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SWARM ROBOTICS FOR MINE DETECTION

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Abstract: Thousands of landmines remain buried beneath the earth's surface across the world, posing a hazard to human lives and the economies of various countries. Because the detection rate must be reliable, human-based mine detection has become a global concern. It causes mistakes in this case, and the precision level is not up to par. In this project, we look into detecting mines while exploring an unfamiliar terrain with a team of swarm robots. The objective is to reduce overall exploration time whiledetecting mines in a terrain. To assist robots in covering the total area in the shortest amount of time, stigmergy, an indirect communication system is utilized. As a result, the robot may concurrently examine different areas of itssurroundings. A technique for modelling and designing three rover-like bots that function under Swarm Intelligence is being developed as a part of its project. It is robot-assisted mine detection method, which is safer, more-accurate and faster than the manual method.

Keywords **-Swarm Robots, Mine Detection, Swarm Intelligence.**

I. INTRODUCTION

Swarm Intelligence have piqued the interests of researchers working on collective robotics, optimization algorithms etc. Swarm robots are a group of rover-like bots that work together to complete a job using swarm intelligence algorithm. It is made up of numerous bots that are connected and communicate in a decentralized manner to complete the tasks. This swarm-enabling technology is a mix of a hardware and software that enables adaptable and responsive swarming across a wide range of multi-robot systems. This is accomplished by equipping each agent with extra interface hardware made of low-cost, off-the shelf components and general-purpose software library.

Most multi-robot systems only have enough processing power to read data from the robot's sensors and deliver it to a central unit. The primary needs for a swarm robotic system which will be the improved co-ordination among individuals who must interact with their surroundings, the second one is the individual robots must be homogenous, or nearly so at least in terms of interactions, and the third one will be they must be simple in terms of their particular capabilities concerning the task, not in terms of the robot's hardware and software capability. The perspective to use swarm robots can be seen in many applications.

The military performs life-threatening operations and missions, and with all the advancements taking place, the incorporation of these technologies is allowing them to carry out the same jobs more confidently because the stakes are fundamentally lower when the human soldiers are not placed in risk. The fact that soldiers are people with feelings, concerns, and battlefield trauma from surviving the extreme risk of a combat situation, which can transform a person's life and ruin it, is one defence for this. It makes sense to use robots at all times if there is a way to protect a soldier from all of that. There are many instances of soldiers who are unable to return to what is regarded as "normal" because the stress of a situation they encountered during the war makes it impossible for them to move on. Another is that some soldiers perish right away. However, if a robot is destroyed in place of a human soldier in the course of a military mission to identify landmines, it is entirely justified. In reality, the entire point of technology is to address the major problems that modern society is confronted with, and one of the primary worries for any country is its national security. Military technology has advanced significantly. From this we are implementing a swarm of robots without any human intervention.

They can avoid human intervention in some high-risk environments. Such as firefighting, landmine detection, or finding survivors after an earthquake. For communication part a mesh network will be formed without empowering master slave technique, instead of that we are implementing distinct communication between the bots in which all work on their own without any master command.

II. METHODOLOGY

2.1 Metal Detection and Motor Driver Section

For detecting mines or any dangerous metal objects by emitting electromagnetic waves using the search coil (Range -1cm to 10cm). The detector's search coil receives the retransmitted field and alerts the user by producing a target response. Mine Lab metal detectors are capable of discriminating between different target types and can be set to ignore unwanted targets. The operation of metal detectors is based on electromagnetic induction principles. One or more inductor coils are employed in metal detectors to interact with metallic materials on the ground. A pulsed current is given to the coil, which creates the blue magnetic field. When the coil's magnetic field passes through metal, such as the coin in this example, it causes electric currents (called eddy currents) to flow through it. The eddy currents produce their own magnetic field, which generates an opposing current in the coil, which induces a signal indicating the presence of metal.

The Motor drivers serve as a connection between motors and control circuits. The controller circuit operates on low current signals, but the motor requires a large amount of current. The purpose of motor drivers is to convert a low-current control signal into a higher-current signal capable of driving a motor.

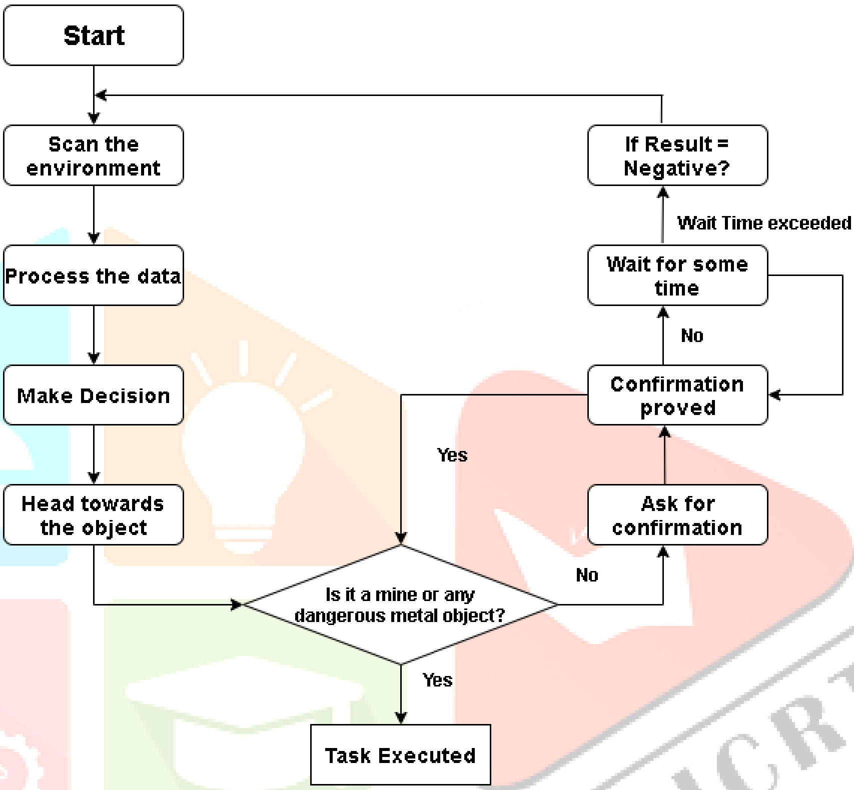

Figure 2.1 – Flowchart of Working of Swarm Robots in Mine Detection

From the above figure 4.8, the working is that the input command will be given from the PC to the ESP8266 NodeMCU module which acts as both router and receiver. From here the bots will communicate with each other with Wi-Fi communication. ESP8266 NodeMCU only senses the signals from each and every sensor and processes them also there will be a Motor Driver which acts as a controller to the motors in which the microprocessor guides the motor driver for the movement of the bots. From here the processed signals will be sent to the user and from the processed signals we can determine if the mine is present or not. If there is a mine in the area. It will notify the user and other bots that a mine has been discovered. and other bots will be given instructions to check whether or not the mine is there. The bot will tell the user whether the confirmation is correct if it is verified. The user will receive the information via the communication module.

2.3 Positioning System section

For displaying the complete coordinates of the location in which the bots are deployed. GPS works through a technique called trilateration. Used to calculate location, velocity, and elevation, trilateration collects signals from satellites to output location information. It is often mistaken for triangulation, which is used to measure angles, not distances.

The GPS receiver has to know the time extremely precisely in order to determine the time it took for the GPS signals to arrive. The GPS satellites contain atomic clocks that preserve extremely accurate time, but an atomic clock cannot be installed in a GPS receiver. However, by using the signal from a fourth satellite, the GPS receiver can solve an equation that allows it to calculate the precise time without the use of an atomic clock. You can still acquire your location if your GPS receiver only receives signals from three satellites, but it will be less precise. As previously stated, the GPS receiver requires four satellites to calculate your 3-dimensional position.

III. RESULTS AND DISCUSSION

3.1 Working Model

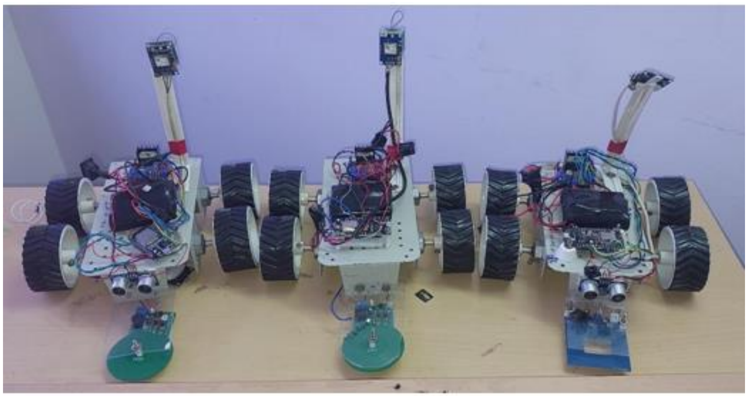

Figure 3.1 – Working model of Swarm Robots

From the above figure 3.1 , The working can be explained as the web server will initially send the instructions for the bot to carry out the duties. For this, we have built a webpage specifically to offer guidance.

3.2 Path Programming

The robot car automatically stores the sequence in its memory the first time we drive it using commands for the wifi programme along the specified path. The code uses a "for loop" to save the sequence, and each instruction is written in hexadecimal, with the hexadecimal values being stored in an array in a linear manner. We have now allocated path1 to the code and the programme in order to repeat this stored sequence. And before you can store a new sequence, you must first delete the one that is already there by using the browser's or an application's command button.Finally, the function button is utilised to permanently store the current sequence to EEPROM. and the path1 button is used to replay it.

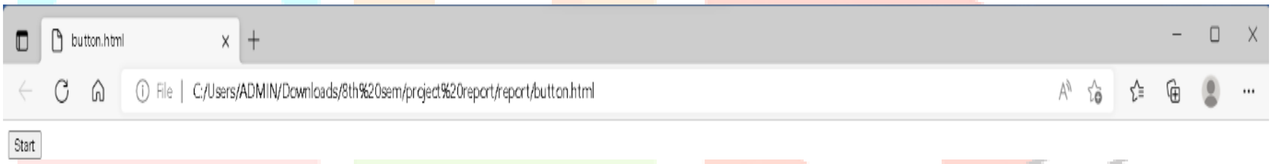

Figure 3.2 – Snapshot of the website

From the above figure 3.2, the pictorial representation of the website we made. Where in which we have used HTML for the overall design of the website. When you press the start button the HTTP request will be sent from the web server which is connected to the web server. From there the microcontroller will be connected to the web server. As the website's in HTTP request acts as a sender where the microcontroller acts as a receiver. The instruction will be given and the microcontroller will receive the instructions and transmits to the other bots which is also integrated with the microcontrollers. The microcontrollers are connected to the mesh network where it works under the principle of a communication hub where the instruction transmitted will send the signals to all the microcontrollers rather than one by one.

3.3 GPS Results

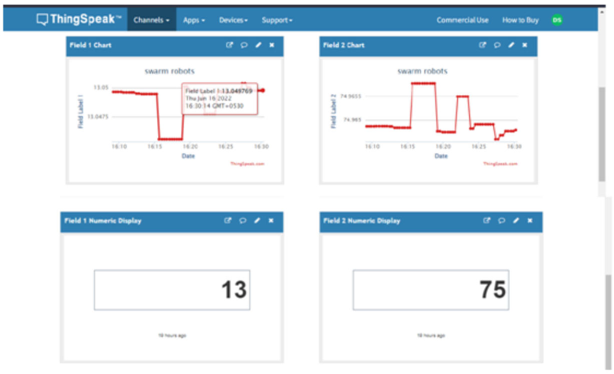

Figure 3.3 – Test Graph 1

From the above figures 3.3 , we have tested the bots in the location while planting the metal in the direction of the path in which the bots move. As soon as the metal gets detected it sends the distress signal to the NodeMCU where there will be an interrupt, that interrupt signal will be sent to the GPS Module. Then the GPS Module sends the co-ordinates through a radio signal . The software we used to display the GPS co-ordinates is the ThingSpeak, where it displays the latitude and the longitude and the location co-ordinates will be displayed as a graph shown above

Figure 3.4 – Test co-ordinates


28/06/2022, 14:34 https://thingspeak.com/channels/1769098/field/1.json

{"channel":{"id":1769098,"name":"swarm robots","description":"mine detection","latitude":"0.0","longitude":"0.0","field1":"Field Label 1","field2":"Field Label 2","field3":"Field Label 3","created_at":"2022-06-15T06:09:55Z","updated_at":"2022-06-17T08:28:05Z","last_entry_id":27},"feeds":[{"created_at":"2022-06-17T12:12:34Z","entry_id":1,"field1":"13.049097"},{"created_at":"2022-06-17T12:12:55Z","entry_id":2,"field1":"13.049097"},{"created_at":"2022-06-17T12:13:17Z","entry_id":3,"field1":"13.049097"},{"created_at":"2022-06-17T12:13:38Z","entry_id":4,"field1":"13.049097"},{"created_at":"2022-06-17T12:14:00Z","entry_id":5,"field1":"13.049233"},{"created_at":"2022-06-17T12:14:21Z","entry_id":6,"field1":"13.049233"},{"created_at":"2022-06-17T12:14:42Z","entry_id":7,"field1":"13.049233"},{"created_at":"2022-06-17T12:15:03Z","entry_id":8,"field1":"13.049233"},{"created_at":"2022-06-17T12:15:24Z","entry_id":9,"field1":"13.049061"},{"created_at":"2022-06-17T12:15:46Z","entry_id":10,"field1":"13.049061"},{"created_at":"2022-06-17T12:16:07Z","entry_id":11,"field1":"13.049061"},{"created_at":"2022-06-17T12:16:28Z","entry_id":12,"field1":"13.049061"},{"created_at":"2022-06-17T12:16:50Z","entry_id":13,"field1":"13.049226"},{"created_at":"2022-06-17T12:17:11Z","entry_id":14,"field1":"13.049226"},{"created_at":"2022-06-17T12:17:32Z","entry_id":15,"field1":"13.049226"},{"created_at":"2022-06-17T12:17:54Z","entry_id":16,"field1":"13.049311"},{"created_at":"2022-06-17T12:18:15Z","entry_id":17,"field1":"13.049311"},{"created_at":"2022-06-17T12:18:37Z","entry_id":18,"field1":"13.049344"},{"created_at":"2022-06-17T12:18:58Z","entry_id":19,"field1":"13.049344"},{"created_at":"2022-06-17T12:19:20Z","entry_id":20,"field1":"13.049298"},{"created_at":"2022-06-17T12:19:41Z","entry_id":21,"field1":"13.049298"},{"created_at":"2022-06-17T12:20:02Z","entry_id":22,"field1":"13.049298"},{"created_at":"2022-06-17T12:20:24Z","entry_id":23,"field1":"13.049287"},{"created_at":"2022-06-17T12:20:45Z","entry_id":24,"field1":"13.049287"},{"created_at":"2022-06-17T12:21:06Z","entry_id":25,"field1":"13.049287"},{"created_at":"2022-06-17T12:21:29Z","entry_id":26,"field1":"13.049287"},{"created_at":"2022-06-17T12:21:50Z","entry_id":27,"field1":"13.049276"}]}

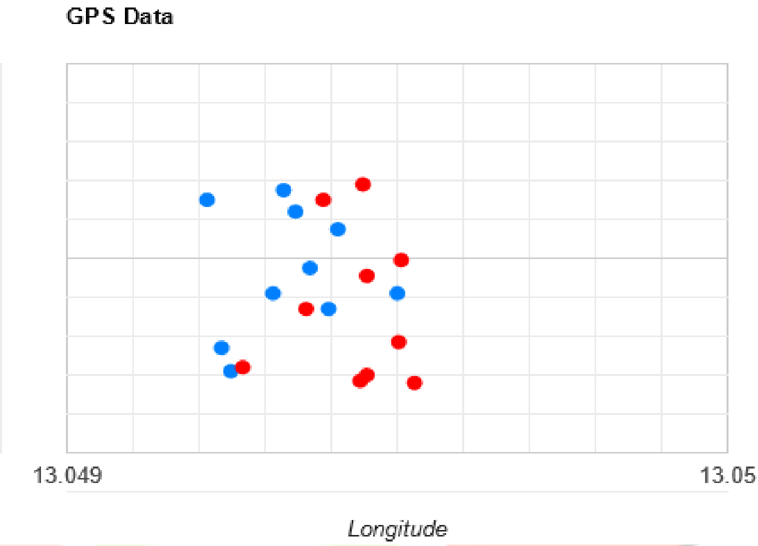

Figure 3.5 – Test graph 3

In this test, the co-ordinates from the above figures 3.4 are made to display in the form of a scatter plot graph in figures 3.5, where both the latitude and longitude are displayed as a scatter markings. The all co-ordinate readings corresponds to the latitude and the longitude of the landmine located. we have tested the bots in the location while planting the metal in the direction of the path in which the bots move. As soon as the metal gets detected it sends the distress signal to the NodeMCU where there will be an interrupt, that interrupt signal will be sent to the GPS Module. Then the GPS Module sends the co-ordinates through a radio signal . The software we used to display the GPS co-ordinates is the ThingSpeak, where it displays the latitude and the longitude and the location co-ordinates will be displayed as a scatter plot as shown above

IV. CONCLUSION

To conclude this could be a handy device for the people who live in areas which are more prone to landmine attacks. Swarm robotics is very much useful than the single operating bots. Even now, the procedures used to detect mines are old and ineffective. Robots could be seen as a viable alternative to the current methods, which mostly rely on humans to complete the task. The use of robots to identify mines There are certain areas where the present work could be improved on. The time required for completing the detection of the mines in the region, can be further reduced using this method

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