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ARTIFICIAL INTELLIGENT BASED AUTOMATIC PATH FINDING AND COMPUTATIONAL COMPLEXITY REDUCTION ROBOT USING PREWITT EDGE DETECTION PARADIGM

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Abstract: **Humanoid Robots are enormously complex and that is why the research on humanoids spreads out over all kinds of scientific fields, from mechanics to electronics, from modeling to control and from informatics to biomechanics. This research paper is concerned with the development of a humanoid robot using edge detection technique. In the design process, the model of a humanoid robot was developed first using the simulink library tools in Matlab/Simulink environment. The guassian block convolved the input matrix with the Prewitt kernel and the block outputs two gradient components of the image, the block also performed a thresholding operation on the gradient magnitudes and output a binary image, which is a matrix of Boolean values. During the development of the humanoid robot an object orientated method was employed. Odometry and landmark method was employed in the navigation of the humanoid system. Sample of robot in ordinary form and also in edge detection form was collected and experimented in paint graphics using Portable Network Graphics format. Both of the two samples were scaled to 300X300 in dimension, and also 300X300 pixels with respect to width and height, bit depth as 32 and result showed that the computational size of the ordinary robot was 90.1kb and that of the prewitt edge detection was 16.6kb using Portable Network Graphics. This amounts to 81.58 percentage improvement. The same sample was also collected for canny edge detector and Sobel edge detector and experimented using paint graphics and their computational sizes were recorded as 19.5kb and 29.0kb respectively. This proves that prewitt edge detector is computationally cheaper than Canny as reviewed in (Karl, 2016) which either too much noise observed or too many information omitted.**

Keywords: **Humanoid robot, Motorized robot, modeling a humanoid robot, Robot obstacle avoidance, Prewitt edge detection, Method of navigation, Robot in canny edge detection, Robot in Roberts edge, Robot in prewitt edge detection form.**

I. INTRODUCTION

There has been a tremendous development in terms of research paper on humanoid robots lately. Most especially as it concerns walking with two legs and mimic human walking style. There is still need for much improvement, to stabilize the efficiency of a humanoid robot. Humanoid robot is a robot that has two legs and two hands, its body structure mimic that of human being. It has so many features that made it look like a human especially as it concerns bipedal working. Another area of humanoid robot that has played significant role is the ability of the robot to maneuver its territory avoiding every obstacle along its part. On the other hand, the amount of computations, or the computational size is of paramount importance, and this has to do with the required computational size that is needed to develop a robot. Robot has witnessed a lot of setback such as inability to maintain biped walking condition, enormous computation time that is always needed during modeling and simulation. As we will see in this work, a more efficient system is introduced to make the humanoid system meet up with the aforementioned challenges. That was why an edge detection paradigm was employed during the design process in other to reduce amount of computations usually required during modeling and simulation. In the development of a humanoid robot system, in tracing the history of a humanoid robot system, there is no suitable algorithm yet for the design of humanoid robot especially as it concerns bipedal walking system and also in the area of computational complexity. That is why an edge detection technique seemed the cheapest and fasted way in terms of development of humanoid robot. The recent development in technology has given rise to a momentous and significant decrease with respect to costs of developing a humanoid robot.

The main objective of this paper is to model and simulate an artificial intelligence based autonomous path finding and computational complexity reduction robot using Prewitt edge detection paradigm.

Humanoid robot previously has to do with a system developed to help human being carry out some task. But the computational requirements are usually much thereby making the design process look cumbersome Includes:

a) To develop a model of a humanoid robot using Matlab/Simulink blockset.

b) To introduce a strategy for reducing computational requirement in the development of a humanoid robot using Prewitt edge detection technique.

c) To incorporate, a framework for obstacle avoidance in humanoid robot.

d) To introduce a multi- tasking system which has a control strategy that would allow the robot to maintain a good balance and also be able to execute tasks concurrently.

The scope of this paper covers humanoid robot to be developed here is specifically for performing domestic task such as picking of dirt and disposing them accordingly. Its design principle should be in line with prewitt edge detection and should be able to maneuver obstacles along its parts.

The limitations of this paper are a good number of issues concerning humanoid robot development, some of those issues are basic research nature, while others explore concept that are general to humanoid robots development, and other main issues that deals with direct usage of robots systems in interacting with human being in a particular perspective. In this research paper, we outlined the following major research challenge inside humanoid robot development.

(i) Balancing and bipedal locomotion

(ii) Pattern recognition

(iii) Ability to know when and how to imitate.

(iv) How the robot does evaluates its actions.

The emergence of the humanoid robots in the world today has played significant role in alleviating human problems.

The following are some of the importance of humanoid in our society.

1. It plays vital role such as Home/office assistance
2. It simplified humanoid robot modeling
3. It saves cost and energy because of lesser computational requirement
4. It is very useful in robot cup goal scoring technology.

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II. REVIEW OF PREVIOUS WORK

The table below is a summary of review of previous work done on humanoid robot.

Table 1.0: presentation of reviewed publications to highlight work carried out and the gaps in research

Name of Author	Title	Technique	Result
Banerjee N. 2015 et.al	Human supervised control of the atlas humanoid robot for traversing doors	**Slanting method**	**Difficult to achieve**
Liu Y. 2015 et. al	Dynamic walking in a humanoid robot based on a three dimensional actuated twin SLIP model	3D Dual-SLIP model method	Produced human-like dynamic walking gaits.
Majid, et. al, 2017	A robust walking controller based on online step location and duration optimization for bipedal locomotion	stepping schedule generator	Made it easier for robots with various endeffector geometry
Bahishti, A. 2017	Influence of human age and gender on acceptance of humanoid robot	Perception	effect of age and gender were found to be the most significant element that defines user's perception
Valez, K. 2019	Self learning guide Bioloid humanoid robot assembly with elements of augmented reality to support experiment learning in research seeding	3D model method	Produced an increased certainty marks with sole aim of creating communications.

III. RESEARCH GAP

The major gap established here is the improvement of humanoid robot in terms of feature extraction and background information retrieval. Several research papers have been reviewed and some lapses were discovered especially as it concerns computational complexity. Since edge detection has good feature for reducing computational complexity, this research paper has employed the usage of Prewitt edge detection in the cause of developing a humanoid robot as it reduced the complexity to abarest minimum as observed in the experiment conducted. Two samples of robot in ordinary form and robot in edge detection form were collected and experimented on using paint graphics. Each of the models was scaled to 300X300 in dimension, and also 300X300 pixels with respect to width and height, bit depth as 32, Result showed that the computational required size of the ordinary robot was 90.1kb and that of the prewitt edge detection was 16.6kb using Portable Network Graphics. The result shows that development of robot using Prewitt edge detection technique gained a computational size of 73.5kb when compared with ordinary robot. This amounts to 18.42 percentage improvement. The same sample was also collected for Canny edge detector and Sobel edge detector and experimented using paint graphics and their computational sizes were recorded as 19.5kb and 29.0kb respectively which is much larger than the Prewitt edge detection. This proves that prewitt edge detector is computationally lesser and better than Canny and other edge detector as reviewed in (Karl, T. 2016) which either too much noise observed or too many information omitted.

IV. MATERIAL AND METHOD

This research paper is concerned with the developing of humanoid robot by means of an edge detection technique, the reason is to reduce amount of computations usually required during modeling and simulation of humanoid robot, thereby gaining a computationally cheaper models. Since humanoid robots are very complex system. The model of the humanoid robot was developed through the use of Simulink blocksets and edge detection technique was adopted in the development of the robot.

It also goes a long way to provide us with a more reliable motion detection employed in the obstacle avoidance platform. In the development of this system an object oriented methodology was employed with respect to the overall concept. As for the method of navigation odometry and landmark method were used.

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V. MODELING A HUMANOID ROBOT.

The first stage in this research paper is to model a humanoid robot and that is our first objective. This is achieved using the tools in Matlab/Simulink library which contains several block sets which enabled us to model the system. The flowchart for the model was first developed to be a guideline for the modeling of the humanoid robot. Below is the flowchart of a humanoid robot.

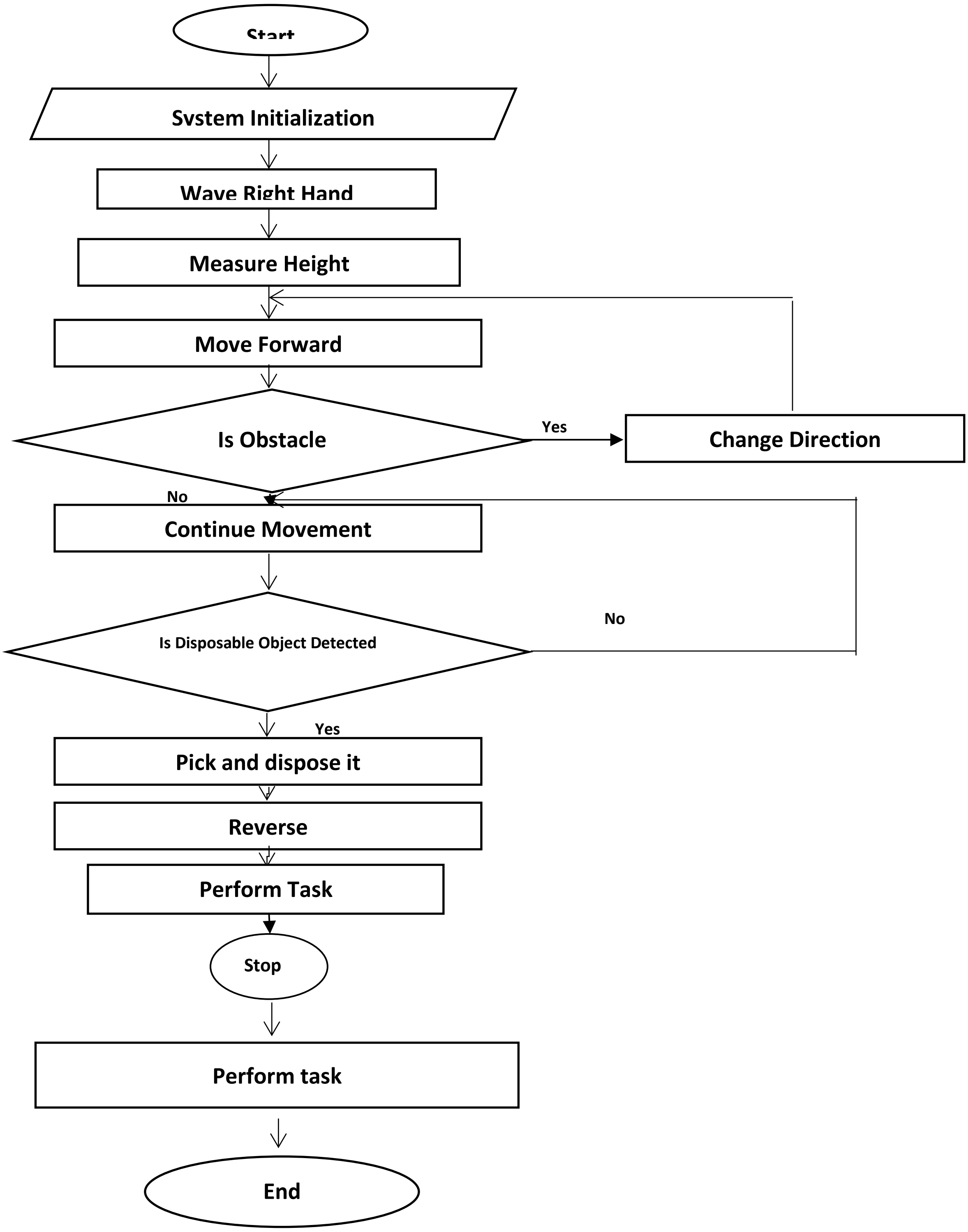

Figure 1: Program Flowchart of Humanoid Robot

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VI. EDGE DETECTION METHOD FOR REDUCING COMPUTATIONAL REQUIREMENT

In this objective an edge detection technique was introduced in the development of a humanoid robot. Edge detection can be referred to as a gathering of dissimilar algorithms, which is aimed at identifying the edges in an input image and in that way simplifying the results obtained. In this case, a prewitt edge detection procedure was used for reducing computation time and eliminates unimportant parts and features of the object in question. This algorithm works perfectly well with the live image acquisition blockset. Live Image Acquisition Tools provides a Simulink block to obtain live image data from the image acquisition device into Simulink model.

Thus, Classical edge recognition technique convolves an input representation with a two dimensional operative O attribute to that precise indicator, giving rise to a gray scale response where edges are uniquely exposed with whichever maxima or minima.

Giving O diverse possessions affect a indicator's sensitivity to good feature (and as such, noise), diverse kinds of limits (thick or thin, unfailing or not in agreement

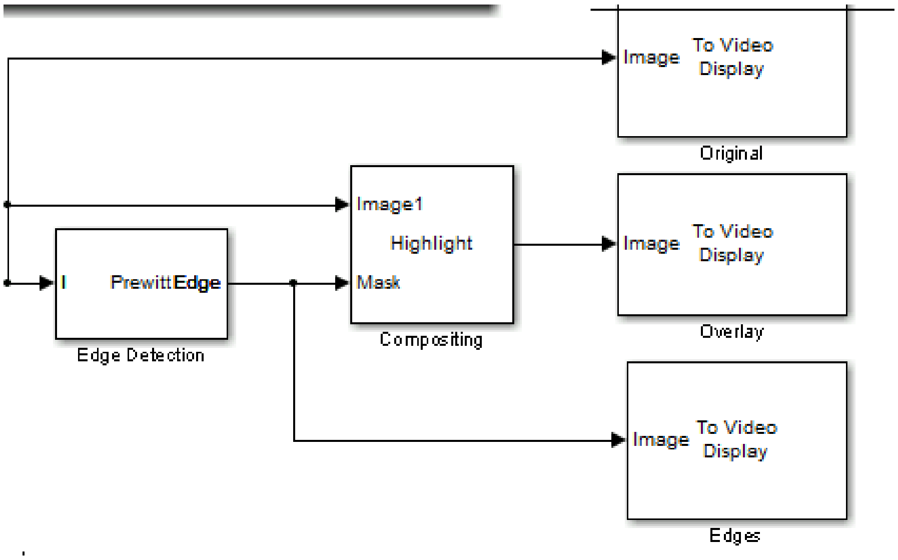

Figure 2: Simulink model of Edge detection

The figure above is an edge detection model, the prewitt edge detector mask is connected to the composition blockset and equally to the original video display mask, the compositing mask is connected directly to the overlay mask, while the prewitt edge detector mask is connected to the edges mask. The essence of introducing the edge detection model is to reduce the amount of computations usually required during simulation.

VII. METHOD OF REDUCING COMPUTATIONAL COMPLEXITY OF ROBOT THROUGH EDGE DETECTOR

In reducing the amount of computations in the model of the simulated robot, the following procedures were followed.

The selection of the output desired form: In this method, a desired format was chosen, and it was prewitt edge detection technique.

(i) User-defined threshold: Here the desired threshold Value was entered, and the block computed the threshold.

(ii) Threshold source: This allowed you to enter the entry value that is within the series of the input data within the dialog.

(iii) Threshold scale factor: This multiplier was used to adjust the calculation of the automatic threshold.

(iv) Standard Deviation of Guassian/Kalman Filter: This computed the derivative of the convolved Gaussian filter of the input image. The filter object was designed for tracking.

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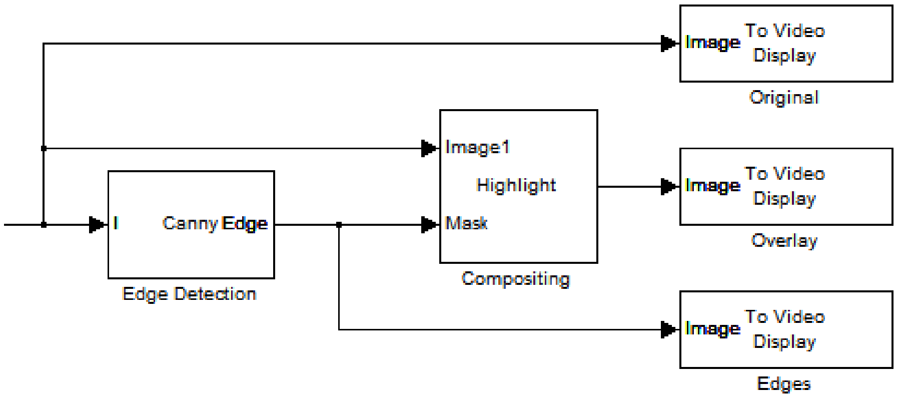

Figure 3: Robot in Canny edge detection

The figure above is the robot in a canny edge detection form, one of the major challenges of canny edge detection is that too many information can be omitted and therefore cannot be relied upon.

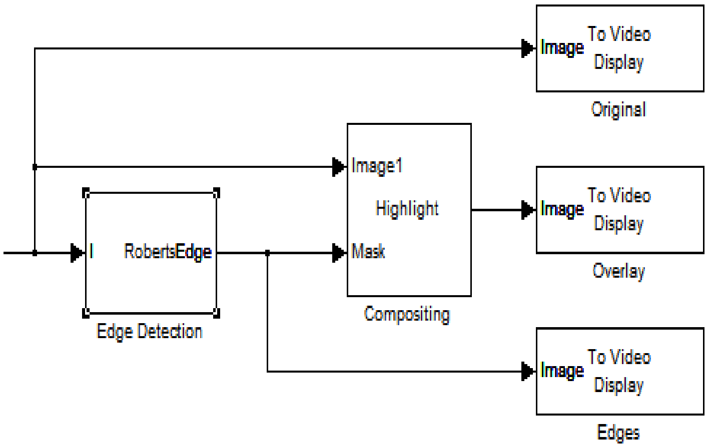

Figure 4: Robot in Robert edge detection form

In the figure above is the simulink model of Robert edge detection. In this edge detection too many information is always detected, thereby contributing to a increase in the computational demand.

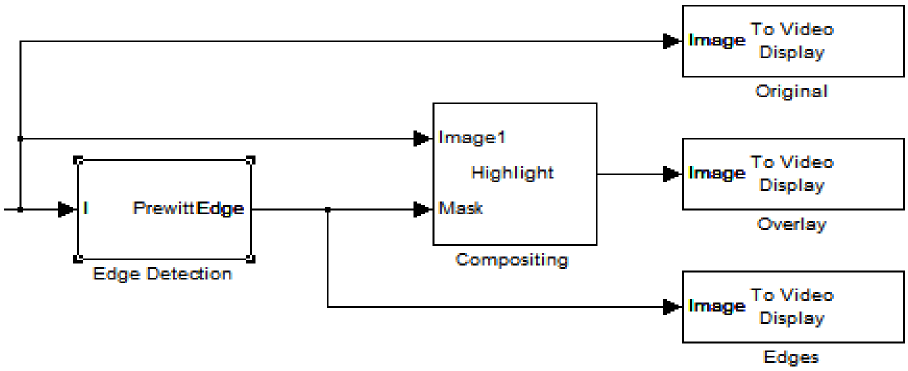

Figure 5: Robot in Prewitt edge detection form

The figure above is the simulink model of a Prewitt edge detection. This model has a higher gain of the computational demand.

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VIII. RESULTS AND DISCUSSIONS

This research paper has successfully implemented the modelling of a humanoid robot using edge detection technique. The framework for obstacle avoidance was also successfully deployed. The robot carried simple domestic assignment, which includes; picking of dirt within its surrounding and disposing them accordingly, it equally converted the robot from its normal form to edge detection form using prewitt edge detection technique. The edge detection was used to reduce the amount of computations usually involved during modelling and simulation.

Below are the results of the simulated robot.

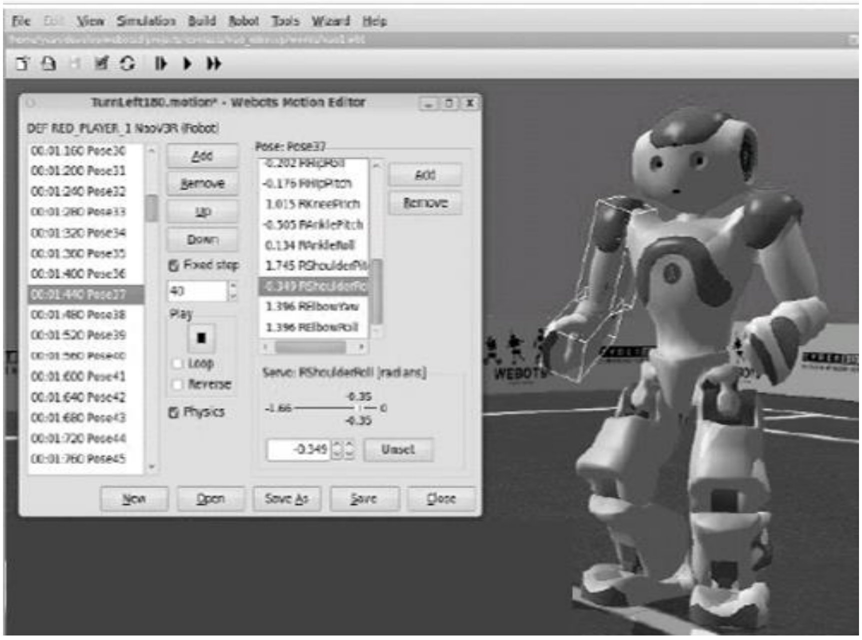

Figure 6: Simulation result of a humanoid robot

The figure 6 above is the simulation result of a humanoid robot model developed in objective one. Different component parts have been integrated to form a complete humanoid robot. The simulation of the model was done in Matlab/Simulink environment.

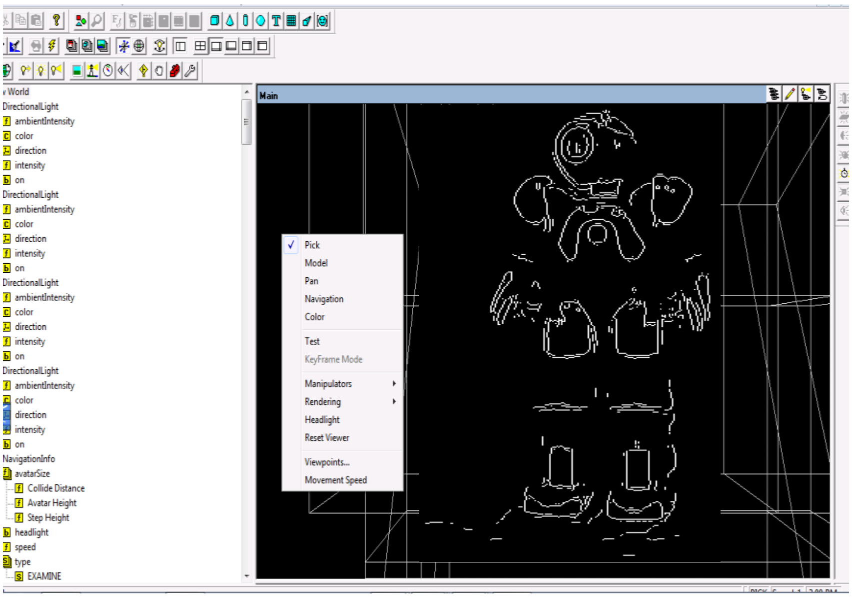

Figure 7: Humanoid Robot using Prewitt edge detection

The diagram above is the simulation result of the modeled edge detection technique introduced in humanoid robot design. The result was obtained by connecting the edge detection model to the model of the humanoid robot and the simulate button was clicked in the Simulink model and it appeared as shown above. The result shows that there is huge advantage in using Prewitt edge detection to build humanoid robot.

IX. RESULTS BASED ON COMPUTATIONAL DEMAND OF HUMANOID ROBOT.

Below are different results obtained from experiment conducted in paint graphics using Portable Network graphics Format? The results show that Prewitt edge detection outweighs other methods of developing humanoid robot. Prewitt edge detection after the experiment gained a computational size space of 16.6kb amounting to 18.42 percentage improvement when compared with robot in ordinary form.

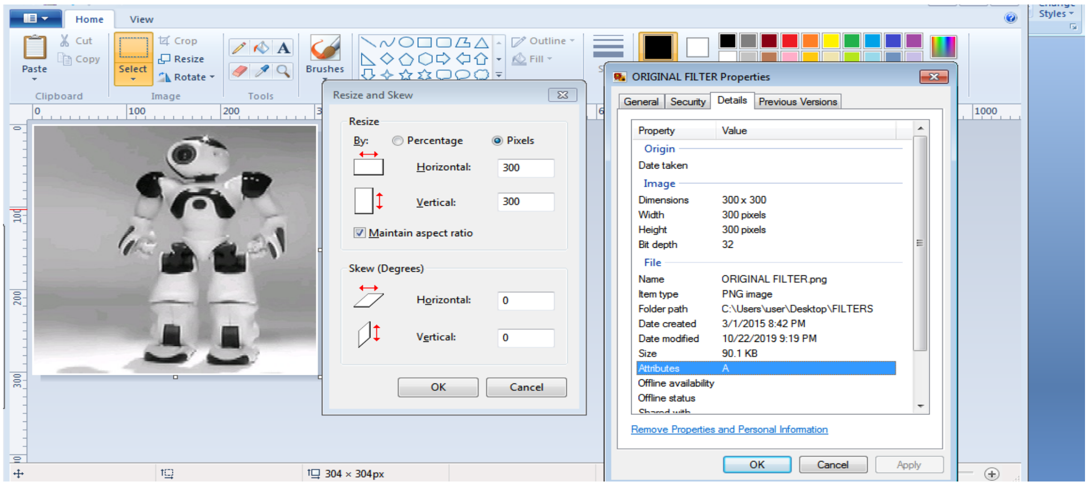

Figure 8: Result of robot in real form

Based on the sample size collected with respect to the real robot, the result shows that robots in real form require 90.1kb computational size for its development.

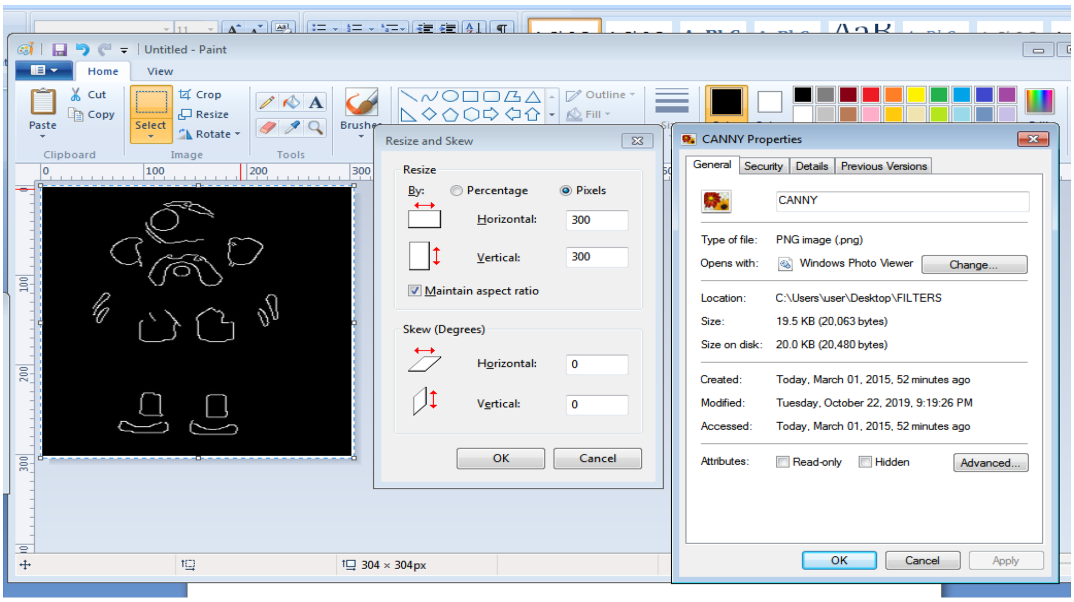

Figure 9: Result of robot in Canny edge detection form

Based on the sample size collected with respect to Canny edge detection robot, the result shows that robots in Canny edge detection form require 19.5kb for its development.

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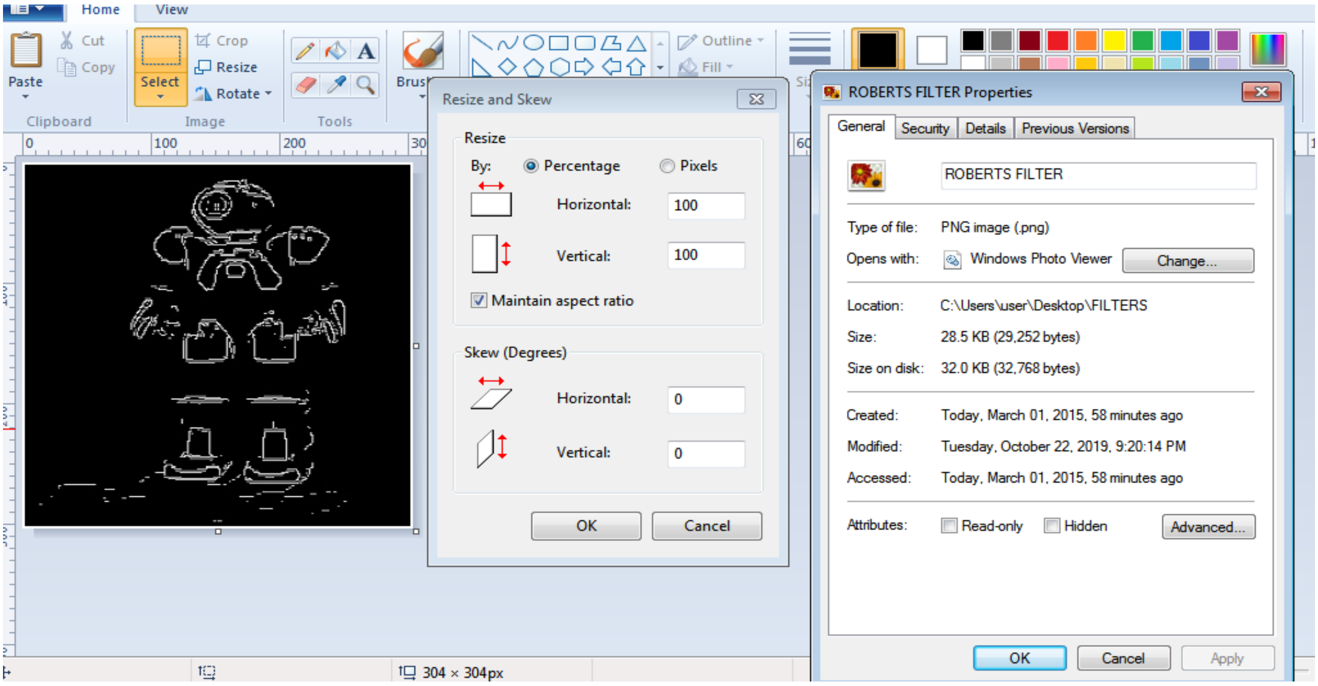

Figure 10: Robot in Roberts edge detection form

From the figure above, the experimental result shows that robot in Roberts edge detection form based on the sample collected for the experiment needed 28.5kb computational size.

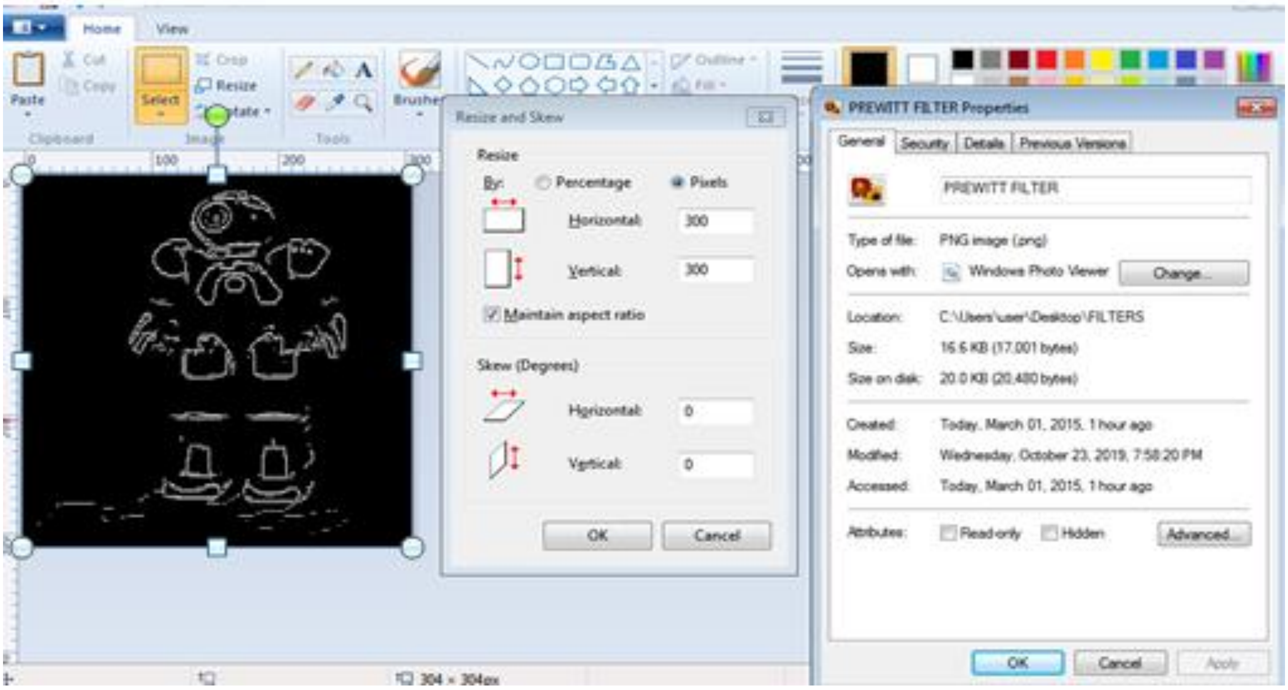

Figure 11: Robot in prewitt edge detection form

From the figure above, the experimental result shows that robot in Prewitt edge detection form based on the sample collected for the experiment needed 16.6kb computational size.

Therefore, from these results, one can conclude that Prewitt edge detection is better than other methods of developing humanoid robot.

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X. RESULTS ON OBSTACLE AVOIDANCE

The figures below describe the result obtained when the robot avoided obstacle along its part.

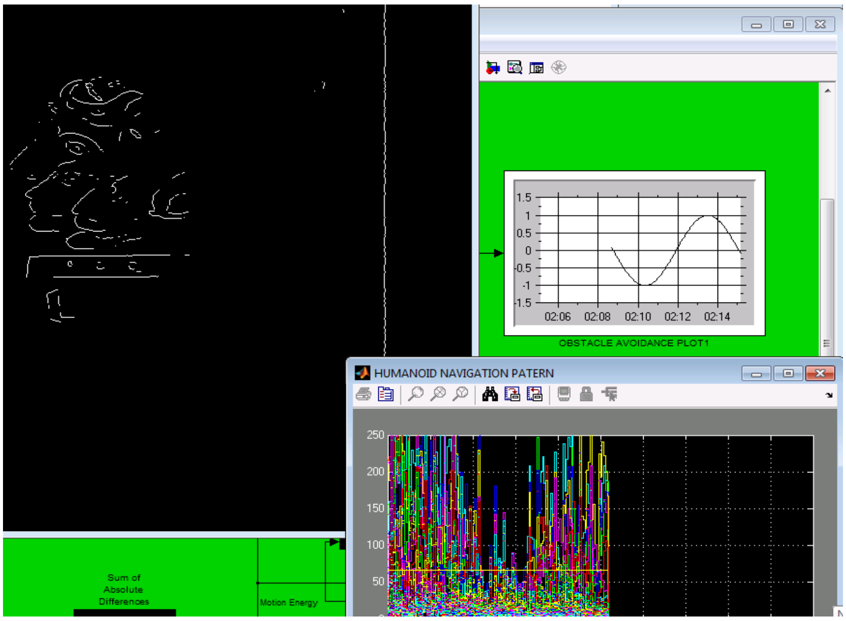

Figure 12: Implementation of obstacle avoidance

From the figure above the robot changed direction of movement immediately it detected an obstacle along its part.

Bipedal locomotion is one of the most difficult tasks as far as humanoid robot is concerned. This makes the robot to mimic human bipedal locomotive style. By so doing, the robot distinguishes itself from normal three or four wheeled robot.

The Body Sensor block senses the motion of a body represented by a Body block. You connect the Body Sensor to a Body coordinate system (CS) on the Body whose motion you want to sense. The sensor specifically measures the motion of the origin of this Body Coordinate system. The Body Sensor measures the components of translational and rotational motion in any combination.

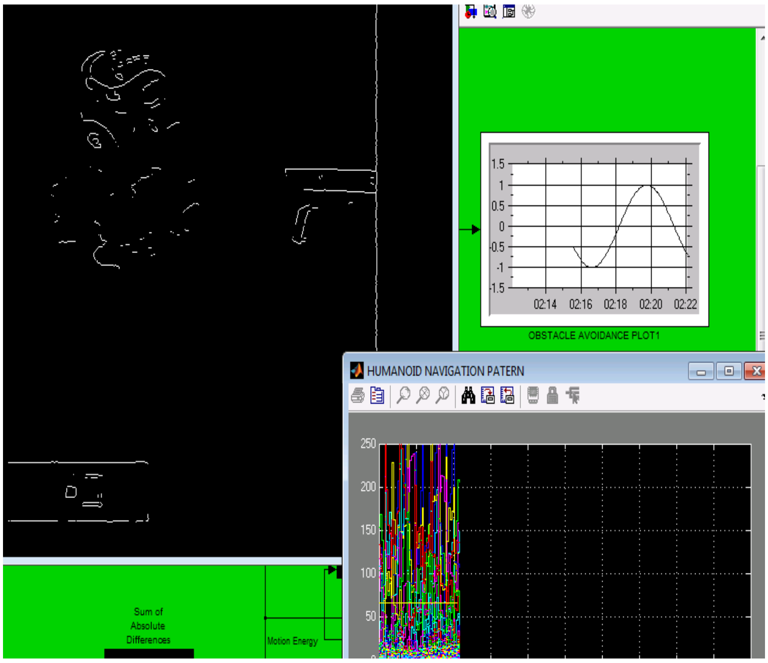

Figure 13: ROBOT OBSTACLE AVOIDANCE IMPLEMENTATION

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The figure above is obstacle avoidance implementation on the humanoid robot. This shows how the robot was able to maneuver obstacles along its way or within its territory. The robot is programmed to change direction of movement any time it detects obstacle along its part.

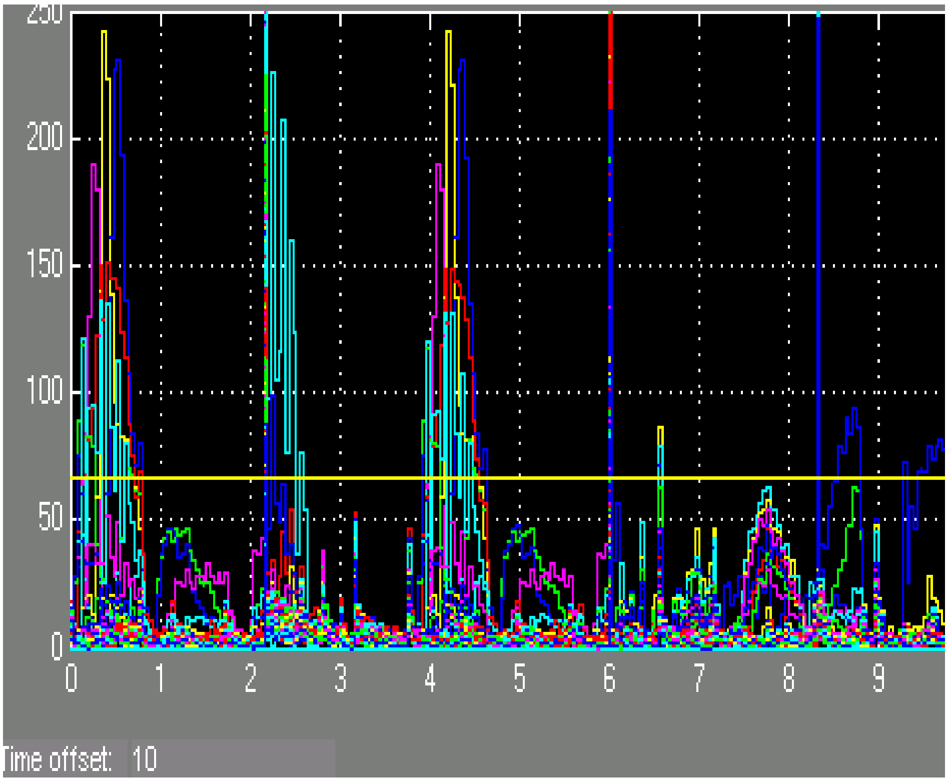
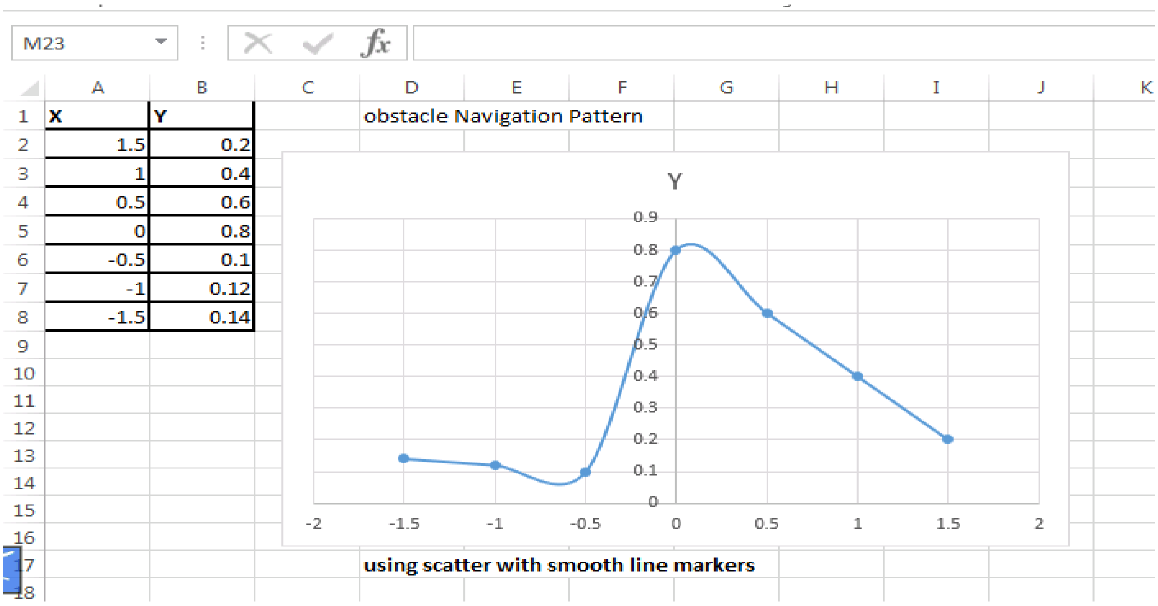


Figure 14: Pattern of Navigation and task scope

The figure above depicts the various point of task executed by the humanoid. When the robot is in a steady state, the graph becomes stable, but when the robot makes any movement it reflects immediately on the graph. The up and down movement of the graph signal shows when the robot is in action and when it is in a steady state. The various colours in the graph connotes different reflextive actions of the humanoid robot



X	Y
1.5	0.2
1	0.4
0.5	0.6
0	0.8
-0.5	0.1
-1	0.12
-1.5	0.14

Figure 15: Obstacle graph plot using scatter with smooth line marker

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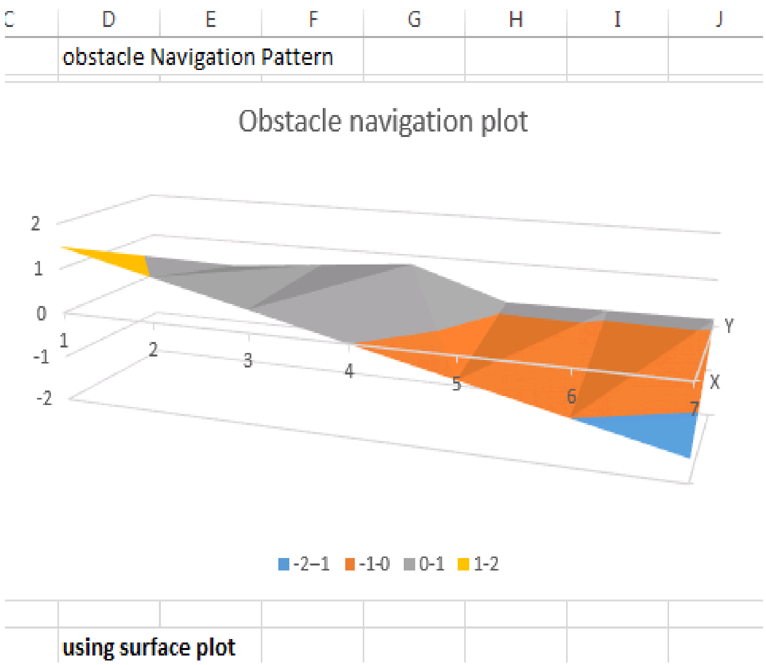
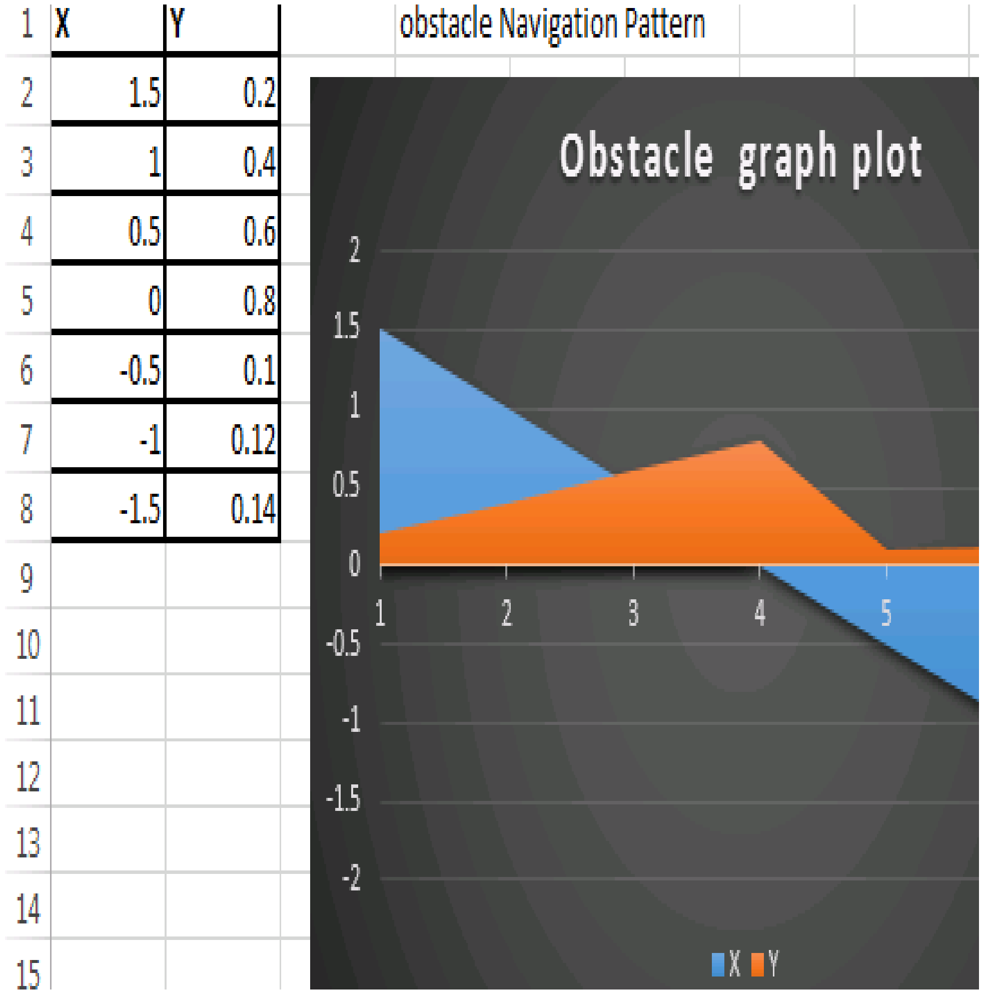


Figure 16: Obstacle graph plot using surface plot



	X	Y
2	1.5	0.2
3	1	0.4
4	0.5	0.6
5	0	0.8
6	-0.5	0.1
7	-1	0.12
8	-1.5	0.14

Figure 17: Using area plot

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The figure above is a plot of the obstacle avoidance in spreadsheet package. It explains how the robot avoids obstacles.

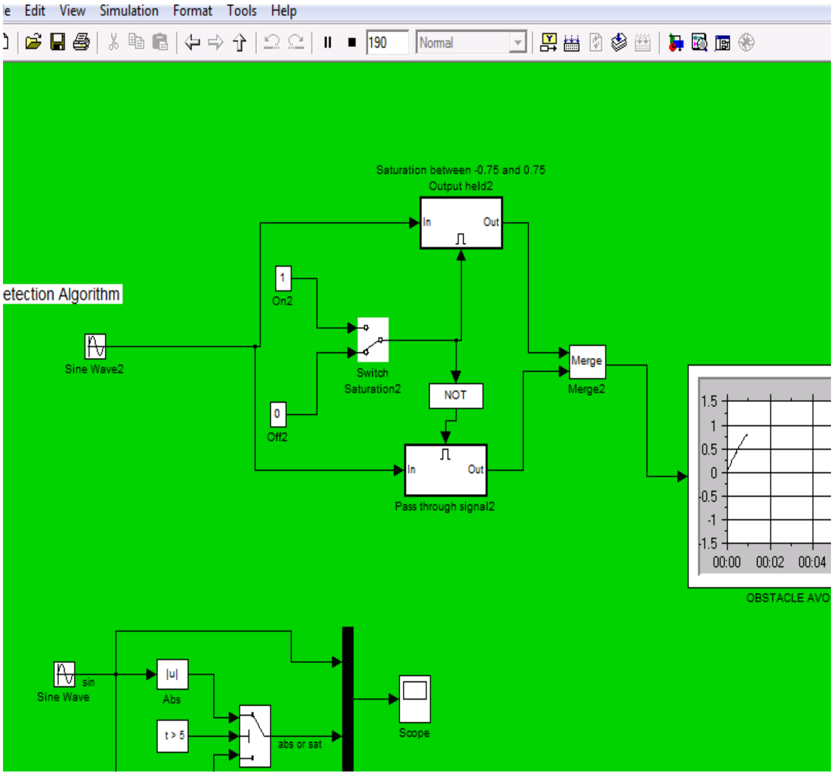
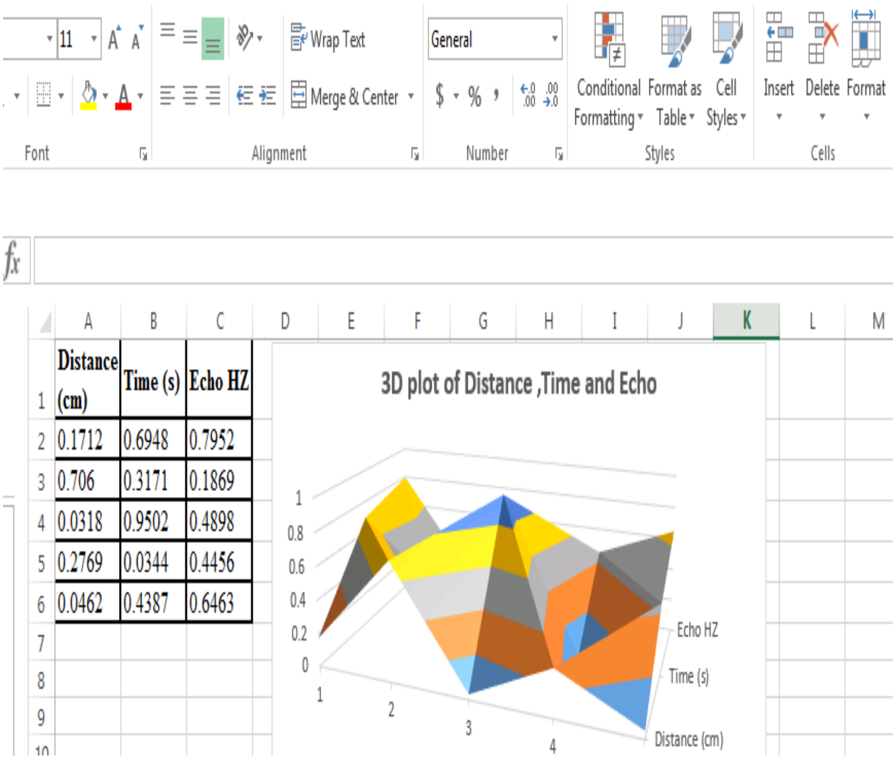


Figure 18: Obstacle Avoidance 1 at one Amplitude simulink blockset

The figure 18 above is the obstacle avoidance procedure of the humanoid robot at amplitude 1. The Reading in the graph represents the movement of the robot.



Distance (cm)	Time (s)	Echo HZ
0.1712	0.6948	0.7952
0.706	0.3171	0.1869
0.0318	0.9502	0.4898
0.2769	0.0344	0.4456
0.0462	0.4387	0.6463

Figure 19: 3D Surface plot of robot navigation pattern

The figure above is a surface plot of the activity of the robot using spreadsheet package. This consists of the time and distance covered by the robot.

Figure: Implementation of task performance

The figure above is the implementation of the task performance of the humanoid robot. The humanoid robot being programmed to carry out an assignement was able to execute that successfully well.

XI. CONCLUSION

The major contribution in this research paper is concerned with the development of a humanoid robot using edge detection technique which selects features of the principal parts of the object, and eliminates parts that are not necessary the essence was to reduce the computational complexity of the humanoid robot. With the help of the new developed system, the humanoid robot performed faster in terms of feature extraction and background information retrieval. It was evident that when an edge detection technique is introduced in humanoid robot modeling, a better and more efficient humanoid system was obtained. The edge detection here took cognizance of all the principal parts of the object in question and removed parts that were not necessary in the object, it also gained a computational lesser and better model, and this in turn reduced the amount of computations involved during simulation activity and moreso, focused on the region of interest. We equally used a more robust tracking procedure in which the humanoids easily maneuvered its environment. The obstacle avoidance features was also employed during the design process, which gave the humanoid ability to navigate its way to the target location without colliding with any object.

XII. CONTRIBUTION TO KNOWLEDGE

Many researchers have worked on humanoid robot but more work still need to be done. Edge detection has been found extremely useful in the development of humanoid robot. Prewitt edge detection seems to be better than Canny edge detector and Random forest edge detector. Canny's edge detector and the random forests edge detector have failure cases in which either too much noise is detected or too much detail omitted, respectively. Both of the two samples were scaled to 300X300 in dimension, and also 300X300 pixels with respect to width and height, bit depth as 32 and result showed that the computational size of the ordinary robot was 90.1kb and that of the prewitt edge detection was 16.6kb using Portable Network Graphics percentage improvement. The same sample was also collected for Canny edge detector and Sobel edge detector and experimented using paint graphics and their computational sizes were recorded as 19.5kb and 29.0kb respectively. The percentage improvement of this work was 18.42 percentage.

REFERENCES

[1] Bahishti, A. (2017) Human Robots asnd Human Society. *Advanced journal of science*

[2] Banerjee N., Cherubini A., Sherikov A., Wieber P., Kheddar A. (2015) Human-Humanoid Collaborative carrying IEEE Transactions on robotics, IEEE in press

[3] Banerjee N., Long X., Du R., Polio F., Feng S., Atkeson C., Gennert M., Padir T. (2015) Human-Supervised control of the Atlas humanoid robot for traversing doors. IEEE RAS 15^{th} international conference on humanoid robots

[4] Choudhury, A.;Greene C. (2018) International Journal of Applied science Res Vol.5 No 4.17

[5] Choudhury, A.; Huiyang, L.; Greene C.; Perumalla, S. (2018) Humanoid Robot Application and influence

[6] Denny, J.; Elyas, M.; (2016) Humanoid Robots Past, Present and the Future *European Journal of Advances in Engineering and technology*

[7] Emelie, B., (2018). *Electronic Theses and Dissertations. 1406.*

[8] Ghosh, S., Mitra, I. (2017) Artificial intelligence and robotics www.pwc.in

[9] Haywood, M., (2017). A Novel 3D printed leg design for a Biped Robot. *http://scholarworks.rit.edu/theses*

[10] Jamet, F.; Masson, O.; Jacquet, B.; Stilgenbauer, J.; Baratgin, J. (2018) Learning by Teaching with humanoid robot: A new powerful Experiment tool to improve children's learning ability *International journal of robotics*

International Journal of Novel Research in Computer Science and Software Engineering
Vol. 9, Issue 3, pp: (1-15), Month: September - December 2022, Available at: www.noveltyjournals.com

[11] Karl, T., Anastasia, B. & Gholamreza, A. (2016). Edge information based object classification for NAO robots. *Cogent Engineering (2016), 3: 1262571 http://dx.doi.org/10.1080/23311916.2016.1262571*

[12] Jinfa, C., (2015). An Intelligent Human-Tracking Robot Based-On Kinect Sensor. *Graduate and Professional Studies of Texas A&M University*

[13] Karl, T., Anastasia, B. & Gholamreza, A. (2016). Edge information based object classification for NAO robots. *Cogent Engineering (2016), 3: 1262571 http://dx.doi.org/10.1080/23311916.2016.1262571*

[14] Kheddar, A., Caron, S., Gergondet, P., Comport, A., Tanguy, A., Ott, C., Henze, B., Mesesan, G, Englsberger, J., Roa, M., Wieber, P., Chaumette, F., Splindler, F., Oriolo, G., Lanari, L., Escande, A., Chapplellet, K., Kanehiro, F., Rabate P.(2019) Humanoid robots in aircraft Manufacturing *IEEE Robotics and Automation Magazine, institute of Electrical and Electronics Engineers*