Open Access Journal of Physics
Volume 3, Issue 1, 2019, PP 10-17
ISSN 2637-5826

Tracking of MH370 Debris Based on Indian Ocean Circulation using Pareto Optimal Solution

Maged Marghany

Faculty Geospatial and Real Estate, Geomatika University College, Prima Peninsular, Jalan Setiawangsa 11, Taman Setiawangsa, 54200, Kuala Lumpur, WP Kuala Lumpur, Malaysia

***Corresponding Author:** Maged Marghany, Faculty Geospatial and Real Estate, Geomatika University College, Prima Peninsular, Jalan Setiawangsa 11, Taman Setiawangsa, 54200, Kuala Lumpur, WP Kuala Lumpur, Malaysia*

ABSTRACT

Regardless of the superior area, marine, and communication technologies, the mystery of the Malaysia Airline flight MH370 cannot be explicated. Excluding twelve countries that allied for the search and rescue efforts of missing the flight MH370 on March 8th, 2014, it is very sophisticated to analyze the dramatic situation of the flight MH370 that non-existent from secondary microwave radar. The core objective is to develop a multi-objective optimization via Pareto dominance to scale back the uncertainties for the debris automatic detection in satellite information like China satellite. Additionally, multi-objective optimization supported the genetic algorithmic rule is developed to forecast the debris flight movements from Perth, west of Australia i.e. the crashed claimed space. The Pareto optimization proved that within a water depth of 3000 m the remaining debris of 60% of total debris would sink down with highest cumulative percentage of 95%. As the debris would undergo the impacts of turbulent across the Southern Indian Ocean. Moreover, The detritus has been found in Réunion Island do not seem to belong to MH370. In fact, the detritus would sink below the ocean surface of 3000 water depths at intervals less than a few months as explained above. It can be said that the flight MH370 detritus can doubtless travel up to 50 km/day with massive eddies of a dimension of 100 km wide.

Keywords: *Multi-objective algorithm. Pareto optimization, Indian Ocean circulation, MH370 flight, debris.*

INTRODUCTION

Notwithstanding that advanced technologies are not able to answer the critical question of where is the Flight MH370.Excluding twelve countries that allied for the search and rescue efforts of missing the flight MH370 on March 8th, 2014, it is very sophisticated to analyze the dramatic situation of the flight MH370 that non-existent from secondary microwave radar. MH370 routes of 5 nmi / 8–10 km wide are delineated conversely differed in breadth as 20 nmi / 35–40 km (Asia News 2014 and Excell , 2014; Zweck, 2014a; staff writer 2014). There have been numerousoptical remote sensingdata, which claimed finding many debris belongs MH370. For instance, a Thai satellite data have detected 300 floating debris on the surface of the IndianOcean, which have foundabout 200 km search area of vanishing MH370.In this view, the optical THEOS satellite withpanchromatic mode have a high resolution of 2 mwhich claimed spotting of more than 100 debris in the ocean surface. However, Marghany 2015 argued that these objects are not MH370 but small cloud covers.

Subsequently, the Malaysian navy microwave radar claimed that vanishing flight cosmopolitan could be in the Malacca Straits. In this regard, the Navy radar spotted a vanishing zone by a white circle. Therefore, In high-resolution satellite images, aeroplane recognition is proved to be a challenging task because of its multifaceted structure, variable dimensions, colours, and orientations. In this view, geometrical shape, image background, and image gradient across the aeroplane are such parameters, which impact the detection of the aeroplane through an image processing tool.

The main approach for aeroplane detection is a function of the aeroplane shape features. This method is considered extremely idealistic for object detection in remote sensing data. On the other hand, this approach is controlled by differentaeroplane shape types. In this context, this approach must be based on the specific templates, which involve physical characteristics for each sort of aeroplane. In this regard, it can be easy to match the detected object to the different template kinds (Marghany 2014; Grady 2014; Linlin, 2014; Zweck, 2014b). In this procedure, the similarity between objects does not relyon the overall shape detection. Consequently, this approach can detect aeroplane persistently deprived of impeccable abstraction of the frame or shape of targets in the function of a circumstance. For instance, it relies on the circumstance of parts missing and shadow disorder.

Generally, the recognition approach involves: (i) possibly refocusing targets areprimarily notorious on time series satellite images; (ii) the object is then retrieved by computing both spectral and spatial features; and (iii) lastly, matching procedure uses to distinguish an aeroplane for precise detection (Figure 1). Moreover, there are also other identification procedures, which is based on computing the direction post binarization (Marghany 2014),and then classify the aeroplane kind. Nonetheless, these procedures also require the binary satellite images of each aeroplane kind as a prerequisite for directionevaluation, which reduces the feasibility. Moreover, aeroplane recognition often experiences numerousdisorders, for example, dissimilar contrasts, clutter and homogeneity strength (Marghany 2015).

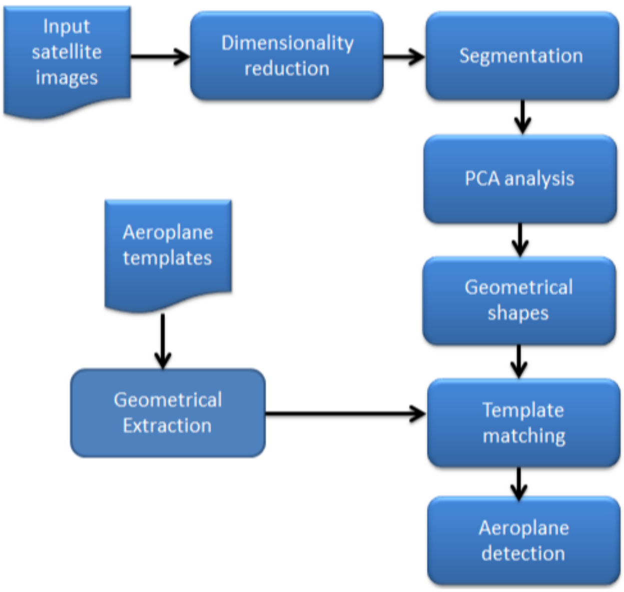

Figure1. *Identification procedures of an aeroplane in satellite images.*

It is not easy to detect the Flight MH370 in the Southern Indian Ocean, although the advanced technologies used in the maritime operational search. Using optical remote sensing technology, which spotted plenty of objects could belong to the MH370 debris. In this regard, the numerous satellite data with suspected MH370 debris are required accurate image processing algorithms to identify and discriminate the MH370 debris from the surrounding environment (Marghany 2014; Grady 2014; Linlin, 2014; Zweck, 2014b). The trajectory debris movement models established by Martini (2015) have been failed to establish the realistic investigation of MH370 debris. In fact, this model is established to track the garbage trajectory movement across the Indian ocean. Additionally, there are several choice dynamic ocean parameters extraordinarily struggling from the debris moves on the surface and through the water column (Marghany 2014; Marghany et al., 2016; Marghany 2017).

This investigation hypothesizes that the optimal solution of the Pareto algorithm can deliver accurate answer about the MH370 debris in the South Indian Ocean. The main objective of this work isto determineuncertainties associated with tracking MH370 debris. To this end, several satellite images are used to identify the physical characteristics of MH370 debris and its trajectory movements across the Indian Ocean.

METHODOLOGY

Study Area

Consistent with Geoscience Australia (2015), the search area is dominated by a complicated geological features. In this view, the seabed involves twofold round Broken Ridges, mountainous sea ground structure, and a vast linearwhich are the margin between dualistic geologicalshields, which developed and reveal separately between 20 and 100,000,000 years ago. Figure 2 suggests the new geological features of seabed involve: (i) seamounts (remnant submarine volcanoes), equal to 1400 m and regularlycreating a semi-linear chain; (ii) ridges (semi-parallel) equal to 300 m height, and (iii) depressions equal to 1400 m deep. In other words, compared to the shallow surrounding sea floor depths the depression of 1400 m is existedand commonlyupright to the slightersemi-parallel ridges (Smith and Marks 2014).

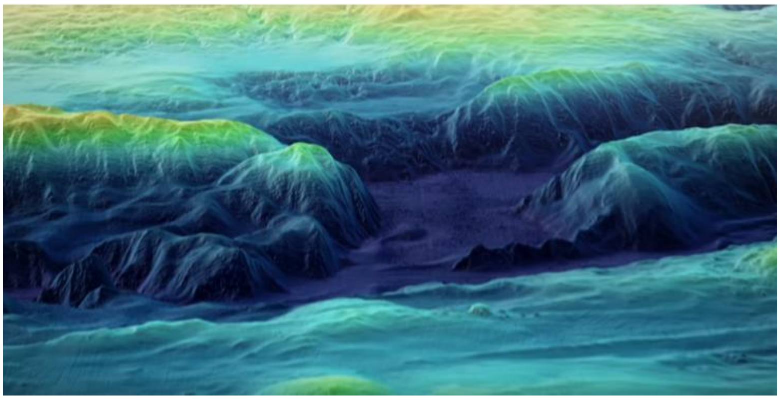

Figure2. *Bathymetry of the MH370 search area.*

These complicated features could be the major impact of failing the sea search operations to detect or observe any MH370 debris. It is a complicated task to search a needle in such huge ocean as the Southern Indian Ocean in spite of using advanced technology such as side scan sonar (Figure 3), which provides a two-dimensional topography maps of the search area.

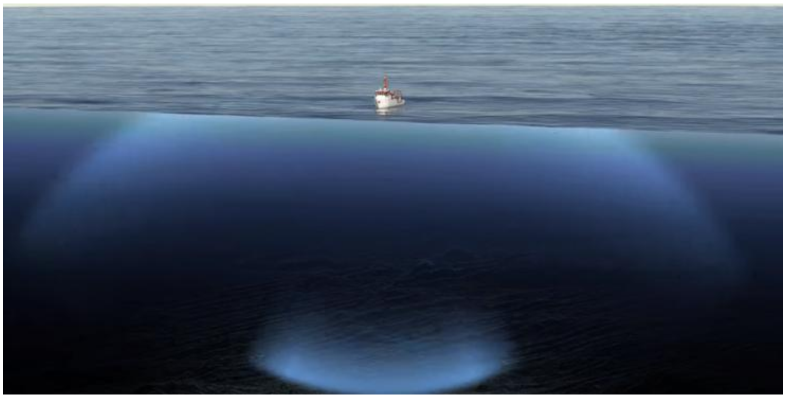

Figure3. *Side scan sonar operation for tracking Indian Ocean bathymetry.*

Pareto Optimal Based on Genetic Algorithm

Let a hydrodynamic system of the southern Indian Ocean with *m* hydrodynamic parameters and *n* flight MH370 debris, and a utility function of each hydrodynamic parameters as

$$\psi = f(\vec{v}_i) \quad (1)$$

where v_i is a vector of the flight MH370 debris, vertical mixing, sea surface current, significant wave height, wind speed, sea level variations, travelling distance and sinking depth and $\vec{v}_i = (\vec{v}_1, \vec{v}_2, ..., \vec{v}_n)$ .Then the feasibility constraint equals $\sum_{j=1}^{m} \vec{v}_j = b_j$ for j=(1,2,3,…….,n).

Lastly, the Euler–Lagrange equations are maximized to locate the Pareto optimum allocation for the flight MH370 debris trajectory movements throughout the southern Indian Ocean.

$$L_i\left(\left((U(\phi)_j^k\right)_{kj}, (\lambda_k)_k (\mu_j)_j\right) = f(\vec{v}) + \sum_{k=2}^{m} \lambda_k (\psi_k - f^k(v^k) + \sum_{j=1}^{n} \mu_j (b_j - \sum_{k=1}^{m} \vec{v}_j) \quad (2)$$

whereby L_k is Lagrangian with respect to each debris v^k for $k=1$,….,m and the vectors of multipliers are λ_k and $(\mu_j)_j$, respectively and $k \neq j$.

The historical data of significant wave heights, sea surface current, sea level variations and wind speed March 2014 to March 2016 are collected from the Jason-2/Ocean Surface Topography Mission (OSTM), and QuikSCAT respectively to simulate the current and possible debris trajectory movements across the southern Indian Ocean.

Multi-objective optimizers are requested to find the non-dominated set as close to the true Pareto front as possible. Moreover, optimizers are demanded to maintain the uniform spread of the non-dominated set along the true Pareto front.

Let $T(L)$be a compact set of feasible decisions in the Euclidean space of the Southern Indian Ocean with $\mathbb{R}^n$ theclosed unit interval [0, 1], and l is the feasible set of criterion vectors in $\mathbb{R}^m$. The MOE consists in to find a vector $\vec{l} \in \mathbb{R}$ that optimizes the vector function $\vec{f}(\vec{l})$. In this definition, MOE is a problem where we have more than one objective function.

Definition 1. Pareto dominance. A vector $\vec{l}$ dominates $\vec{l}'$ which is denoted $\vec{l} \prec \vec{l}'$.

1. If $f_i \leq f_i(\vec{l}')$ for all $i$functions in $\vec{f}$,and
2. There is at least one i such that $f_i(\vec{l}) < f_i(\vec{l}')$.

Definition 2. Pareto optimal. A vector $(\vec{l}^*)$ is Pareto optimal if does not exists a vector $\vec{l} \in \mathbb{R}$ such that $\vec{l} \prec \vec{l}^*$.

Definition 3. Pareto optimal set. The Pareto optimal set for a MOE is given by

$$P^* = \{\vec{l}^* \in \mathbb{R}\}$$

From Definition 1 it noticed that a solution is better than another if it is better in one objective and in the other is equal. However, form definition 2 the Pareto optimal is a solution where no other existing solution in the solution space that dominates it. Nevertheless, From definition 3 we said that the Pareto optimal set is confirmed by all the Pareto optimal solutions (all the non-dominated solutions) and this set is known as the Pareto front, the optimal solution of a MOE (Anderson et al., 2013; 2013 Serafino, 2015; Marghany et al., 2016).

Let X be a compact set of feasible decisions in theEuclidean space with $\mathbb{R}^n$ closed unit interval [0, 1], and Y is the feasible set of criterion vectors in $\mathbb{R}^m$. Then Pareto front can be expressed as:

$$P(Y) = \{y_1 \in Y : \{y_2 \in Y : y_2 \succ y_1, y_2 \neq y_1\} = 0\} \quad (3)$$

The time series of archived data of significant wave heights, sea surface current, sea level spatial variations and wind velocity March 2014 to March 2016 are collected from the Jason-2/Ocean Surface Topography Mission (OSTM), and QuikSCAT respectively to simulate the contemporary and feasible debris trajectory movements throughout the Southern Indian Ocean.This information perhaps assists in finding precise information regarding the impacts of Southern Indian Circulation on the trajectory movements of MH370 debris.

RESULTS AND DISCUSSION

Ocean circulation is the keystone of determining the MH370 debris drifting across the Indian Ocean. In this view, Figure 4 affords the simulated mechanical phenomenon movements of MH370 (white circles and blue rectangular) that supported multi-objectives of Indian Ocean circulation. Two satellite data are used to simulate the Southern Indian circulation: (i) Jason-2/ satellite data; and (ii) QuickSCAT satellite data.

Figure 2 reveals that an anti-clockwise water circulation across the Indian Ocean which are formed from March to October 2014 with average current velocity of 0.6 m/s. In initial stage, the debris isexpected to be on the water surface in March 2014 (Figure 4a). The trajectory movement of any object, including debris must be controlled by the water circulation of this region. In other words, the debris must be dynamically fluctuated under the impact force of water circulation.

It is clear that the water circulation formed small-scale eddies within velocity of 0.5 m/s. In this regard, the debris must be sink down to water depth more than 3000 m within month of July 2014 (Figures 4c and Figure 5).

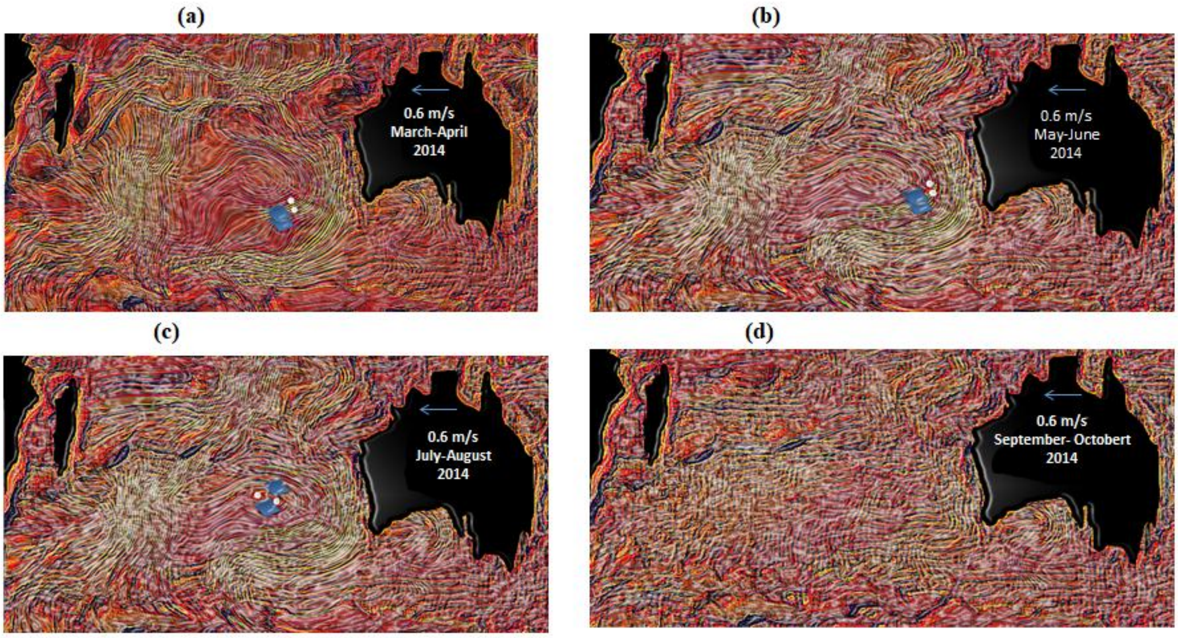

Figure4. *A multi - objective algorithm for suspected MH370 debris trajectory movements during (a) March-April 2014,(b)May-June, (c) July-August 2014, and (d) September-October 2014.*

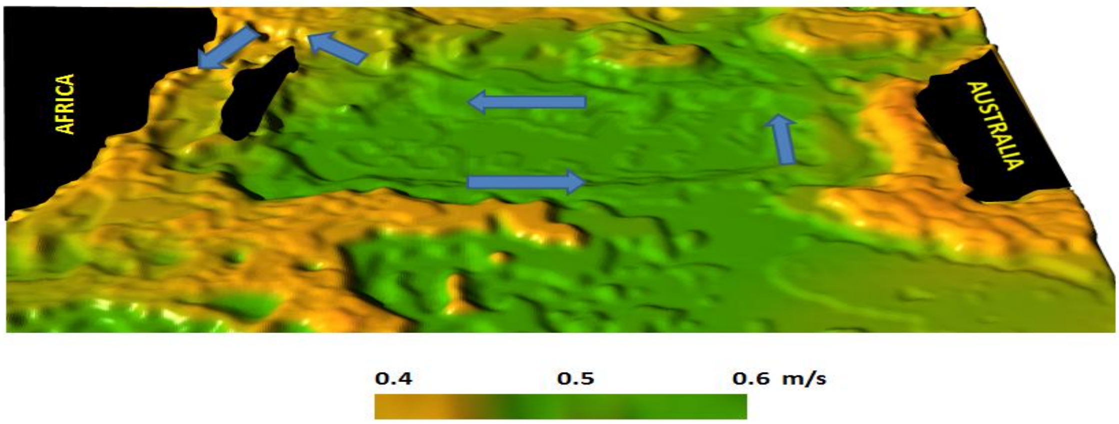

Figure5. *Southern Indian Ocean circulation.*

These results are proven by the Pareto optimization curve, 60% of debris must be sunk down with the highest cumulative percentage of 95% (Figure 6). Indeed, the extreme turbulent movements are dominated across the Southern Ocean from the upper surface layer to few hundred meters below the sea surface could not allow the debris to move further toRéunion Island and must sink to water deep water depth of more than 3000 m

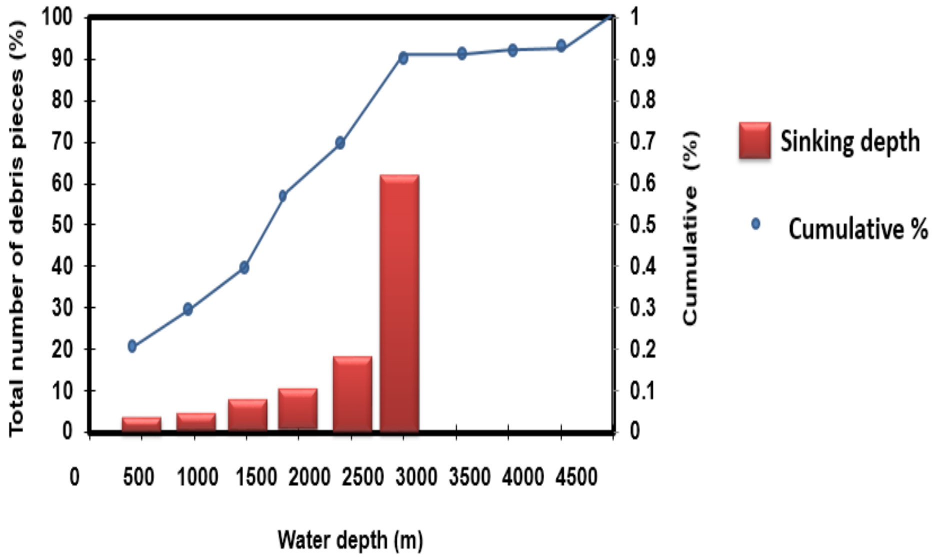

Figure6. *Pareto optimization for debris concentration in water depth.*

In fact, these turbulent flows associated with the anti-clockwise gyre could be stirred down the debris of MH370 till accumulate on the water depth more than 3000 m. In addition, it is difficult to obtain any clues regarding fuselage because of the complicated seafloor topography (Figure 2).

In fact, Marghany (2015)and (2017a)(2017b) and (2017c) noted that the dynamic instability, either detritus is additional buoyant than water, within which case they float, or they are less buoyant, within which case they sink. Hence, the turbulent actions with 50 km/ day of the big southern Indian curl with a dimension of one hundred km would cause the detritus to submerged thorough of 3,000 m to 8,000 m across the Southern Indian Ocean.

The detritus has been discovered in Réunion Island do not appear to belong to MH370. In fact, the detritus would sink beneath the ocean surface of 3000 water depths at intervals much less than a few months as defined above. If there is no clue confirms the existence of particles both from far off sensing records or floor search throughout the Southern Indian Ocean, this implies the MH370 have landed vertically via the ocean surface and stony-broke proper down to many items through the water column as an end result of the immense hydrostatic pressure of 29,430,000 Pa. This confirms the notion of subgenus Chen et al., (2015) (Marghany et al., 2016).

Nevertheless, the part of the detritus would no longer have drifted for numerous months at the upper ocean surface layer alternatively would have sunk deeply of more than 3000 water depth. Furthermore, the Antarctic Circumpolar Current (ACC) can motivateunsteadiness of MH370 debris across the Southern Indian Ocean. Finally, the large-scale counter-clockwise eddy could not drifted the debris westwards to Mozambique and Madagascar coastal waters as MH370 debris would undergo instability till sinking down to extreme water depth of more than 3000 m depth (Marghany 2017c).

CONCLUSIONS

This investigation has castedoff optimization approaches of the Genetic algorithm to explore the stimulus of ocean surface circulation on flight MH370 debris.

The study reveals that MH370 debris could not drift further to Réunion Island and Mozambique and Madagascar coastal waters. In fact, the anti-clockwise circulation and its extreme turbulent flows did not allow this debris to float and drift across the Southern Indian Ocean and must drift deeply to water depth more than 3000 m water depth with at least July 2014. This is proven by the Pareto optimization curve, 60% of debris must be sunk down with the highest cumulative percentage of 95%.

To put it briefly, the Pareto optimization algorithmrecommends that fake and doubt data had been distributed with the aid of satellite data and media. Needle to say that MH370 never ever flight and vanished in the offshore water of Perth, Australia on March 2014.

REFERENCES

[1] Anderson S.J., Edwards P.J., Marrone P., and Abramovich Y.A. 2003. Investigations with SECAR - a bistatic HF surface wave radar, Proceedings of IEEE International Conference on Radar, RADAR 2003, Adelaide.

[2] Anderson S.J., Darces M., Helier M., and Payet N. 2013 . Accelerated convergence of Genetic algorithms for application to real-time inverse problems, Proceedings of the 4th Inverse Problems, Design and Optimization Symposium, IPDO-2013, Albi, France, 149-152.

[3] Anderson S.J., 2013. Optimizing HF Radar Siting for Surveillance and Remote Sensing in the Strait of Malacca IEEE Tran. on Geosc. and Rem. Sens., 51, 1805-1816.

[4] Anderson S.J., 2014. HF radar network design for remote sensing of the South China Sea: In Marghany M.(ed.), Advanced Geoscience Remote Sensing. Intech, Retrieved August 10, 2014, from http://cdn.intechopen.com/pdfs-wm/46613.pdf.

[5] Asia News 2014. Missing Malaysian flight MH370: Is satellite data not enough? 2014 Geospatial World, 9:13.

[6] Chen, G., Gu, C., Morris, P. J., Paterson, E. G., Sergeev, A., Wang, Y. C., & Wierzbicki, T. (2015). Malaysia Airlines Flight MH370: Water Entry of an Airliner. Notices of the American Mathematical Society, 62(4), 330-344.

[7] Excell J. 2014. Down deep. The Engineer, 296 3.

[8] Grady B. 2014 NSR Analysis: OU Or Contribution The Business of Pre-Planning For Breaking News. Sat magazine, June , 2014 p.60.

[9] Geoscience Australia (2015). MH370: Bathymetric Survey. http://www.ga.gov.au/ about/ what-we-do/projects/marine/mh370-bathymetric-survey. [Access on August 29 2015].

[10] Linlin G., (2014). Opinion can satellites help find flight MH370?https://newsroom.unsw.edu.au/ news/science-technology/can-satellites-help-find-flight-mh370. [Access on August 28 2015].

[11] Marghany M. (2014). Developing genetic algorithm for surveying of MH370 flight in Indian Ocean using altimetry satellite data. 35th Asian conference of remote sensing, at Nay Pyi Taw, Mynamar, 27-31 October 2014. a-a-r-s.org/ acrs/administrator/components/com.../OS-081%20.pdf.

[12] Marghany M. (2015). Intelligent Optimization system for uncertainty MH370 debris detection. 36th Asian conference of remote sensing, at the Crowne Plaza Manila Galleria in Metro Manila, Philippines, 19-23 October 2015. acrs 2015. ccgeo.info/proceedings/TH4-5-6.pdf.

[13] Marghany, M., Mansor, S. and Shariff, A.R.B.M., 2016. Genetic algorithm for investigating flight MH370 in Indian Ocean using remotely sensed data. In IOP Conference Series: Earth and Environmental Science(Vol. 37, No. 1, p. 012001). IOP Publishing.

[14] Marghany,M. 2017a. Simulation of Indian ocean circulation impacts on MH370 debris using multi-objective evolutionary algorithm and Pareto optimal solution. 38th Asian Conference on Remote Sensing - Space Applications: Touching Human Lives, ACRS 2017; The Ashok Hotel New Delhi; India; 23 October 2017 through 27 October 2017.

[15] Marghany M 2017b. Multi-Objective Evolutionary Algorithm for MH370 Debris. Ann Mar Biol Res 4(1): 1020,pp:1-6.

[16] Marghany, M. 2017c. Multi-objective optimization evolutionary algorithm for investigation of fake MH370 debris. International Journal of Civil Engineering & Geo-Environmental (Special Publication for NCWE2017). pp.108-113.

[17] Martini K. (2015). How currents pushed debris from the missing Malaysian Air flight across the Indian Ocean to Réunion. Deep sea news [http://www.deepseanews.com/2015/07/how-currents-pushed- debris- from-the-missing- Malaysian-air-flight-across-the-indian-ocean-to-reunion/]

[18] Staff writer (2014). Missing flight satellite finds 122 floating objects http://whotv.com/ 2014/ 03/26/missing-flight-satellite-finds-122-floating-objects/[Acess on August 28 2015].

[19] Serafino, G. (2015). "Multi-objective Aircraft Trajectory Optimization for Weather Avoidance and Emissions Reduction." Modelling and Simulation for Autonomous Systems. Springer International Publishing, 226-239

[20] Smith, W.H. and Marks, K.M., 2014. Seafloor in the Malaysia airlines flight MH370 search area. Eos, Transactions American Geophysical Union, 95(21), pp.173-174.

[21] Zweck J. 2014a. How Satellite Engineers are Using Math to Deduce the Flight Path of the Missing Malaysian Airliner. Retrieved August 10, 2014, from www.utdallas.edu/~zweck/MH370.pdf.

[22] Zweck J. 2014b. How Did Inmarsat Deduce Possible Flight Paths for MH370? SIAM News. Retrieved August 10, 2014, fromhttp://www.siam.org/news/news.php?id=2151.

Citation: *Maged Marghany, " Tracking of MH370 Debris Based on Indian Ocean Circulation using Pareto Optimal Solution ", Open Access Journal of Physics, vol. 3, no. 1, pp. 10-17, 2019.*