Modified Tentacle Algorithm for Collision Avoidance for UAV

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Abstract: **A collision avoidance methodology in UAV Operation using the modified tentacles algorithm is proposed in this work. Tremendous and remarkable achievements have been recorded in the area of collision avoidance in UAV operations. Applying the modified tentacles algorithm, this research used two point research objectives the principal aim was to maintain accurate collision avoidance. With a reliable simulation result, an algorithm based on the modified tentacles technique was proposed. This was also modeled. In executing the proposed algorithm, a 3D environmental data and information were converted to 2D information for ease of mathematical computation. Appropriate occupancy grid maps were generated to show a practical result of the 3D conversion to 2D. Thus, instead of dealing with an *x, y, z* or three dimensional environments, an *x, y* or two dimensional environment results and mathematical differentiation was applied. A development of an integrated model comprising of the conventional, Modified Tentacles Algorithm. This all inclusive integrated model was simulated in order to validate and justify the work. It is a justification and validation of this research on the use of Modified Tentacles Algorithm in achieving energy efficiency in UAV operations. It has been established that energy consumption in UAV operations is influenced by its mode of operation at a given time.**

Keywords**: unmanned aircraft system, collision avoidance, navigation, modified tentacles algorithm, unmanned aerial vehicle**

I. INTRODUCTION

A tentacle is a flexible elongated tactile and prehensile system used to feel or grasp the two feelers at the head of the snail are tentacles with which it uses to feel object as it

[1] To propose an algorithm for UAV using modified tentacles algorithm.

[2] To simulate the collision avoidance for UAV using modified tentacles algorithm.

II. MATERIALS AND METHOD

The materials used in this research are articulated below

- Stop Watch – Time measuring instrument
- Physical Model of UAV
- Frequency Synthesizer – for seamless communi- cation and monitoring
- UAV Model in Simulink
- Video Display Units (VDUs) – for monitoring UAV operations in the control room

moves about.[1] generally in animals, tentacles work as muscular hydrostats for feeling or grasping objects in the form of sensory organs. Technically speaking, a tentacle is a sensor used in detecting objects and obstacles to obviate possible accidents. In this research, the modified tentacles algorithm was applied as a technique in this research to stem the shortcoming of collision avoidance occasioned by UAVs high speed and unstructured environments. Thus ensuring a high performance avoidance of collision. A complete departure from the conventional tentacles algorithm which uses inverse derivation, the modified tentacles algorithm comes in handy, to match the radius of each tentacles as well as the steering command. This ensured that the data calculation problem encountered in the conventional tentacle algorithm is solved.

the study of embedded sensor and communication de- vices. Every day, available civil, commercial and even military applications of UAVs motivated this growing interest. Navigation is of primary concern when stud- ies relating to UAVs are carried out. Apart from col- lision avoidance arising from a reliable trajectory path planning. [2] the problem associated with both the speed sets and tentacles in one speed set are significantly reduced and thus reconstructed such that its application could be made to multiple numbers of UAVs .

The aim of this research is to modified tentacles algorithm for collision avoidance for UAV.

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- Simulink – a tool in MATLAB used to create models for real-time simulations
- Display terminals
- Computer system

2.1. Method

3 The research methodology was achieved by implementing a modified tentacles algorithm in a flowchart below.

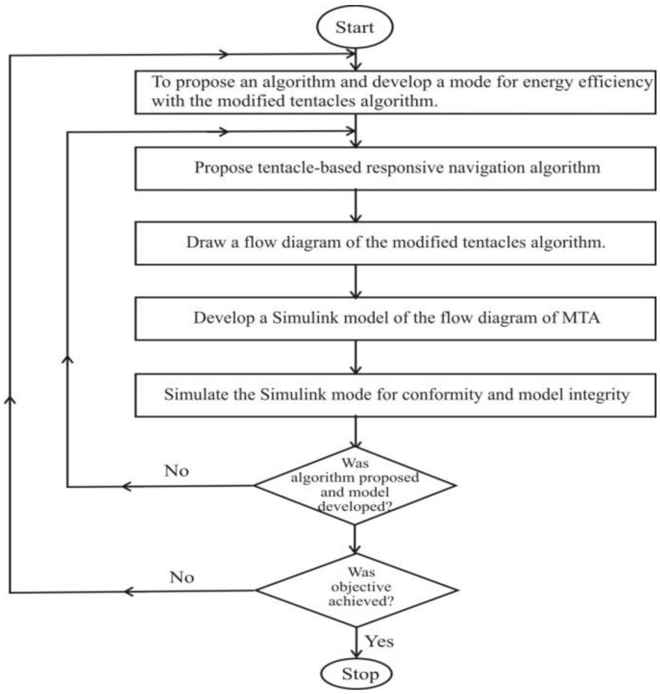

Figure 1: Flowchart for the Implementing modified tentacle algorithm

The following algorithm was proposed for a UAV undergoing a navigation process based on modified tentacle algorithm. In the algorithm, it is expected that obstacles avoidance capability is also optimally achieved. The algorithm in Module B was proposed as a response to this objective one.

Module B Algorithm: Modified Tentacle-based Responsive Navigation Algorithm

1. Gather environmental information.
2. Transfer XYZ or 3D collision avoidance to XY or 2, 2D problems.
3. Create occupancy grid $P(M/J_{1 \text{ to } t})$ while $t < T_{limit}$, DO 4 otherwise DO 10.
4. Divide UAV speed into sets.
5. Create 10 sets from $1ms^{-1}$ to $10ms^{-1}$.
6. Determine tentacle Number in each speed set.
7. Set 51 tentacles in each speed set.
8. Compute tentacle or radius and length given values from 2 above.
9. If length of tentacle or radius is found at t=T, DO 10, otherwise DO 4.
10. Select best tentacle.
11. Detect obstacle.
12. Compute energy value.
13. Show control instruction.
14. Determine/compute energy efficiency value.
15. Stop.
16. End

The algorithm proposed in Module B was subsequently modeled and used to generate the results as expected in this research. Figures 2 and 3 are the resulting models of the Modified Tentacles.

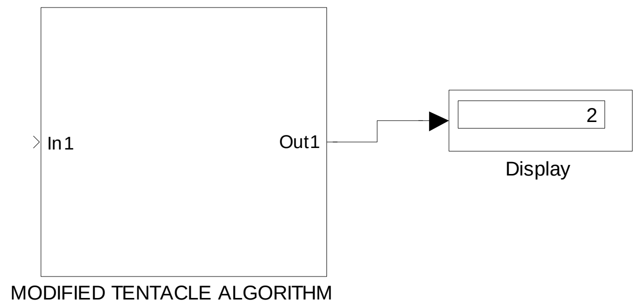

Figure 2: shows Model of the Modified Tentacles Algorithm of Module B

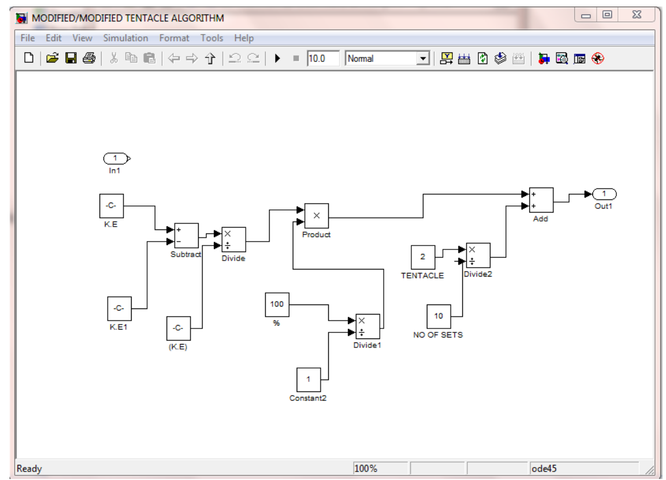

Figure 3: Simulink Detailed Model of the Modified Tentacles Algorithm of Module B

The above detailed model was used to achieve the ability of the technique applied in this research to bring about a more reflexive and responsive obstacle detection and avoidance by the UA. When this model was integrated with the conventional Simulink model, the result of its real-time simulation was used to justify the research.

3.1. *Equations*

Gather environmental information

UAV environmental information for path planning comprises topology of the environment, deployment of various sensors to specific nodes including information involving such sensors with respect to their respective types, statistics of wireless communication channels that are location dependent as well as other relevant environmental based information.

Transfer XYZ or 3D collision avoidance to XY or 2,2D problems.

This algorithm affirms the fact that the UAV is operating in a real-time, three dimensional plane. However, to be able to carry out reliable evaluation, the three dimensional plane with XYZ coordinates has to be transferred to two dimensional planes in two places with XY and YZ coordinates. This was carried out as shown below.

$$X^2 + Y^2 + Z = 1 \qquad (1)$$

$$X + Y^2 + Z = 1 \quad (2)$$

$$X + Y^2 + Z = 1 \quad (3)$$

Then, transferring XYZ to XY differentiate equations 4.1, 4.2 and 4.3

Dx, dy and dz of equation 4.1 becomes

$$2x + 2y + 1 = 1 \quad (4)$$

Similarly, dx, dy and dz of equation 3.2 becomes

$$1 + 2y + 1 = 1 \quad (5)$$

Then, dx, dy and dz of equation 3.3 becomes

$$1 + 2y + 1 = 1 \quad (6)$$

So equations 4, 3 and 6 become

$$2X + 2Y = 0 \quad (7)$$

$$2y = -1 \quad (8)$$

$$2y = -1 \quad (9)$$

Equations 8 and 9 becomes

$$4Y = -2$$

$$Y = -1/2$$

To find x put -1/2 for Y in equation 7

$$2X + (2 \times -1/2) = 0$$

$$2X - 1 = 0$$

$$2X = 1$$

$$X = 1/2$$

III. RESULTS AND DISCUSSION

Table 1 Comparison of Conventional and Modified Tentacle Algorithm UAV Velocities

Time (s)	Conventional UAV velocity (ms-1)	Modified Tentacle Algorithm UAV Velocity (ms-1)
0	0	0
2	9	8
4	10	9.061
6	10	9.061
8	10	9.061
10	10	9.061

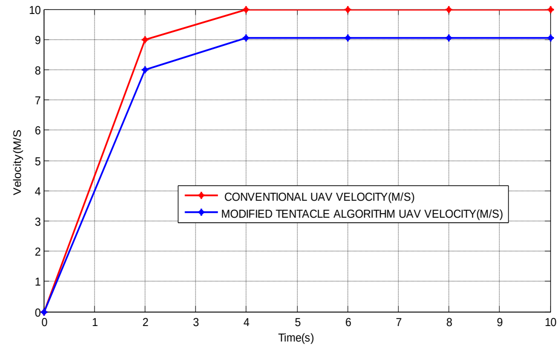

Figure 5: Velocity-Time Graph for Conventional and MTA based UAV

As shown in the velocity-time graph for the conventional operated and MTA based UAV of Figure 4, while the conventional UAV attains a cruise velocity of 10m/s after 4seconds, the MTA based UAV attains its cruise velocity of 9m/s also after 4seconds. This is a justification for the application of the modified tentacle algorithm in this work. The graph of Figure 5 shows this clearly. Having established this position, a Simulink model showing the conventional operation was developed using MATLAB. The characterized parametric data were used as input into the model after which it was simulated in order to confirm their operational values already established. In the simulation of the model, it was observed that the results were conssistent with the theoretically characterized values thus showing the realization of the objective. In analyzing objective three, the proposed Modified Tentacle Algorithm was in focus. The option of differentiation was applied in converting the 3D environmental information to 2D. Thereafter, the values of X and Y were evaluated.

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