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WORD COUNT	5568	TIME SUBMITTED	30-MAY-2022 12:12PM
		PAPER ID	86650314

Comparative Study of Identification of Critical Factors for failure of Superheated Boiler Tubes in Thermal Power plants And Stigmergic And Flocking Strategies to Enhance Target Searching Capability of Swarm Drones.

Capstone Project-II Report submitted in Partial fulfillment for the award of the

Degree of

BACHELOR OF TECHNOLOGY

Submitted by

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IN

MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL ENGINEERING

Under the Supervision of

Mr. Manoj shukla

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

May - 2022

GALGOTIAS UNIVERSITY

SCHOOL OF MECHANICAL ENGINEERING

CERTIFICATE

Certified that this project report **"Identification of Critical Factors for failure of superheated boiler tubes in Thermal Power plants"** the bonafide work of SHOMAK KHAN(19021012107) and KAUSHAL KUMAR SINGH(19021012105)" who carried out the project work under my supervision.

SIGNATURE OF DEAN

SIGNATURE OF SUPERVISOR

APPROVAL SHEET

This thesis/dissertation/project report entitled titled **Identification of Critical Factors for failure of superheated boiler tubes in Thermal Power plants** by **Kaushal kumar singh (19021012105) Shomak khan (19021012107)** is approved for the degree of bachelor of technology in mechanical engineering.

Examiners

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Statement of Project Report Preparation

1. Project report title: **"Identification of Critical Factors for failure of superheated boiler tubes in Thermal Power plants".**
2. Degree for which the report is submitted: BACHELOR DEGREE OF TECHNOLOGY.
3. Project Supervisor was referred to for preparing the report.
4. Specifications regarding thesis format have been closely followed.
5. The contents of the thesis have been organized based on the guidelines.
6. The report has been prepared without resorting to plagiarism.
7. All sources used have been cited appropriately.
8. The report has not been submitted elsewhere for degree.

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Name- SHOMAK KHAN

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Statement of Project Report Preparation

1) Project report title: **"Stigmergic And Flocking Strategies to Enhance Target Searching Capability of Swarm Drones".**

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19021012105

ACKNOWLEDGEMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

I am highly indebted to **Dr. P.K.S. NAIN (DEAN S.O.M.E., G.U.)** & **PROFESSOR PRAMOD KUMAR (S.O.M.E., G.U.)** for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

I would like to express my gratitude towards member of **GALGOTIAS UNIVERSITY** for their kind co-operation and encouragement which help me in completion of this project.

My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

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ABSTRACT

Identification of Critical Factors for failure of superheated boiler tubes in Thermal Power plants

The failure of boiler tube is one of the important causes of electricity Outrages at coal fired thermal power plant. With ever growing call for strength, it's far very essential for the power plant to generate electricity without electricity outrages. This study focuses on motive & impact evaluation of boiler tube disasters. A past 10 years data of disasters has been referred for thermal power plant in state of Maharashtra and Out of overall 144 disasters, 43 disasters are found in Economizer zone. Feed water is transported to boiler drum through Economizer and it is the primary part of the boiler. It enables to increase the boiler efficiency. Economizer is positioned withinside the flue fuel line path, to take in the warmth from the fuel line and enhance the feed water temperature. Fatigue, Pressure rupture, erosion, water aspect corrosion, hearthplace aspect corrosion and shortage of fabric quality are the main cause of failure of tubes of economizers. Recent study shows that Out of these elements Erosion is main cause which results in tube damage. Factor influencing the erosion are mineral content present in coal, association of strain components and deviation from layout circumstance and rate and temperature of flue fueloline. Amongst these causes rate of flue fueloline ash particle has the severe impact on erosion of economizer tubes. Moreover the intense provider circumstance in coal fired thermal plant to strengthen plant life , disasters which includes the consequences due to excessive rise in temperature, erosion or rupture, pressure, vibration and corrosion blended ensuing in failure of the boiler tubes have to optimize to decide and accurate the foundation motive to get boiler again on-line and decrease or take away destiny compelled outages

CHAPTER 1

INTRODUCTION

Identification of Critical Factors for failure of superheated boiler tubes in Thermal Power plants

A boiler is a critical component and its proper functioning and overall performance is important for long life of the thermal power plant. Steam generation in boiler takes place through the optimized combustion of fuels (fueloline Coal, & oil, etc.). It includes numerous additives of rotary system and stress components. The green and trouble-loose operation of a boiler is tough to maintain due to enter of traits of gasoline over time range. It detorizes overall performance of boiler and repetitive failures of stress components of boiler is also an inevitable unusual issue. One of the crucial additives of stress components is the superheater. Failure of Superheater, which ends up in the forced outage of the operating of a boiler, ensuing in huge losses. A superheater is essentially a warmness exchanger in which warmness is transferred from furnace fueloline to steam. In the current growing aggressive environment, a green working criterion for pulverized coal fired furnace is crucial for the destiny of thermal strength station. Thermal strength plant life contributes approximately 75% to all India established potential of electrical strength producing stations. In international power sector, overall, 37% of strength is produced with the aid of using combusting coal. [1-2] In the thermal power station, the boiler overall performance is a spine for strength to production. With ever growing call for strength, it's far very important to strengthen plant life for generation without pressured outages. Plant life are dealing with the trouble of boiler tube leakage and it's far greater crucial whilst they may be going for walks on complete load. It will become one of the crucial motives amongst several motives of the power crisis. Boiler tubes have constrained lifestyles and might fail because of numerous failure mechanisms. Tube screw ups are categorized as in-carrier failure in boilers[3,4]. These screw ups are pressure rupture, fatigue, corrosion, erosion, fabric failure and welding defects. Tube failure inside the superheater is hazardous to cause the compelled evacuation of the complete plant. So it's far vital to take remedial actions to minimize technical and monetary losses[5]. It is exceptionally important now no longer simplest to seriously perceive areas of disasters however additionally to seriously decide the root motive of disasters. Prolonged localized heating, which is taken into consideration a root motive of tube disasters, is a result of unsuitable running procedures. Flue fueloline passes over notable heater tubes main to harm over the time of operation and termed as fireplace harm / corrosion[6-7]. The volume of harm depends on fineness of coal, substances used, operation and maintenance. Interior of these tubes are also susceptible and, in most cases, harmness/erosion depends on quality of water used for producing excessive stress. Continuous / consistent go with the drift of steam via these tubes is essential to keep tube substances below prescribed temperature. If it is not so then there will be a chance to shoot-up of temperature inflicting speedy detoriation and failure of substance. In such cases overall performance of the plant is dropped. Therefore, it is essential to identify and locate such incidents for the boiler tube failure and to look the answers to avoid such incident in future[8]. The motives for the harm usually consist of a hard and fast of things with reference to corrosion in addition to excessivetemperature failures. Because it has a tendency to be suffered from failure, which brings approximately now no longer simplest outstanding monetary loss however additionally people's lives and property lost, it's far a vital studies discipline for home and remote places scholars[9-10]. heater tubes provide the floor to trade warmth in which the vapor passing through is heated a good way to reap better temperatures. Boiler tubes are usually subjected to an excessive inner stress and temperature or uneven outside environmental temperature. The maximum vital cause for the destruction of the heater tubes is due to the temperature of steel pipe exceeding the described electricity limit. The steel temperature can also additionally steadily move up through the years with the boom of oxide layer at the pipe, or it can also additionally even all of sudden boom due to the lower in fueloline go with the drift or the cooling inside.

CHAPTER 2

LITERATURE REVIEW

2. Important causes for Boiler Tube Failure

1. Erosion

2. Fire side corrosion

3. Stress rupture

4. Fatigue

5. Water side corrosion

6. Lack of quality control

2.1 Root Causes for Tube Failure–

2.1.1. Short term overheating - Boiler tubes are subjected to some of damaging situations like excessive pressure, excessive temperature, abrasive fly ash, corrosive nature of water, etc. during operation. The failure takes place whilst the diploma of adversity exceeds the restriction up to which it could withstand. The failure takes area in numerous manners[11]. It might also additionally fail generating longitudinal thin lip rapture with considerable bulging. It may additionally fail longitudinally with a thick lip fracture with little bulging. The failure might also additionally take area in shape of a small pin-hole puncture, commonly close to a welding joint. At instances the failure may even bring about to a window kind beginning at the tube. Some failure might also additionally arise as a crack forming in the transverse direction.

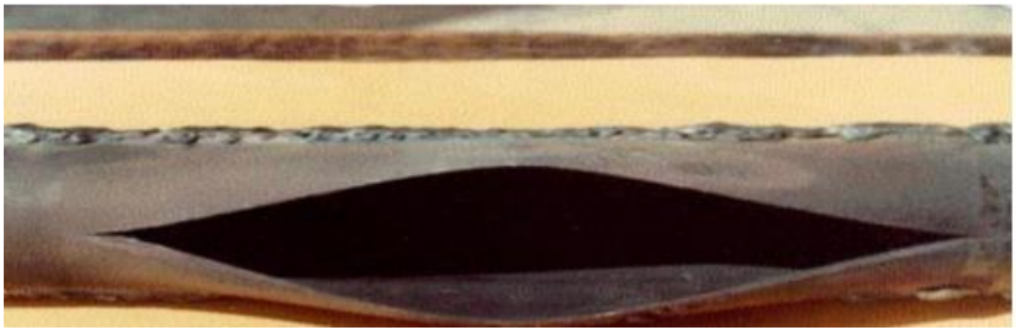

Fig.1-Tube failure due to short term heating

2..1.2 High temperature creep - Creep can be described as a time-based deformation at elevated temperature and steady stress. The give up of beneficial carrier existence of the large temperature additives in a boiler is often a failure through a creep or stress-rupture mechanism.

Fig.2-Tube failed due to high temperature

2.1.3.Dissimilar metal welds - Dissimilar welding alludes to the manner in the direction of associating substances with diverse mixtures via welding. The filler fabric and the 2 metals need to be assessed previous to selecting the maximum perfect method to partner the metals. While aggregate welding is a well-known technique, it doesnt characteristic admirably for sure blends of metals. Different strategies might also additionally provide a greater strong hold, specially for makes use of in high-strain environments[12].When a welder joins distinct substances, they need to consider some additives previous to deciding on the great welding approach and apparatuses to utilize. These additives depend upon the shape of the metals due to the fact even mixtures of comparable metallic fall beneathneath the elegance of disparate metals. For instance, carbon metal and hardened metal have diverse homes and require the equal quantity of coaching as welding collectively unalike metals, like copper and aluminum. Tube failures because of dissimilar metals

2.1.4. Long Term Overheating-Long-time period overheating can end result from immoderate deposition, flame impingement, slight go with the drift restrictions, or terrible water or flue fueloline flow patterns. Probably the maximum not unusualplace of those is immoderate deposition, which prevents right warmth switch and immoderate metallic temperatures.

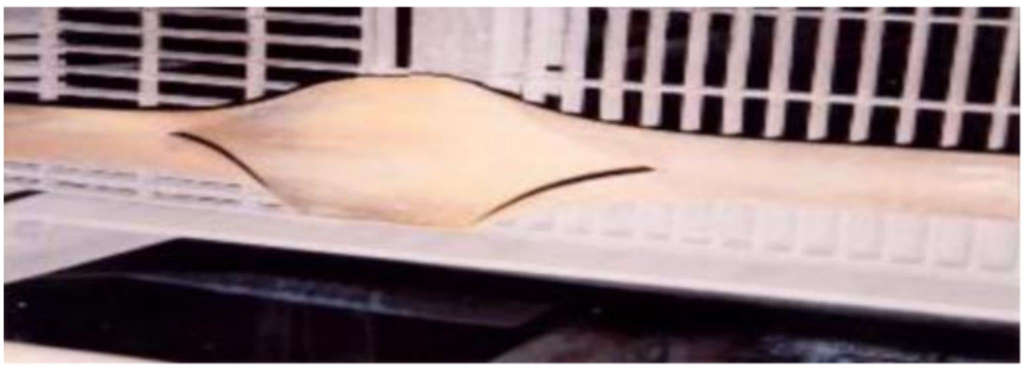

Fig-3 Tube Failure due to long term overheating

2.1.5 Fatigue failures - Corrosion fatigue failures end result from cyclic stressing of steel in a corrosive environment. The fatigue cracking will provoke on the inner diameter floor of the tube. As it maintains to propagate into the tube wall thickness, the newly created crack surfaces (bare steel) could be uncovered to the boiler feedwater.

Fig-4 Tube failures because of fatigue failures

5. Stress corrosion cracking - Various corrosion mechanisms make contributions to boiler tube failure. Stress corrosion may also bring about both inter crystalline or trans granular cracking of carbon steel. It is resulting from a mixture of metal stress and the presence of a corrosive.

CHAPTER 3

Result and Discussion

Study shows that reason of failure due to various factors are mutually sustainable. Corrosion and overheating are the main factors among all causes while we have not reviewed material capacity factor in receiving pressure in detail and it a future scope for study in failure of tubes. Boiler tube screw ups would possibly result in extra critical problem, if left uncorrected. Managing boiler tube screw ups can assist lowering compelled outages and as a consequence enhance plant availability and reliability. Plants which enforce a powerful tube failure prevention software can reduce the hazard of screw ups. There are truly many elements that want to be diagnosed with a view to enforce a a success BTF prevention software. This study presents a complete overview approximately the various root reasons of boiler tube failure thereby producing the want for figuring out the needful corrective motion to minimize such occurrences in future. Following point can be recommended to limit the rupture of the superheater tube are1) Different forms of steel should be use with better alloying elements. 2) Optimization of the gas combustion to save diminution atmosphere across the tubes and to absolutely burn the gas. 3) Utilization of mazut gas without or much less impurities which include sulfur or changing mazut with natural herbal gas, if possible. 4) Cladding the touchy and essential areas of the superheater tube which include corners, regions near the nuzzles with plates and welded sections, which are extra endurable in opposition to better temperatures and corrosive environments. 5. Use API Standard and Von mises Criteria to calculate capacity of material to receive the pressure for determination of strength of tube

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CHAPTER 4

INTRODUCTION

Stigmergic and flocking strategies to enhance target searching capability of swarm drones

In the past few years, there is an exponential growth observed in the development of micro-electronics which led to decrease in prices of electronic research which leads the development of microvehicles which also called as MAVs which are able to perform outdoor flight. The reduction in pricesof essential electronics leads to raise the concern of researchers to develop their own MAV's and modifies them according to their specifications. As these developments occurs these researches keep going on they start developing small airplanes and then quadcopters and the scientists recently started UAV's which are unmanned Aerial Vehicles and are generally used for surveillance, military recompense, traffic monitoring, scientific research in critical situations as well as in forest fires and wildlife tracking and many more[1]. Inspite of these features they are also equipped with sensors and self-localization capabilities for collection of information for target search and environmental changes sensing and various other functions. Moreover these small drones provide ease to work in harsh environments as well as the environment where human reach was limited and also where large or medium sized drones was not able to work. Similarly for scanning large area with precision requires costly drones as well as well trained staff .So to overcome this problem small drones was used. Use of single drone to perform the above mentioned task requires both structural and control logic, hence it will leads to increase in costin terms of design, construction and maintenance. Centralized approaches which lead to frequent increase in communication bandwidth requirements and software complexity is the cause behind it [2]. To resolve such kind of issues while maintaining balance application based designers are investing in swarm based technologies to do all these activities more efficiently. The main idea for swarm drones was comes from the observations of social animals like ants, Fish, bees and birds exhibiting us how to do collective work through simple interactions [3]. The advantage of these swarm drones are as (i) Fortitude-the ability to overcome the loss of individuals; (ii) Scalability-the ability of performing well of individual with different group size; (iii)flexibility-the ability of individual to perform well in harsh environment. For this purpose each swarm has ability to act with a 2 certain level of autonomy as well as ability to perform local sensing andcommunication and also had the ability to work without centralized work and also had the ability to perform globally. From structural point of view, the drone should possess following properties like having wireless communication for sending and receiving messages to the ground station, having Global positioning system (GPS) for tracing the location as well as self-localization features, multiple target sensing facilities and also capable of capturing sample images and sending them to the ground station, also having fast processor with limited computing ability and also having the capability of obstacle avoiding when flying in the surrounding. A basic swarm coordination mechanism is marker based stigmergy [4]. With stigmergy, one individual will leave the instructions in the form of pheromones which will starts accumulating in the environment, these volatile components will creates a local environment for the other drones so that other drones will modify themselves according to the information present in the pheromone[5]. These pheromone will acts like a messenger for the other drones will convey the message to other drones and helps in coordination of the drones. We can say that these pheromone will act as signal channels for the other drones in the group and help in conveying the message to other drones as well as it creates the mapping signal during search and surveillance process which is availableto other drones from mapping point to the ground station [6]. In case of elementary target it was considered that drone distribution was not uniform and hence there are multiple targets in that area. When any of these drone sense any obstacle or target in their way their stigmergic property will gets activated and starts releasing their pheromone in the environment in the form electric signals which starts accumulating in the environment densely and hence guiding the other drones which are moving in the group. These pheromone will coordinate these drones to reach their specific target. To be attracted by these pheromone trails, it is compulsory for the other drones to be in range of these pheromone. For this reason, the structural dimensions was taken into considerations as well as swarm size. Otherwise a highly diffused or poor pheromone will attract unequal amount of swarms leading creating an imbalance or chances are also there that it will not attract the swarms and hence they will not perform well [7]. In this article we are trying to use flocking and stigmergy with combination of other capabilities ofdrones like obstacle and boundary avoiding to observe the performance of the drone. The bottom up design technique was used to design the combination strategy of the drones which consists finding the proper setting at micro level and implementing it to macro level to analyze the performance of the drone (swarm level or global level system) [8]. In this paper we are trying to implement various combinations of strategies and observing their performance. For this purpose, we adopted software based simulation method where we can import real life irregular environments as well as importing irregular shapes for obstacle avoiding purpose.

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2. Related work

In this section we are trying to review the approaches which was performed by different researchers and the results they obtained about the literature of stigmergic coordination of swarms of small drones for the purpose of target search and coordination. We have characterized the published work into three different categories: (i) Using a physical substance which acts as a pheromone which is compulsory to be released in the environment during the process; (ii) Using a digital pheromone which was directly released by drone itself and transmitted to other drones directly; (iii) Using a digital pheromone which was indirectly transmitted to other drones. Then the other category which we are going to use. The use of physical substance as a repulsive pheromone was shown in [9] for environment exploration. If we combine the three basic (obstacle avoiding, target searching, and pheromone coordination) requirements of these drones then they will work more efficiently. There are various moreapproaches are there because physical pheromone does not require any structural body. Although these physical pheromones cannot be used in aerial vehicles because they cannot be stimulated. Therefore these pheromones are used only as a digital simulator to study new types of stigmergy. The use of stigmergic coordination between swarm drones was presented by [10] where the authorwas focused on the automatic control of these drones. If the potential target was found by the drone it starts releasing gossiped pheromone which will communicate with other drones and passes the information and is inversely proportional to the distance. The other drones when find the same target they start releasing negative pheromone to inform other drones about the same. The disadvantage of thisscheme was that it requires to increase the 3 bandwidth exponentially. Also to avoid any problem in targetsearch the drones had to maintain its memory and visual graphics. Therefore the communication between swarms directly is limited. The indirect communication between swarms was proposed by [11]. In this type the coordination between swarm of drones is maintained by the digital pheromone maintained at pheromone map (an artificial space) and this is composed by artificially placed agents called as intermediate controlled nodes. There are mainly two types of agents placed on pheromone map walkers and avatars. A walker isthe agent which takes decision for movement of drones while avatars collects local information which isavailable in the surrounding when sensors are not working properly[12]. This information was used for the calibration of the different conditions. The main problem in this approach is it is totally depend upon the initial deployment of the swarms and also this model was not applicable on the complex targets and if it isimplemented on simple targetsit was not reciprocal.

3. Design of Drone Behavior and Environmental Dynamics

This section of the article was going to explain about the logic structure of drones as well as the environment together along with their parametric behavior. A. Dynamic of Pheromone and environment Dynamics In general, we assume a specific area as our working environment. We superimpose a grid of cells each of having area C2, each of these cells were assigned by a pair (x,y) coordinates in which xy € [1,...,C]. The size and the actual area and no. of cells were depend upon the area of the specific domain. Below listed figure shows some basic marking of cells in that specific area. The degree of Pheromone intensity are represented by various different gray radiation, the darker the spot the higher the intensity.

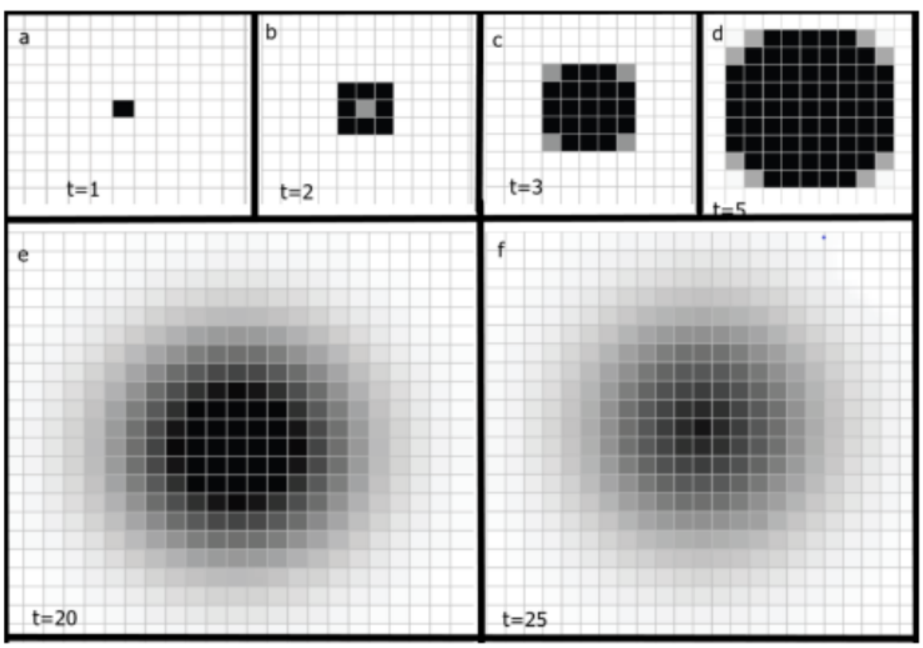

Fig. 1 Pheromone Dynamics (i) Releasing of Pheromone (ii) Diffusing (iii-iv) Diffusing as well as evaporating (v-vi) Evaporating 4 Figure 1 describes the pheromone behavior at different stages (a) it describes the release of pheromone from a drone, (b) it describes the pheromone starts diffusing and trying to reach other cells, (c-d) these figures shows the pheromonic diffusion as well as evaporation, as time increases the pheromone starts evaporating ultimately decreasing its intensity, (e-f) evaporation only. The pheromone intensity released p at instant t was can be calculated from following formulas:-

7 $Px, y(t) = \in [(1 - \delta)\, Px, y\,(t-1) + \Delta Px, y\,(t-1,t) + dx, y\,(t-1,t)]$ ……(1)

13 $dx, y\,(t-1,t) = \delta\; 8 \sum \sum Px + i, y + j(t-1)\; 1\; j=-1\; 1\; i=-1$ …………….(2)

The 8 neighboring cells of each unit propagate the portion δ of its pheromone to the cell (x,y) at each cycle. To calculate the evaporation total amount is multiplied by $\in$.

A. The Behavior of Drone

To justify the drone behavior we try to explain it in three categories and each category will explain about the different behavior of drone. The lowest priority layer of drone behavior is random fly also called as exploration stage while the pheromonic activity constitute second layer also called as exploitation in the series and the obstacle avoiding and pheromone realizing present in the environment was tops the layer. Figure 2 is a UML activity diagram which shows the overall activity of drones. The diagram was divided into three structural categories horizontal lane, physical lane and logical component.

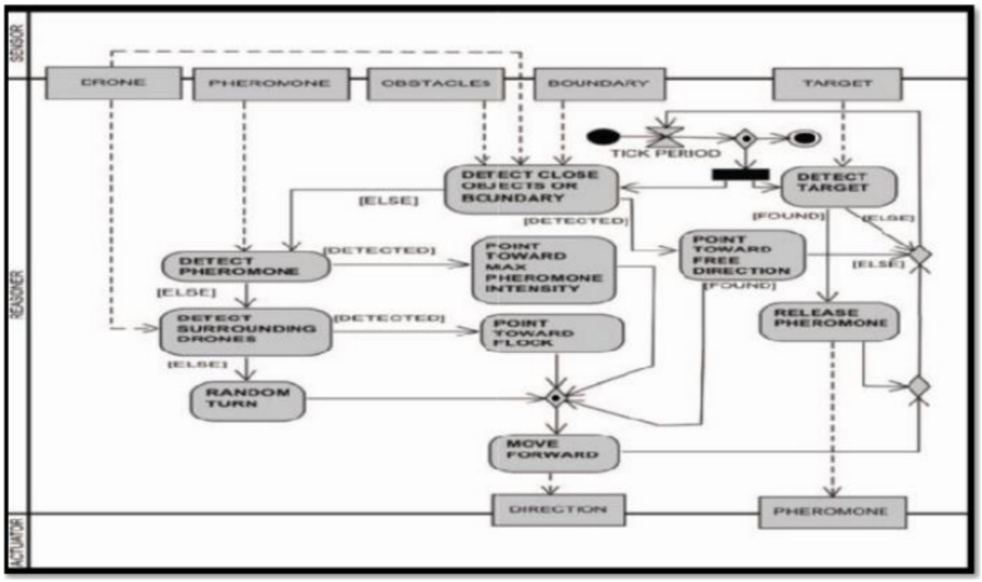

Figure 2 UML activity diagram to show drone behavior

The drones perform in parallel coordination like is 1st process is target detection i.e. release of pheromone and the 2nd stage is boundary and object detection. If any obstacle or drone is detected in its way then it starts moving towards free zone and release a pheromone in a little amount to inform other drones and if no object is detected in its path it keeps moving forward and starts searching for pheromone release and if detected it towards moving to reach its release point. If pheromone not detected it starts searching other drones to flock and if does not find any drone it performs random turns and starts searching for its target.

In flocking behavior, drones only consider those drones which have suitable flocking visibility radius (ρ). Below fig.3 shows the main flocking parameters figure-3a shows the separation behavior of drones: while moving in group drones have to separate from each other for better results; thus if a droning sense another coming nearer to it then flock mobility distance (μ), it starts angular movement (σ: flock separation angle) to separate from another drone.

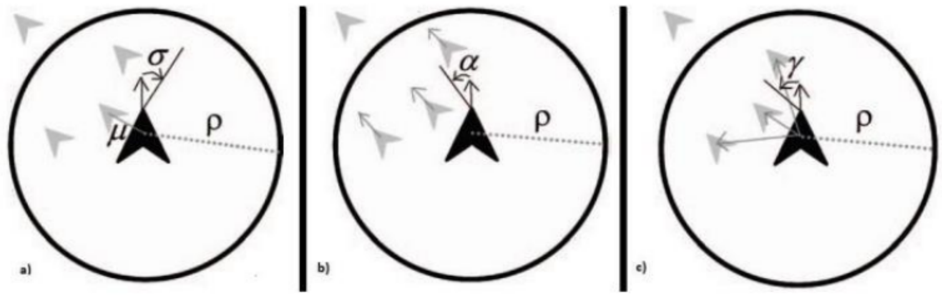

Figure 3 Parameters used in flocking a) Drone separation b) Alignment c) Cohesion

The alignment of drone behavior was shown in Fig. 3b: within flock visibility radius the drone calculates the average direction of each drone and turns by an angle α (flock alignment distance) to confirm its distance between the flocking radius. Cohesion behavior was described by fig. 3b, some of the isolated drones was not able to detect digital pheromone and therefore it reduces the cooperation between the drones therefor the drones stay in proximity, and hence to keep moving the drones calculate the barycenter of flocking visibility radius and turns by an angle γ (flock Cohesion angle).

To justify the parameters used in this modelling we have plotted table 1.

Parameter	**Description**	**range**	**Set *v*.**
v	Drone horizontal speed(m/s)	(0,15)	1.2
θ	Drone max. Range fly angle (°)	(0,180)	90
o	Drone object sensing distance(m)	(0,5)	6
ρ	Flock visibility radius(m)	(0,50)	10.5

μ	Flock mobility distance(m)	(0,5)	2.5
σ	Flock separation angle(°)	(0,180)	25
α	Flock alignment angle(°)	(0,180)	6
γ	Flock cohesion angle(°)	(0,180)	5
I	Pheromone release intensity	(0,∞)	50K
δ	Pheromone diffusion rate (%)	[0,1]	0.85
ε	Pheromone evaporation rate (%)	[0,1]	0.85
π	Pheromone sensing distance (m)	(0,∞)	1.2

Table 01 -Different Parameters used in description of drone

Experimental Studies

All the above-proposed analysis were tested on a swarm intelligence simulation software NetLogo. We have evaluated the model on three basic behavior (i) Random fly ('R'), (ii) Stigmergic Behavior ('S') and (iii) Both Flocking and Stigmergic behavior ('S+F'). We have taken 10 trialsfor each observation in the interval at which 90-95% targets detected. We also plotted the graph showing the resulting performance indicator samples. The result of each case was summarized in table 2 in the form of a "mean ± confidence level".

Scenario	No of targets / clusters	Type / No. of Obstacle	Drones	Completion time (ticks)	
Plane Field	50/5	Tress=0 Building=0	84	R	1743±140
				S	806±140
				S+F	686±143
Forest	20/1	Trees=350 Building =0	84	R	742±186
				S	740±192
				S+F	670±75
Urban	110/2	Trees=0 Building=7	42	R	1440±105
				S	856±148
				S+F	806±98

Rural Mine	28/28	Trees=292 Building=5	210	R	720±82
				S	692±80
				S+F	665±66
Urban Mines	40/40	Trees=60 Building=30	27	R	350±23
				S	452±58
				S+F	410±48

Table 02 Experimental Result

The 5 targets get scattered over the synthetic area called a scenario, with about 12 targets per group. Figure 4a represents the initial arrangement with almost 84 drones distributed into 4 swarms represented by triangular form and they are placed as antipodes in that area and the targets are depicted as a chunk of dots. 7 Fig. 4b shows the different arrangements of swarms with different sizes. The stigmergic formation was shown in Fig 4c. From table 2 and these figures, we conclude that stigmergic formation will reduce the time for target search.

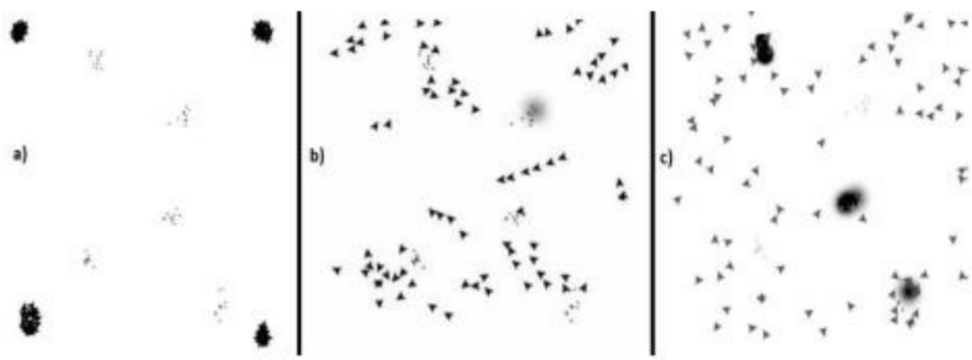

Figure 4 Basic Scenario a) Initial State b) Flocking c) Stigmergic and Flocking

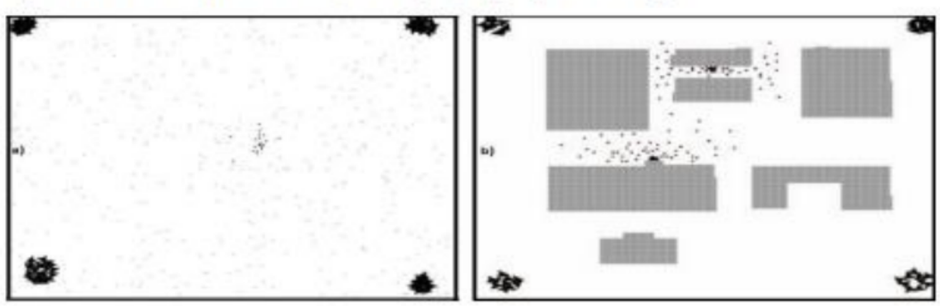

Figure 5 Synthetic and real world scenarios Model a) Forest b) urban c) Urban mines d) Rural mines

The synthetic reconstruction of forest scenario was shown in Fig5a. The tree which is 400 in numbers and targets which are 20 in number are represented in black and grey dots. There are 84 total drones that are moving in 4 8 swarms which are placed at antipodes in that area. With the flocking and stigmergic behavior improves the overall target search operation.

The characterization of the urban scenario with a chunk of 112 total targets kept on the sides of the total 7 buildings were shown in fig 5b. At the antipodes of the area total of 44 drones with 4 swarms are placed with no trees.

CONCLUSION

In this article, we are trying to use Flocking and Stigmergic behavior to improve the target search operation in the swarm. The drones use stigmergy behavior to attract drones towards potential targets and use flocking behavior to organize other drones into the swarm. The results of stigmergic and flocking behavior in both real and simulated worlds are satisfactory. If these results are suitably implemented then they will help to increase the overall search operation of the drones. But these accurate results are not easy to work but if implemented correctly it will improve the performance. Thus using appropriate parameters we can improve the target search operations of the present drones working on swarm technology

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