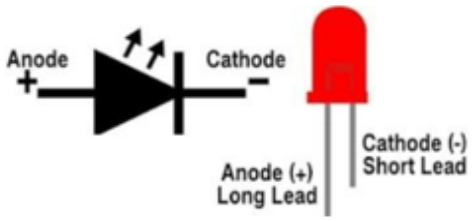


Fig 3:- LED

Produce visible radiation when a low voltage direct current is applied to a suitably doped crystal containing a p-n junction. Usually, elements from columns III and V of the periodic tableare used for the doping. When the p-n junction is activated by a forward biassed current (IF), it produces light with a wavelength determined by the active region.

*C. Push Button*

It is a small switch that completes an electric circuit when you press on it. When its on a small metal spring inside makescontact with two wires , allowing electricity to flow.

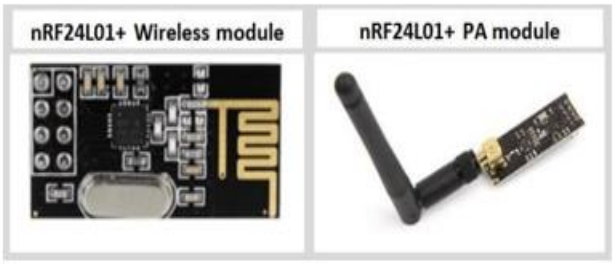


*Fig 4:- Nrf24l01 Module*

*D. Jumper Wires*

*Fig 5:- Push Button*

1.9 to 3.6V is the range of operating module of this module and the logical pins being 5V tolerant. So, Logic level conversion is not required to connect it to any 5V logic microcontroller. The module upholds programmable result power viz. 0 dBm, - 6 dBm, - 12 dBm or - 18 dBm and consumes unimaginably around 12 mA during transmission at 0 dBm, which is even lower than an LED. What's more, the best part is that it consumes 26 µA in backup mode and 900 nAat shut down mode. That is the reason they're the go-to remotegadget for low-power application. The SPI transport utilizes an idea of a Master and Slave, in most normal applications our Arduino is the Master and the nRF24L01+ handset moduleis the Slave. Not at all like the I2C transport the quantity of slaves on the SPI transport is restricted, on the Arduino Uno you can utilize a limit of two SPI slaves for example two nRF24L01+ handset module.

*B. LED*

A specific kind of PN junction diode is a light-emitting diode(LED). The light-emitting diode is built of a unique kindof semiconductor and is specifically doped. When placed in the "on" position, this diode may produce forward-biased con- dition. Indium gallium nitride with aluminium indium gallium phosphide (AlInGaP) (InGaN) are two of the semiconductors for LED technologies that are most frequently employed. employed older LED technology. Aluminum gallium arsenide, Jumper wires are just wires that have connector pins at eachend, permitting them to be utilized to interface two points to one another without soldering. Jumper wires are commonly utilized with breadboards and other prototyping devices to make it simple to change a circuit on a case by case basis. Genuinely straightforward. It doesn't get considerably more essential than jumper wires, as a matter of fact. Howeverjumper wires arrive in various varieties, the tones don't really make a difference. This implies that a red jumper wire is in fact equivalent to a dark one. However, the varieties can be utilizedfor your potential benefit to separate between sorts of associations, like ground or power. Jumper wires commonly come in three variants: male-to-male, male-to-female and femaleto-female. The

ISSN No:-2456-2165

distinction between each is in the end point of the wire. Male closures have a pin distending and can plug into things, while female finishes don't and are utilized to plug things into. Male-to-male jumper wires are the most widely recognized and what you probably will utilize most frequently. While interfacing two ports on a breadboard, a male-to-male wire you'll require.

*E. Arduino Software Ide*

Since Arduino is an open-source project, hobbyists can readily utilise the potent ATMega chips. The software used to develop code and upload it to the ATMega chip is called the Arduino IDE. The chip then runs the code in question.

*Fig 6:- Jumper Wires*

The majority of 3D printer electronics are compatible with Ar-duino; they make use of the ATMega chip and let users uploadtheir own code using Arduino. Megatronics, Minitronics, and RAMPS are all included in this. You need software firmware that converts machine instructions into actual motions before you can use the electronics. Several variations are available, including Marlin, Sprinter, and Repeater.

You must first use File Open to open the files in order to upload a firmware. From the directory containing the firmware, choose the.ino file. Arduino will launch numerous tabs containing files. The appropriate electronics board must then be chosen. Find the Board item under the Tools menu. Megatronics, Minitronics, Arduino Mega 2560 (RAMPS with Mega 2560), and Arduino Mega 1280 are a few sub itemsthat this item should have (RAMPS with mega1280). Choosea board for your electronics. The serial port that the electronicsare linked to must also be chosen. Find the Serial port item under the Tools menu. If the board is connected and the driversare correctly loaded, this should include at least one item. If there are additional items, you really want to figureout which is the right one by turning off the board and checking which port was eliminated. Whenever you have set the board and sequential port, you can transfer the firmware by squeezing File → Upload. Arduino will attempt to order the firmware, assuming any mistakes happen the cycle will stop and you should fix the blunders prior to attempting once more. When accumulation is finished, the genuine transfer willbegin. This might require a moment for a larges ketch. Arduinoprogramming is the instrument to consume the hex document on the chip. It gives the plat structure to circuit format, circuit plan and real time execution.

## VI. DESIGN AND IMPLEMENTATION

*A. Hardware Implementation*

First of all, plug all thirty female-male jumper pins to the Arduino. Then, connect the positive (+) pin of the sensor and 3.3v (+5 volts) of your Arduino to VCC on breadboard, the ground (-) pin of your sensor and GND (-) of your Arduino to GND on breadboard. Enable CE pin of the sensor to determinewhether module is transmitting or receiving data. MOSI is master out slave in which is the SPI input to the module. CSN is chip select not is an active low pin but is normally kept highso that when it turns low the module begins listening to itsSPI port for data processing SCK. Serial clock for accepting clock pulses from the SPI bus master. MISO is master in slaveout in which SPI output to the module. IRQ is an interrupt pin but in most of the projects with Arduino not used. For SCK pin 13, MISO pin 12, MOSI pin 11 is used. Once all of the connections have been done, you are ready to go onto the software side of this project.

*B. Software Implementation Programming ARDUINO*

Once Arduino IDE is installed on the computer, con-nect the board with computer using USB cable. Now openthe 46rduino IDE and choose the correct board by se- lecting Tools¿Boards¿Arduino/Genuino Uno, and choose the correct Port by selecting Tools¿Port. Arduino Uno is pro-grammed using Arduino programming language based on Wiring. To getit started with Arduino Uno board and blink the built-in LED, load the example code by selecting Files¿ Examples¿ Basics¿ Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given onthe top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking.

*1) Arduino – Program Structure:*

We will study in depth; the Arduino program structure and we will learn morenew terminologies used in the Arduino world. It is free to get the Arduino software. The LGPL governs the licencing of C/C++ microcontroller libraries, while the GPL governs the source code for the Java environment. Sketch: The Arduino programme "sketch" is the first example of new nomenclature. Structure The three basic components ofan Arduino programme are Structure, Values (variables and constants), and Functions. The Arduino software programme will be explained in detail in this tutorial, along with howto develop a programme without making any syntax or com- pilation mistakes. Starting with the Structure, please. There are two primary purposes of software structure: Configure() function () function loop PURPOSE: A sketch begins by calling the setup () function. Use it to start using libraries, pin modes, initialise the variables, etc. The setup process will only be executed once.

INPUT:
OUTPUT:
RETURN:

ISSN No:-2456-2165

PURPOSE: Following the creation of a setup () method that initialises and sets the initial settings, the loop() function performs exactly what its name implies: it loops sequentially, allowing your programme to evolve and respond. You can useit to directly control an Arduino board.

INPUT:
OUTPUT:
RETURN:

Then make an RF24 object with two arguments, using the CE and CSN pins as arguments. Pins 8 and 9 are being used in this instance, respectively. For the address or pipe that the two modules use to communicate, create a byte array. Any five-letter string will do. We use the radio.begin() procedure to initialise the radio object for Transmitter. The radio is on. The WritingPipe() function is used to set the address of the transmitter, whereas radio is used to set the address of the receiver. use openReadingPipe(). Since the modules are close to one another, we set the Power Amplifier level to minimal using the radio.setPALevel() function. The module is configured as transmitter by the radio.stopListening() function, and the radio.start Module is set as recipient via listening(). radio. write () function is used to communicate with the recipient. Themessage that we wish to transmit and the number of bytesin that message make up the first and second arguments for this function, respectively. The variable that stores the data to be transferred is denoted by the symbol "," and sizeof() returns allof the variable's bytes. You can send up to 32 bytes at a time using this technique. Because the nRF24L01+ can only handle a single packet of such size. The radio.available() method for the receiver is used to determine whether data is available for reception. If there is data in the buffer, this function returns TRUE. The function radio.read() reads and stores information into a variable such as The state of LEDs is then managed by fbuttonState. How to Increase RF Signal Power. Any wireless communication system's primary concern is communication range, which also determines the type of device to utilise for a given application. We can consider the following fixes to increase the nRF24L01+ module's broadcast range.

1. Utilizing bypass capacitors between the modules' GND and 3.3V that have a capacitance of roughly 4.7 to 47 F will help reduce power supply noise and improve the modules' operating voltage stability. An nRF24L01 adaptor module canbe used to accomplish this with ease.
2. Altering your channel frequency to cut down on interference from WiFi and other nearby wireless network signal sources. The nRF24L01+ module should typically operate between 2.40 and 2.524GHz. Using the radio.setChannel()function in the code, the frequency can be changed. For instance, the modules will speak at 2.421 GHz if we useradio.setChannel(21).
3. Significantly reducing the data transfer rate improves the range. The radio is used to set the data rate in the code.the setDataRate() method. The slowest speed available—250 kbps—is denoted by the argument RF24-250KBPS, and itprovides the widest range of data transfer. RF24-1MBPS standsfor 1 Mbps, while RF24-2MBPS stands for 2 Mbps, providinga faster transfer speed but with a shorter range.

## VII. RESULTS

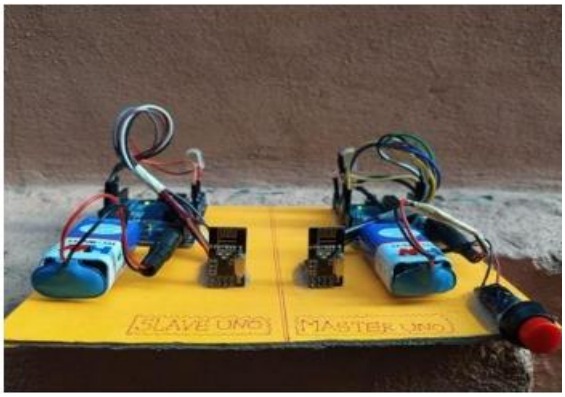


Fig 7

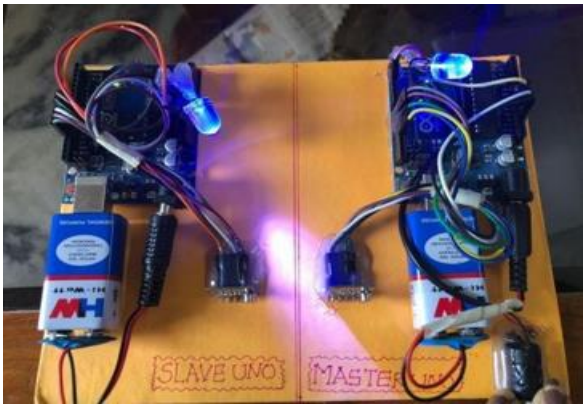


Fig 8

## VIII. CONCLUSION

We demonstrated a straightforward swarm robot controller utilising an Arduino UNO and nRF24L01 transceiver module. In order to use Arduino in a swarm robotics application, an experiment was conducted. Led is used to observe the master-slave method algorithm for multirobot communication. Here, one robot instructs other robots to perform a specific task; anytime we press a button, two LEDs light displays the predicted outcome and coordinates.

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