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Improved Intelligent Base Technique for Path and Solution in Robotic Using Prewill Edge Detection Paradigm

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ABSTRACT: 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 developed prototype of the motorized robot shows that robots in real life exhibit some level of intelligence. In the design process, the model of a humanoid robot was developed first using the simulink library tools in Matlab/Simulink environment. This research paper has improved autonomous path finding robots by incorporating very powerful and well-structured program/codes that gives the robot the ability to predict and make smart decision lending to efficient execution of desired assignment (picking of dirt in the surrounding).Result shows that the developed robot has simplified the way No robot interacts with object thereby saving cost and energy. A motorized autonomous path finding robot was designed and constructed to demonstrate the working principle of robot. The motorized robot and the humanoid robot have the capability to detect obstacle along its part at 30cm away from the obstacle. When the robot is switched on, it initializes after which forward movement until it gets 30cm closer to an obstacle it then stops, reverse backwards and then change direction. When it moves 30cm close to another obstacle, it stops reverse backwards, then turns left or right to another direction, and will continue to behave that way until the power button is switched off.

KEYWORDS: Humanoid robot, Servomotor, Motorized robot, modeling a humanoid robot, Microcontroller, Obstacle avoidance, Edge detection, Ultrasonic sensors, Robot motion process, Autonomous motorized, Dynamic motion.

I. INTRODUCTION

Recently there is a growing technology known as physical mobile robot agents, this is becoming part of our everyday life. This robot has the ability to work in hazardous environment such as the hospital, battle field and in our homes .There is a strong believe that this type of robot will continue to wax stronger and stronger in our modern society. Robots are designed in a way to perform a number of roles in our modern society today which covers areas such as factory automation and entertainment. This has drastically reduced a lot of work for human since humanoid robot can virtually do everything perfectly well. In the recent days some humanoid robot can perform surgical operation on patient perfectly well. This sense of complexity exhibited by today humanoid robot has necessitated a new dawn in the era of humanoid robot which is capable of accomplishing interactive task in human environments.

Furthermore, this work focuses on modeling, simulation and analysis of path-finding, object identification and obstacle avoidance robot using edge detection paradigm.

To tackle the problem of humanoid robot in terms of effective obstacle avoidance algorithm a more robust system was introduced called motion sensor detection technique, which uses powerful motion sensor to detect object within the robot's field of view. The major hindrance for humanoid robot is their ability to remain balanced and stable during walking. However, knowing fully well that humanoid robot and humans resemble in terms of walking pattern, it makes it more complex and cumbersome in planning its structure and the required computations more complicated task.

The aim of this paper is to 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 include:

(i) To develop a model of a humanoid robot using Matlab/Simulink blockset.
(ii) To incorporate, a framework for obstacle avoidance in humanoid robot.
(iii) 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
(iv) To design and construct a prototype of a motorized robot.

II. LITERATURE REVIEW

According to (Jinfa, 2015). An electronic device is said to be universal nowadays. With recent development in the area of computer vision technology and digital imagery, the way humans interrelate with the electrical equipment are being enhanced. The emergence of low-priced cameras has allowed additional people to enjoy the advantage of the expertise. (Jinfa, 2015). The kind of robot he designed was made mainly for household. In developing the system two modes exist, manmade tracking mode and motion-control mode of the system. For the human-tracking mode, the Kinetic antenna keeps detecting and keeps sending depth of data to the laptop through a USB data cable.

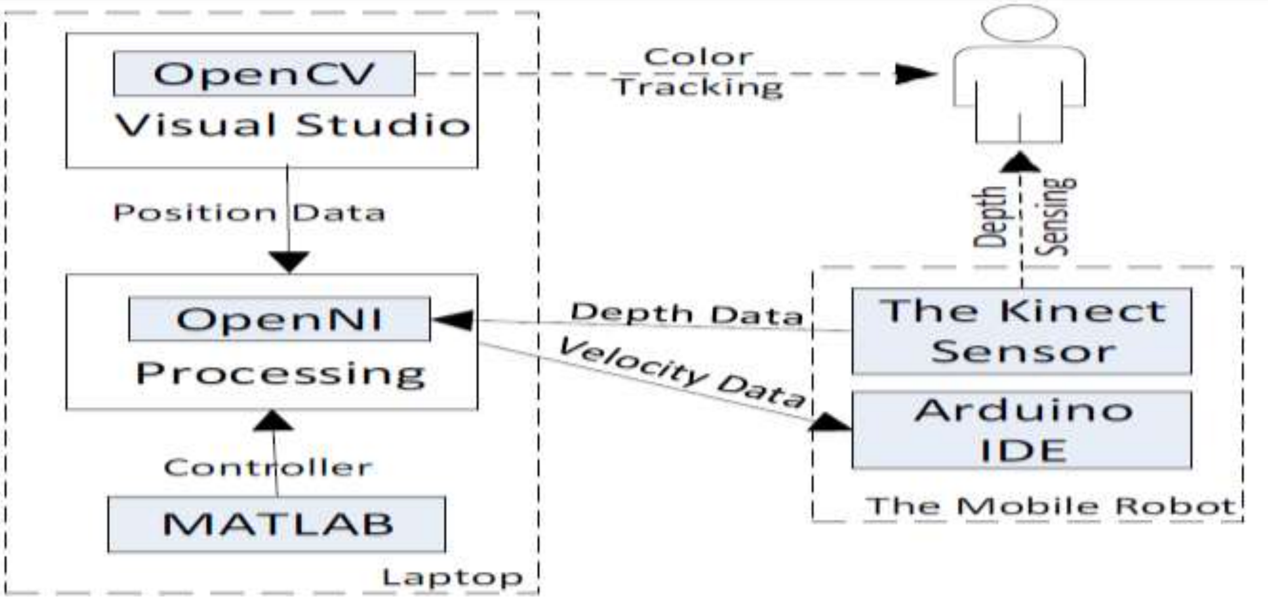


Figure 1. cooperation among software components (Jinfa, 2015)

The figure above is cooperation among software components as proposed by (Jinfa, 2015) the diagram shows how Matlab command is linked with an Arduino IDE to actualize a process.

Edge Information Based Object Classification for NAO Robots

According to (Karl, T. 2016) the robot built by NAO is a made of computer programs which was designed by programmers in Aldebaran industry. The NAO robot has gained significant recognition both in the world of academic circles and also in the private division.

In this research paper two methods were proposed namely; haphazard forest and cranny's pattern of edge detector. These two edge detectors have their disadvantages as each of them with failure cases as observed during experiments of both edge detectors. This was as a result of too much noise detected or omission of important details during detection. Not many researchers could work successfully on robust face recognition and basic mathematical teachings by the humanoid robot. He attributed Behavior-based robots (BBR) as a term associated with more biological behaviors unlike their counterpart which is more intensive in computations, which are very deliberate in their actions**.**

The research paper started by knowing and describing the morphologies of soft actuators. He went further to use a material known as soft lastomer during the design and fabrication of the fluid ally driven soft actuators. Fluidic ally driven actuators is also known as bodies that are made of materials which appear soft rubber-like, the material have interior chambers which enables it to pressurize through fluids, such as air or water.

According to (Kumar, P. 2018 et.al.) in a research work "An intelligent navigation of humanoid NAO in the light of classical approach and computational intelligence" presented a classical method of regression analysis and artificial intelligence.

Fluidic allys Actuated Soft Robots

According to work done by (Linert, 2018 et.al.) it is obvious that soft robotic technologies not only enhance traditionally rigid locomotion and manipulation approaches, but also offers a fresh resolutions where there were none existing before. The field of robotic bipedal motion studies uses diverse approach to handle modalities for space movement. The field of robotic operation deals with systems that have to do handling and interaction of human beings and also handle jobs like picking of object, moving the object and placing them accordingly.

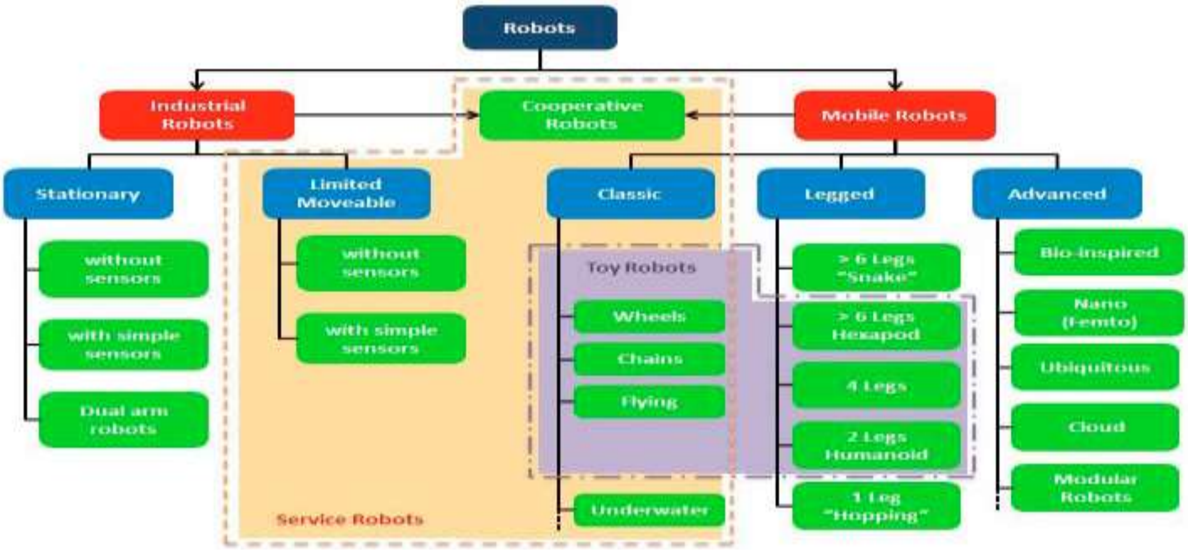


Figure 1.1. Categorization of Robots (linert, 2018 et.al.)

The figure above is a categorization of robots as proposed by (Linert, 2018 et.al.) Two major areas were used in this research work, namely; active operations with soft arms and also the reflection of marine life through biometric unresponsive machinery.

The thesis addressed some of the major challenges as it relates to innovation in the design concept, fabrication, modeling and control structure. Those innovations are validation in applications for locomotion and manipulation.

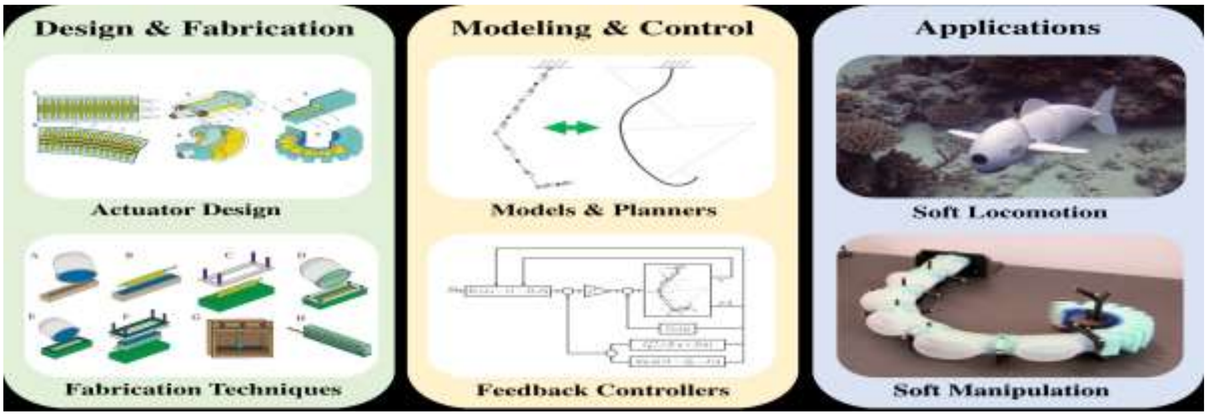


Figure 1.2. The design and fabrication of the soft robotic systems(linert,2018 et.al.).

Bipedal Robots for Lower Limb Rehabilitation

A careful study of the work done by (Xiong, 2017 et al), in his research paper titled “State of the Art: Bipedal Robots for Lower Limb Rehabilitation” it was observed that the two leg walking robot is one of the greatest good-looking robot kinds given its likeness to the motion of human existences together with their ability to assist people especially during psychoanalysis. The review in this research paper summarized the sequential consecutive development of bipedal robots and introduced some recent popular bipedal robot age. In the course paper, the rudimentary notion firmness directs key technology-motion scheduling of bipedal robots which was introduced and well evaluated. Two leg walking robots have remained known for its popularity and extensive usage in the service such as teaching, theater, and many other manufacturing.

The biggest issues with these procedures are the tuning of the gain factor in the regulator rule. When that comes the occasion of response and the usage of LQR optimization, takes course which is either to choose from either from Q and R conditions which eventually effects mainly dissimilar regulator improvements and hence forth diverse reaction properties which has to do with the promptness of retrieval from an impulse interruption. The links of the system serves to describe the offsets of the joints from the parent. The links also describes the rotation relative to the parent. (Pedro, 2019) “An Omni-Directional Kick Engine for NAO Humanoid Robot” Due to the complex nature of the robot with respect to components such as non-linear forces applied on the robot’s links, the dynamics of the robot is very complicated.

Figure 1.3. Webots Graphical Interface (Pedro, 2019)

The figure above is a webot graphical user interface as designed by (Pedro, 2019) the graphic user interface enable the robot developer to set the properties and functions of the robot.

Figure 1.4. The ZMP error between the reference point and the actual ZMP, and the position of the COM in x and y. (Pedro, 2019)

The figure above is the result of zero moment point inaccuracy amongst the reference position and the real system.

Simplicity and efficiency Our proposed stepping controller employs a simple linear dynamics (LIPM) which ignores angular momentum around the CoM and also consider fixed CoM height. This, together with introducing the idea of DCM offset and the change of variable in (20), enabled us to construct a very simple optimization problem for the walking controller. Simulations on the full humanoid id model showed the great capability of our approach in rejecting disturbances despite its simplicity.

According to (Poobathy D. 2017 et.al.) in a research paper titled " An analysis on edge detection algorithms based on processing time" presented a detailed analysis of processing time which the system uses to find and plot edges for the input images. Results showed that processing time for each image. And it therefore means that canny operator needs more time than other edge detectors for algorithms and that prewitt edge detector has the processing time. This results shows that prewitt edge detector is better than every other edge detectors in terms of processing time.

In other to ensure the effectiveness of robot in the real world scenarios, there are certain capabilities which must robustly navigate such a complex 3D environments through the usage of multiple modes of mobility. This implies that, legged robot to be capable, it must be both dexterous. (Simon, 2017)

Based on the implementations and results of this research paper it can be deduced that the usage of Acumen brings some better features and advantages. These advantages of Acumen are proving the correctness of the thesis considering the research question. Apart from the aforementioned, there is still place for improvements. Due to the limited time and the fact that Acumen is an experimental language the humanoid robot in 3 dimensions is only able to move forward ona slope and also the double support phase is only capable of sagittal movements.There are lots of computational requirements observed on the research paper based on the usage of Lagrangian Formalism

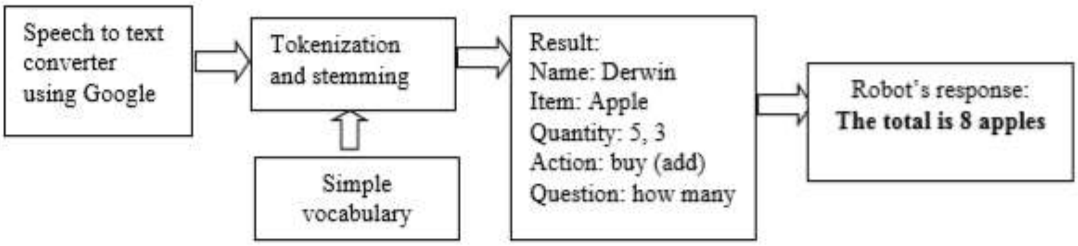


Figure 1.5. Block diagram of the tokenization and stemming process until the robot able to answer the question from user (Simon et al, 2017).

The figure above is a tokenization and stemming process of a robot as proposed by (Widodo, 2017 et.al.) the process keep executing until a certain condition is mate.

According to (Raffard, S. 2016 et.al) in “humanoid robots versus humans” evaluated how schizophrenia patients reorganizes facial feelings demonstrated by humanoid robots. The method used here, was the display of human photographs and that of the humanoid robot photographs and result showed that patients recognized better and faster the emotional valance of facial expressions by human beings than that of the humanoid robot. According to (Retto, J., 2017) in a research paper titled “Sophia, first citizen robot of the world” Affirmed that Sophia being the first humanoid robot has so many new technological advancements.

The robot lacked good manipulation skills which in turn hinders good grasping.

It is good to know that a robot that can jump needs a very great winding output in other to speed up its controller at the commencement often movement and also must understand a very great speed during the completion of the movement.

Figure 1.6. (a) BHR6 humanoid robot(Robert, 2018).

The figure above is a result of a humanoid robot model as proposed by (Robert,2018).

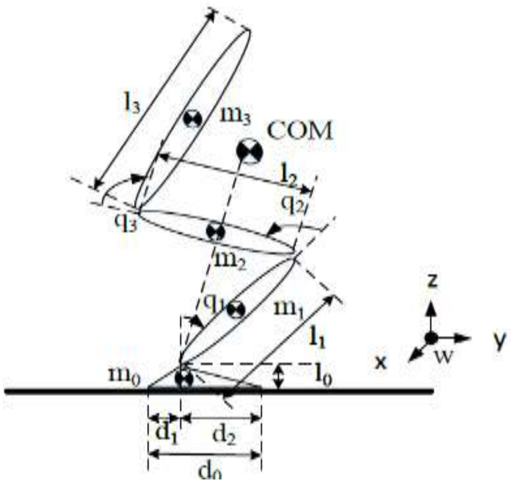


Figure 1.6(b) The simplified model with the similar physical properties

The figure above shows a basic model together with the comparable bodily properties of BHR6.

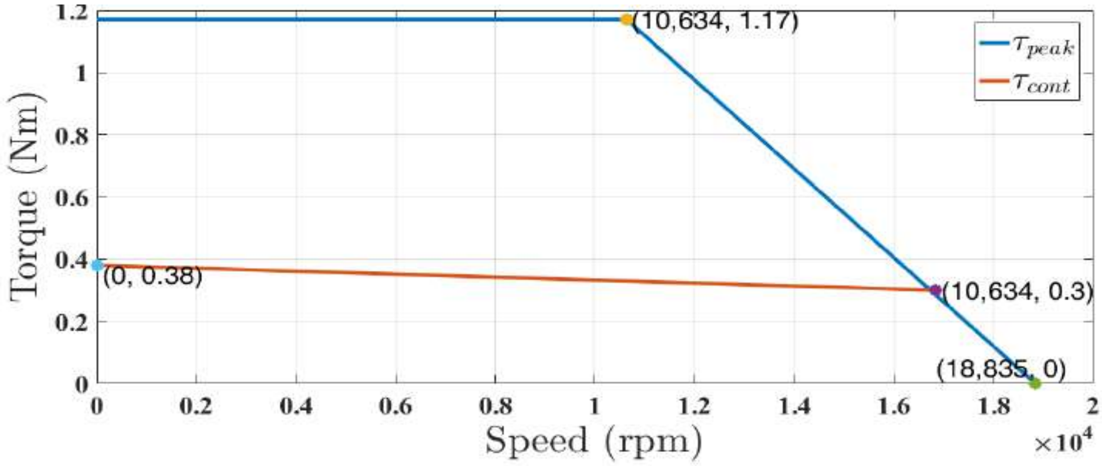


Figure 1.7 Torque speed curve of the motor K044100-6Y-4.98Ams when the voltage supplied to the motor is 120 V

In the figure above, it is a turning speed curvature of a robot arm with motor based system. In his research paper, the effectiveness of harmonic reduction agent was not measured. Thus, there were calibrations of the torques based on its rapidity curvature of the motorized on a specialized motor testing stage, with or deprived of reducer.

(i) While the robot obtains an amplified jumping height based on the principle of the torque and ZMP constraint, he quickly reduces the contact force and maintains a land able equilibrium during which the landing segment which remained important scenario.

(ii) It was initiated that the obstacle bearing and the beginning ankle angle q of 10 had a virtually linear affiliation.

OPTRAGEN is a Matlab tool within is toolbox, that was used in converting the optimal control problem to a problem that is not linear in nature, which was then solved by a arithmetical optimization program.

The trajectory generation for the planar model of the humanoid was successfully completed.

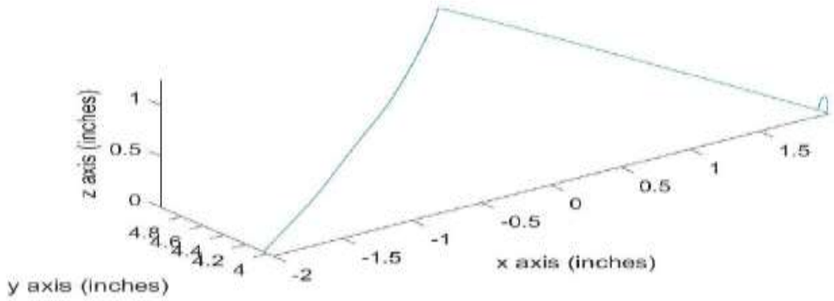


Figure1.8. Result for 3D walking Gait (Change in left leg position along the x, y, and z directions during Left Leg Gait)

The figure above is an end result of the gait synthesis was visualized using the 3D model of the robot in Matlab.

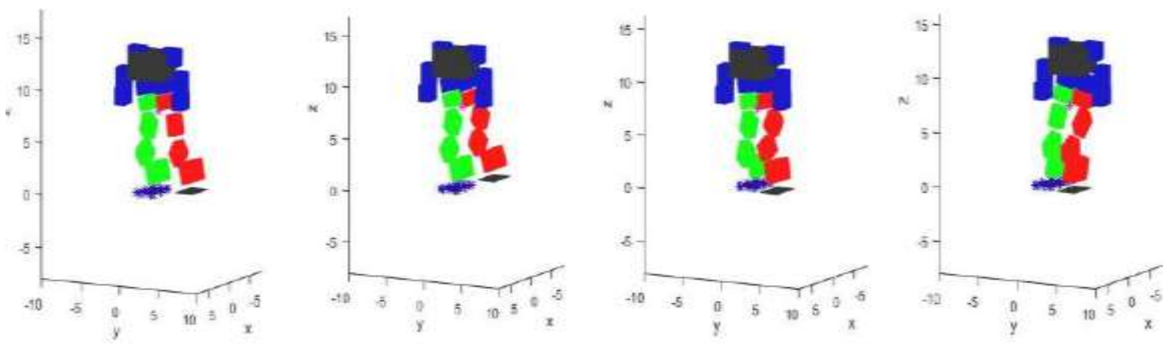


Figure1.9. The left leg-walking gait displayed on visual model in Matlab

The figure above is a left leg walking gait displayed on visual model in matlab. In this research work there was an important constraint, The results do satisfy all of the above requirements; the left leg position along the z-axis does not go below 0.The work lacked proper implementation of an integral control that would balance the effect of the load on each other.

Model Based Control

From Open Loop to Model-based Control" Bipedalandhumanoid robots are said to be a mechanical system, hybrid systems. Modeling and simulating such system is a highly multifaceted task. Furthermore, a humanoid robot with a higher number of DOF is also highly unstable in their dynamics. Therefore, it is realized by improving a simple 2 dimensional passive walker with 2 links in a stepwise manner.

The basic principle of the passive walker is the transformation of potential energy into kinetic energy, which is done by a walking gait along a slope.

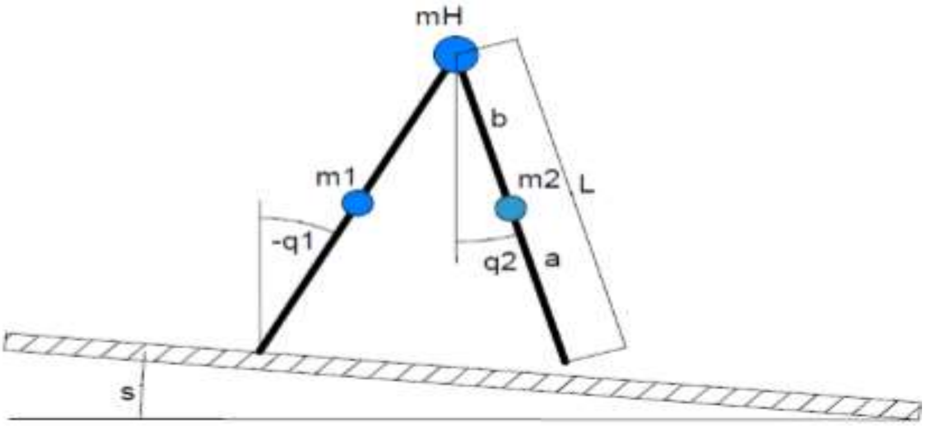


Figure 2. Bipedal robot with 2 joints, 3 masses in 2 dimensions

The figure above is a bipedal robot with 2 joint masses in two dimensions.

Table 1. Physical parameter of bipedal robot

Parameter	Description	Value
m	leg mass	5
m_H	hip mass	10
g	gravity	9.81
a	length shank	0.50
b	length thigh	0.50
l = a + b	length leg	1

Bipedalrobotcan be described with two different phases. The SSP defined by the Lagrangian formalism on the one hand and the DSP formulated using conservation of angular momentum on the other hand.

The Components of the Humanoid Robot are as Follows.

1. The power source unit section: The power source unit is used to provide power to the humanoid robot.
2. Actuators: This device is used as energy converter inside the humanoid robot.
3. Electric motor: This is referred to as an electromechanical component that is used in converting an electrical energy in the humanoid robot to mechanical energy. This helps to provide rotational movement to the humanoid robot.
4. Sensor: this device is used to provide real-time information to the humanoid robot.
5. Controller: this is used to coordinate motions of the mechanical systems of the humanoid robot.
6. User Interface: This is the environment where the user interacts with the computer.

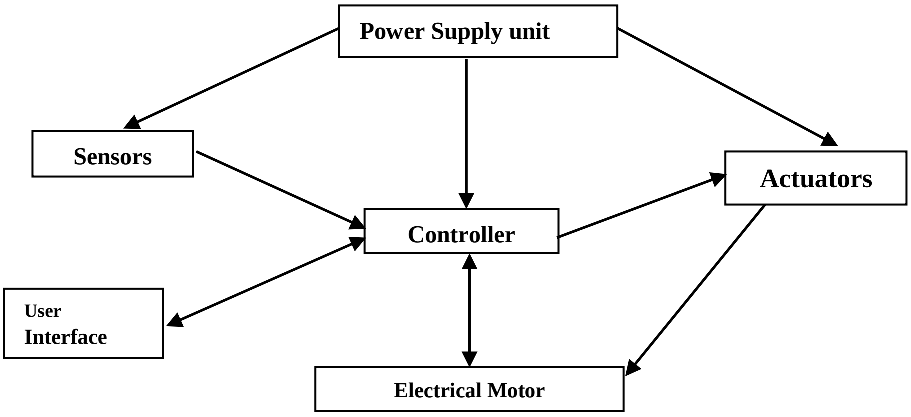


Figure 2.21 Components of A Humanoid Robot

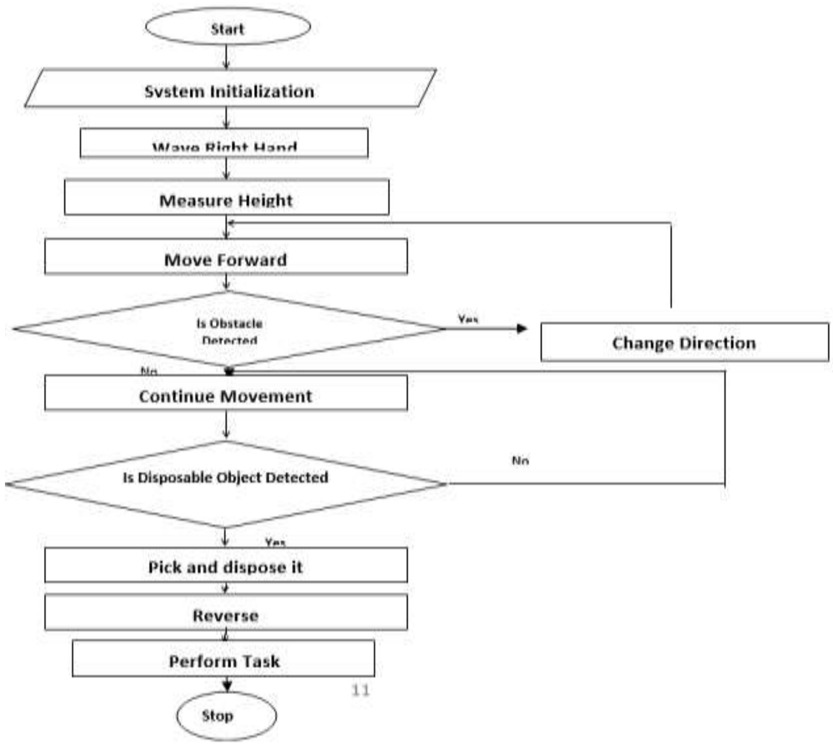
The figure 2.2: above describes the five major components of humanoid robot. The power supply unit is used to supply power to the humanoid robot. The sensors are devices used to provide real-time information to the humanoid robot while the actuators are energy converters in the humanoid robot. The controller is used to coordinate the activities of motion of the mechanical system of the humanoid robot. The electric motor, which is an electromechanical component, is used to convert electrical energy to a mechanical energy.

MATERIAL AND METHOD

The research paper describes the method through which the expected system is achieved. The modeling of this humanoid robot passed through so many stages before actualization. Humanoids are extremely multifaceted and that is the reason why researchers have spreads out over all kind of systematic field, from technicalities to electronic from model based to control based and also from informatics extending to biomechanics. 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.

IV. Modeling a Humanoid Robot.

The first stage in this research work 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.



The figure 2.3. above is the flowchart of the humanoid robot.

The robot initializes itself display a wave command, maintains its balance and moves forward. When the robot covered a distance of about 2cm, it detected an obstacle and maneuvered it, it went further to detect an object, which turned out to be dirt and robot picked it and disposed it accordingly.

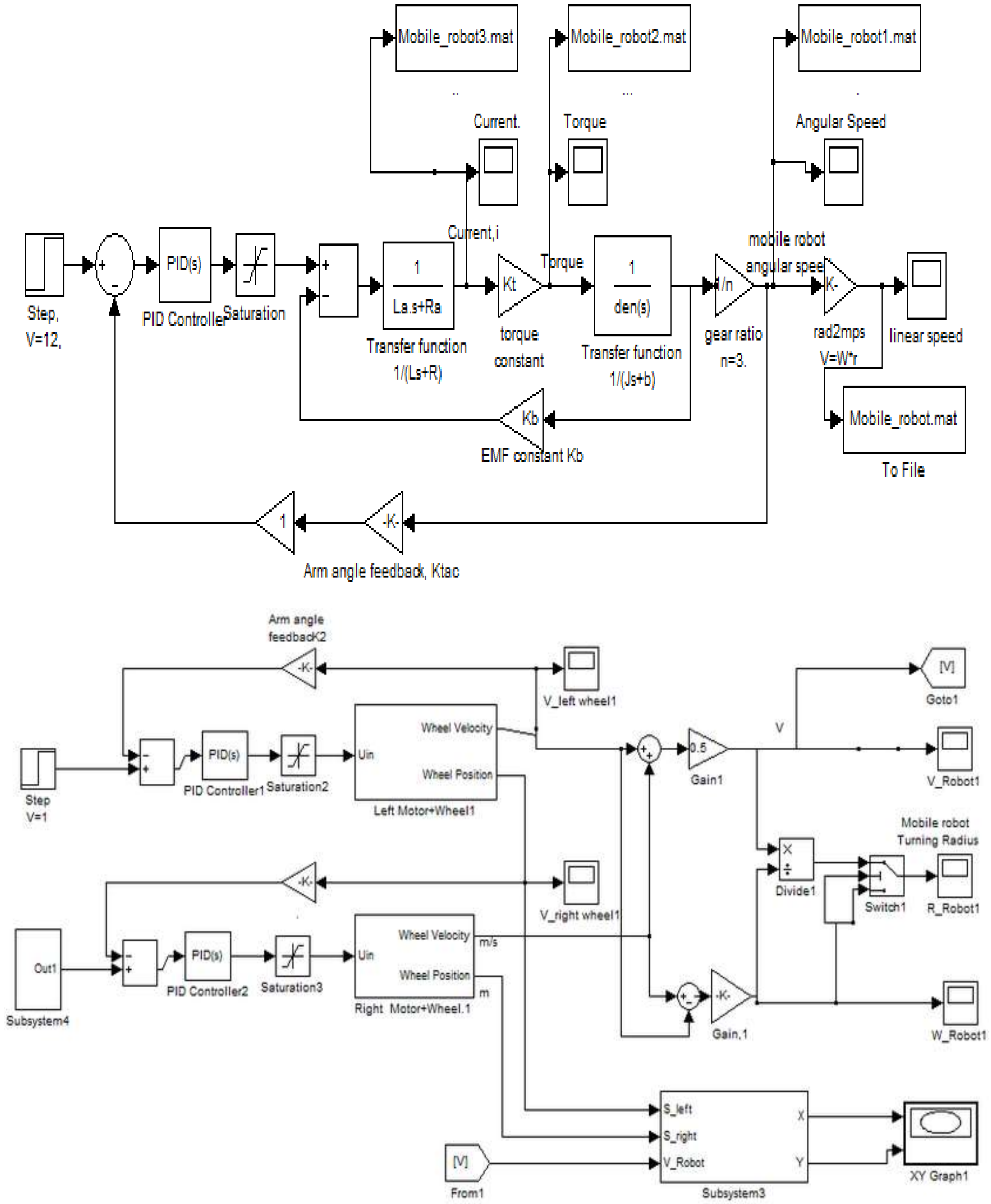


Figure 2.4. Simulink Block Diagram of a humanoid robot

The figure above can be referred to as a Simulink blocks of a humanoid robots. The blocksets were sourced from the Simulink library and connected as shown. The model which consists of so many subsystems, each subsystem handling a task in the development of a humanoid robot. The Inputs were provided for the linear actuator distances along with the joint angles for the hip and toe through the Simulink blocksets. The inverse kinematics was solved for the Sagittal plane and as such the toe joint along with the hip roll and yaw joints were kept at a fixed angle. A Matlab script was written to solve for the inverse kinematics for each joint along with the corresponding linear actuator lengths based upon the foot trajectory during the swing leg or the hip location for the stance leg.

V. Optimal Control based Trajectory Generation

All of the above methods were derived to achieve the stability in the walking pattern of humanoid. They aimed at maintaining stability in walking even in the cases of uneven surfaces, or sudden disturbances. Other than the above-mentioned methods, there have been many more proposed methods to achieve the same target with more robustness. An optimal control Matlab toolbox called Optragen, can be used for numerically solving optimal control problems.

Measurements and setting up of coordinate frames. The first task involved assigning each joint with a reference coordinate frame, which is described in terms of a translation and a rotation relative to the frame of the previous joint. There are 22 joints in total for the humanoid, with each leg having 6 joints and each arm having 5 joints. shows the assignments of coordinate frames for joints on the left leg and left arm of the humanoid. The right leg and arm assignments are similar to the assignments on the left side of the humanoid. In addition to these coordinate reference frames, a few other frames were also added. These include the torso reference frame, and a reference frame at the center of the base of each foot.

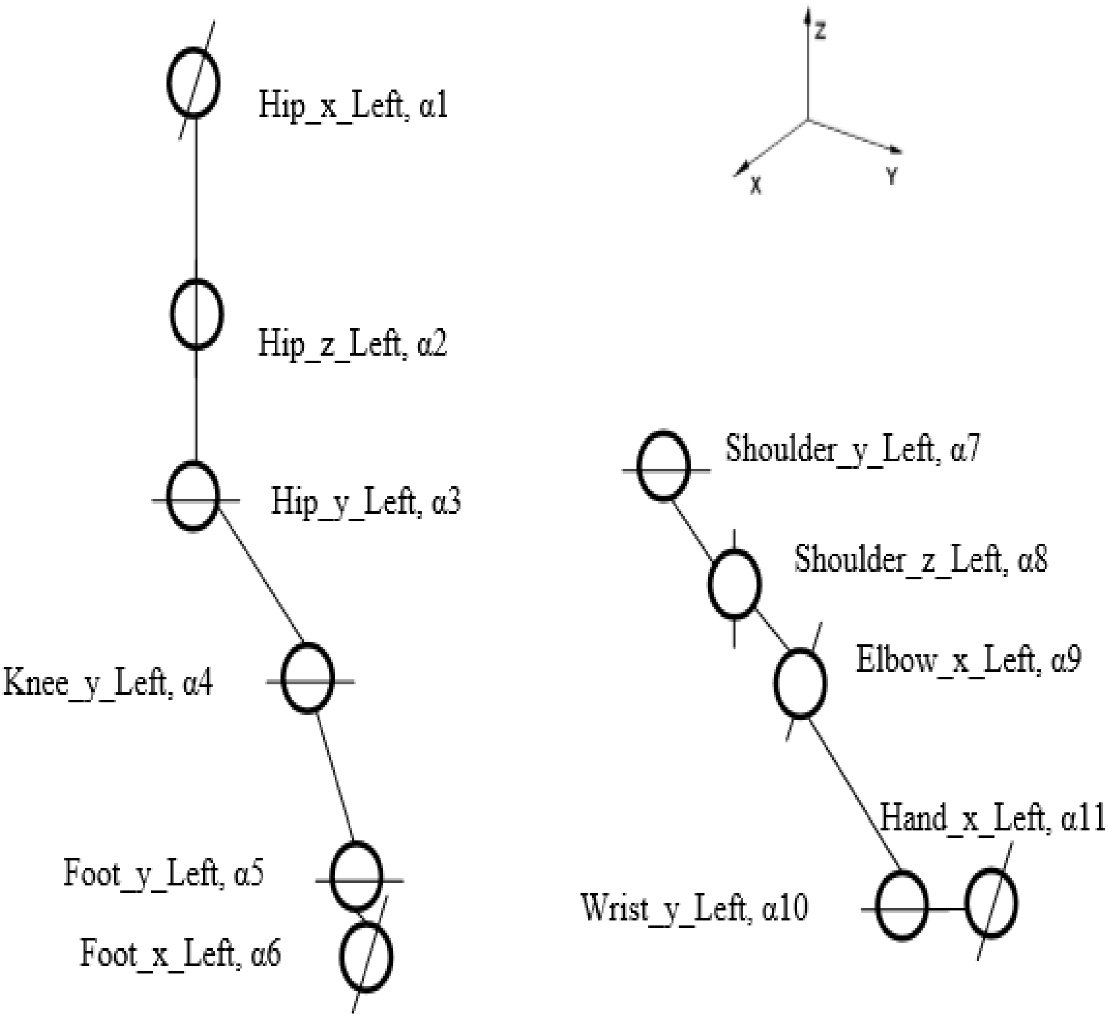


Figure 2.5. Description of Coordinate Frames for Joints on Left Side of Humanoid.

VI. Robot Motion Process

Generating dynamic motions on a robot without explicitly programming the motion is a difficult task and a new research area. In robotics, motion is the process of moving a link or links of a robot from one place to another in order to achieve an objective. When moving the links of a robot, the motion of the robot might shift the weight distribution to an unstable position. When the robot compensates for the instability and shifts the weight to a stable configuration, then the robot generates dynamic motions. The sensor also detects object and the robot navigate within its territory.

Otherwise, if the robot has a predefined set of motions, then the robot generates static motions.

Dynamic Motion and Task performance

In this objective, a framework for executing task by the humanoid robot was incorporated in the modeled humanoid robot. The sensors are programmed using Matlab Command to execute instruction according to the desired task. Dynamic motions are motions that have not been preprogrammed and are interactive with the environment. A dynamic motion generator receives feedback from perceptors. The information from the perceptors can then be filtered, and a model of the robot responds to the instruction. These models do not have all the nonlinear equations of motions to understand how the robot is behaving in the worldbecauseit is not feasible, but rather the models are simplified to a reasonable degree.

VII. Obstacle Avoidance Design

The robot tracks objects within its field of view or Region of interest and determines which ones remain stationary. Objects that could obstruct its navigation are intelligently avoided, using the embedded object detection paradigm.

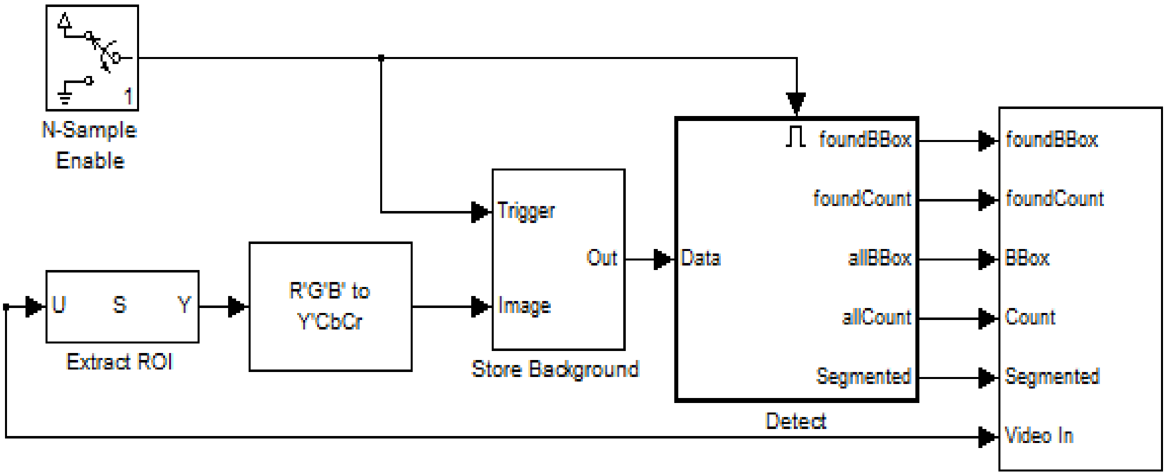


Figure 2.6. Simulink model for Obstacle avoidance

The Simulink blocks above describe an algorithm on how best to engage the services of the Blob scrutiny plus rooted MATLAB blockset to form a tracing procedure and maneuvering technique by humanoid robot. The system implements this process by the ensuing steps: 1) Disregard video areas that are doubtful to contain unrestrained objects by take out a region of interest (ROI). 2) Perform video segmentation using background subtraction. 3) Calculate object statistics using the Blob Analysis block. 4) Track objects based on their area and centroid statistics. 5) Visualize the results.

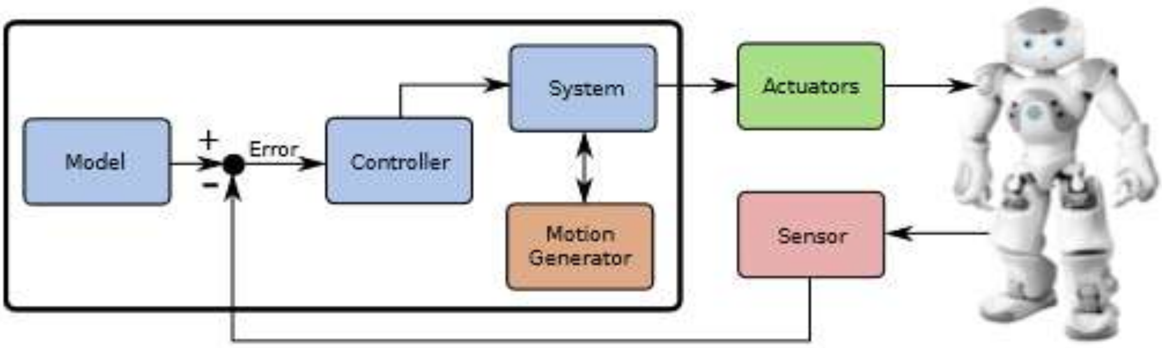


Figure 2.7. Dynamic Motion Frameworks

The figure above is a dynamic framework for a humanoid robot. The data from the sensors and the model is integrated and an error is calculated. The error is determined by the task being performed. For example, if a robot is walking, the error is the model's reference, or if a robot is trying to grasp an object, the error will be the perceived robot arm and the object's position in the world. When the error is calculated, then the controller tries to adjust the system by reducing the error and bring the actual output closer to the reference point. The system then receives this control input and communicates with the motion generator to produce a motion that satisfies this control input. The motion is then executed using the actuators of the system, and the whole process starts all over again. This type of c Controller is a closed-feedback loop, and it is essential for dynamic motion generation.

Interaction Dynamics

The most essential part of robotics is how the robot behaves in the physical world. It is also crucial to integrate the physical world in the design of a robot. For example, if a robot needs to lift load, the robot designer needs to consider the torque output of the motors to be able to lift these loads in the physical world. Although the robot might be stable on its own, it can lose stability as soon as lifts a load if the mass is heavy. Also, if a robot has to grasp an object, the material of the object influences how an object should be grasped. Therefore, without integrating the physical world, the robot is not able to interact with it. Hence, interaction dynamics

The general design specification that were followed in creation of this humanoid robot are as outlined in the specific objectives. The first is the development of a humanoid robot using an edge detection technique.

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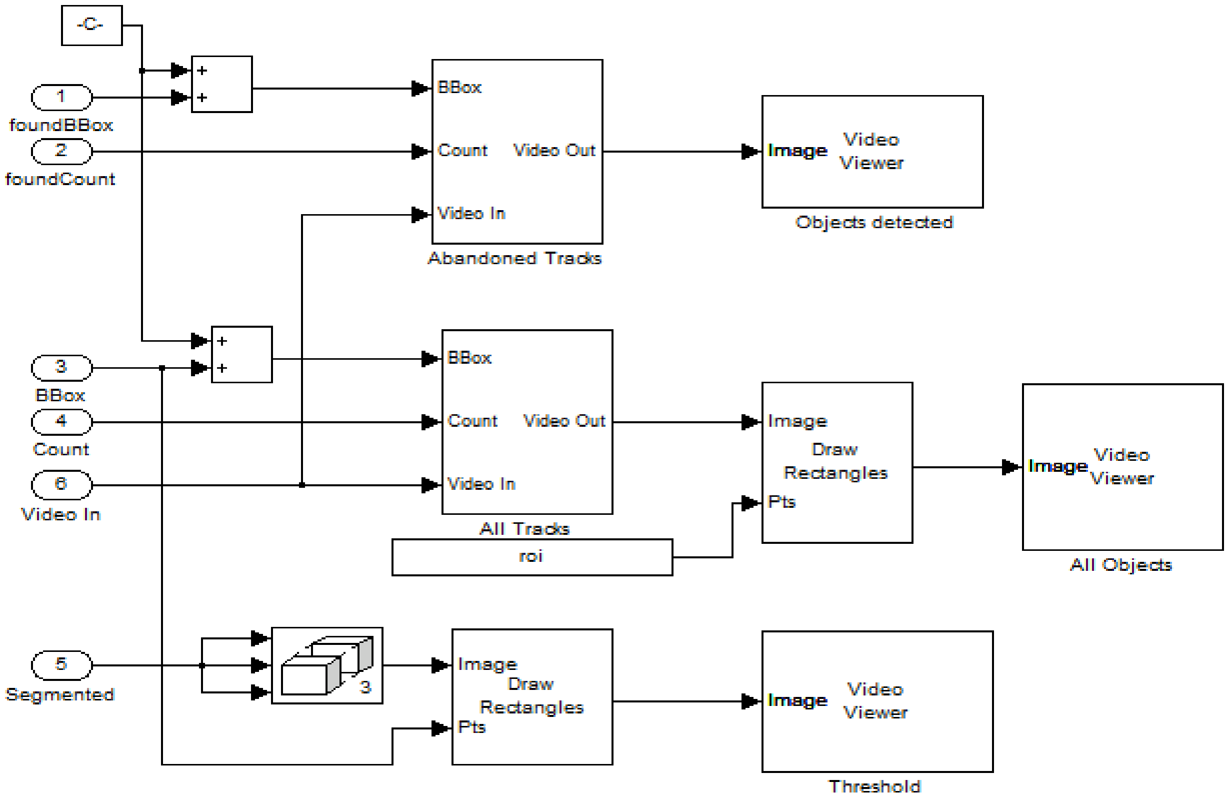


Figure 2.8. Analysis of identified object obstacle

The diagram above illustrates how the robot senses object and intelligently maneuvers its way to the targets locations. The Detected sub-system contains the main procedure. Inside this sub-system, the glance Separation and Color Separation sub-systems execute contextual detraction using the strength and color data. The program joins these two separation outcomes using a binary OR operator. The Blob Examination block computes measurements of the objects existent in the section.

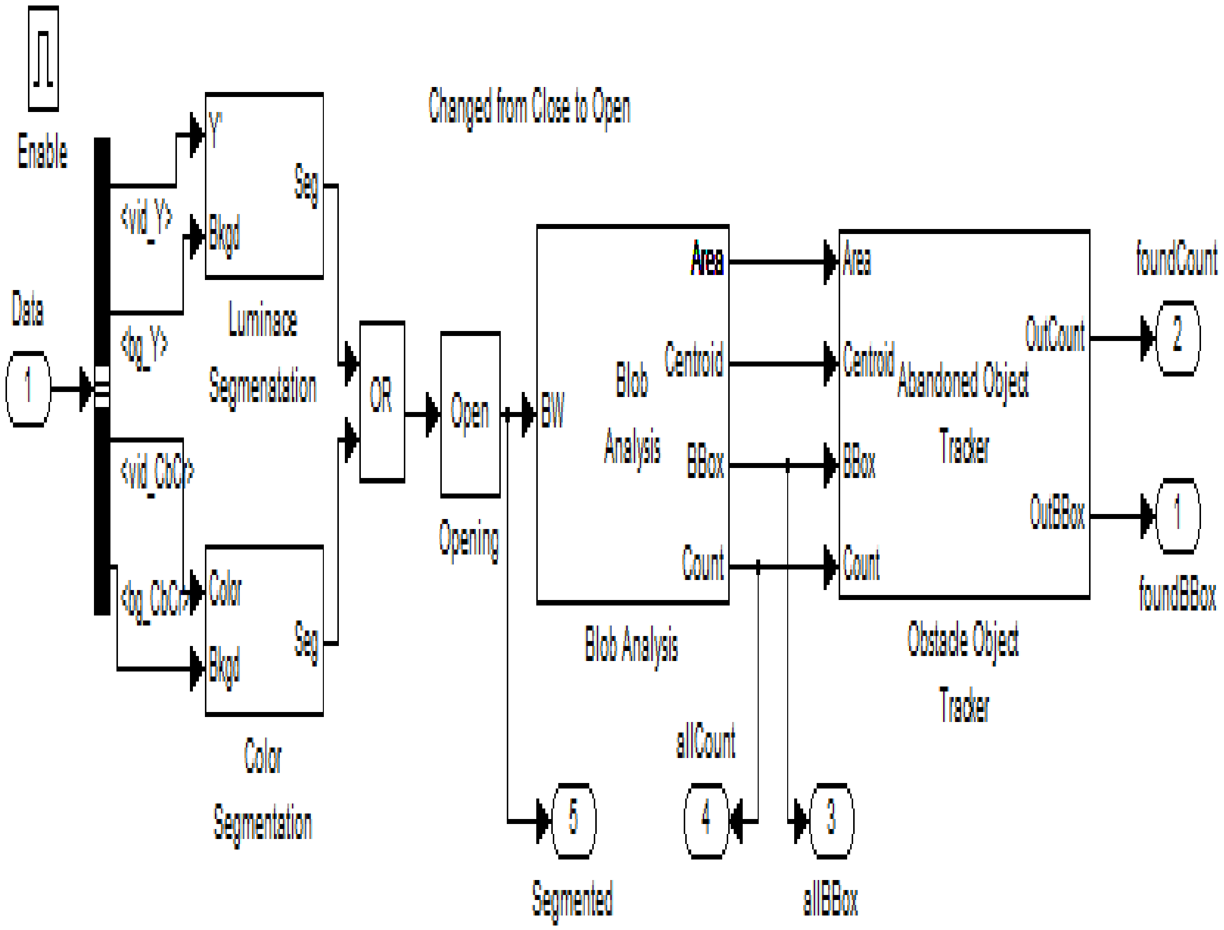


Figure 2.8. Tracking Algorithm of Obstacles

The system tracks object within its field of view using Blob analysis tools and object tracker block set features that are present in the Simulink library.

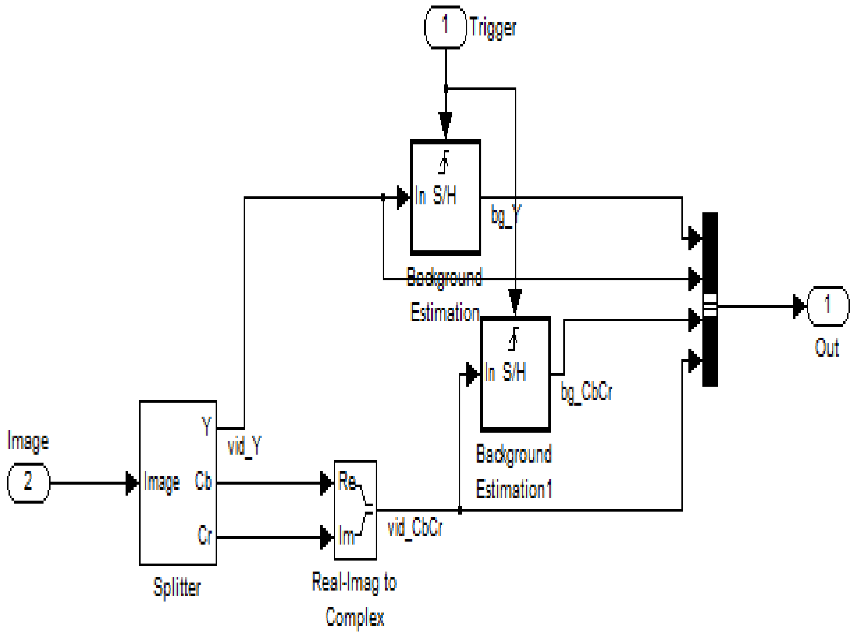


Figure 2.9. Stores Background Estimation

The figure above is a Store background estimation. The model uses the first frame of the video as the background. To improve accuracy, the program uses both intensity and color information for the background subtraction operation and this help the robot in decision making as to whether an object is an obstacle or mere dirt.

3. DETAILED DESIGN CONSIDERATION OF THE PROTOTYPE ROBOT

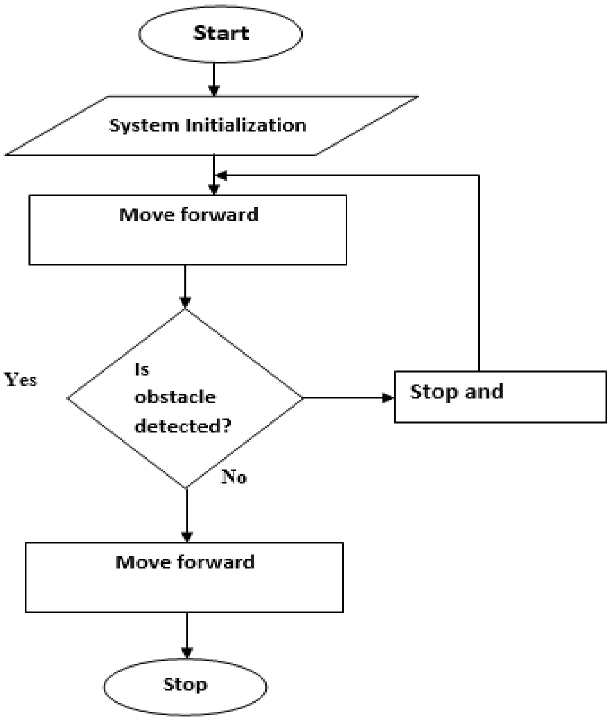


Figure 3.0: Flowchart for Autonomous motorized Path finding robot

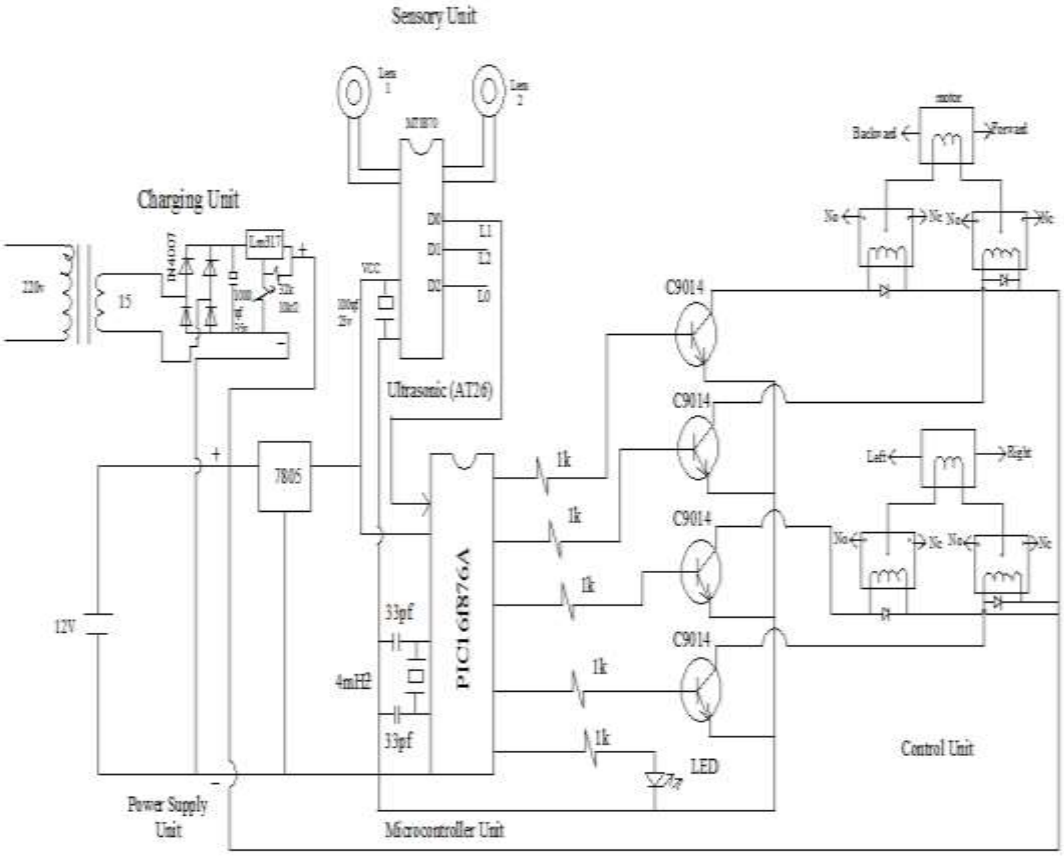


Figure 3.1: Circuit diagram of the constructed robot

The figure above is a circuit diagram of the constructed robot. The microcontroller is programmed in a way that it directs the action of the robot. The microcontroller is programmed to move the robot forward whenever the power button is switched ON. Whenever the robot detects obstacle, the sensor will detect the obstacle and the motorized robot will stop and reverse.

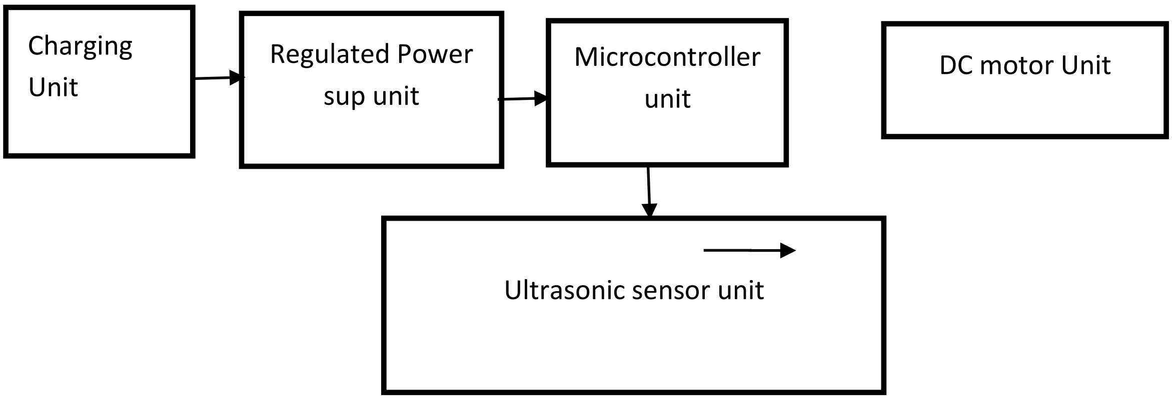


Figure 3.2: Block diagram of motorized robot

The figure above is the system block diagram of the charging unit is linked to the regulated power supplying unit which is linked to the microcontroller. The microcontroller is linked to the dc motor and ultrasonic sensor unit.

VIII Transformer Section

Transformer is a static device that transforms sinusoidal signal from one level to the other and both sides operating at the same frequency. This transformer is a step down type, which steps 220volts to 15volts.

Calculation

Number of turn

$$\frac{Np}{Ns} = \frac{Vp}{Vs} \quad 1$$

Where the N.p. = Number of turns at the primary

N.s. = The Number of turns at the secondary side

V.p. = The Voltage at the primary side

V.s. = The Voltage at the secondary side

Since N.p. and N.s. are unknown, the above formula will not work.

The formula that can handle it is the transformer voltage rating per coil rule.

This rule states that for a coil to work effectively without heating.

3 turns = 1 volt will be the estimated coil to voltage ratio

If 3 turns = 1volt, how many turns can handle 15volts and 220 volts respectively.

Determination of primary turns

For 220volts

1V = 3Turns

220V = ?

$$\frac{220}{1} x\ 3T = 660\ Turns$$

For 15 volts

1V = 3Turns

15V $= \frac{15}{1} x\ 3T = 45\ Turns$

Wire gauge determination

Primary side

P = VI

10watts = 220 I

$$I = \frac{10}{220} = 0.04545A \quad 2$$

Secondary side

P = VI

10watts = 15 I

$$1 = \frac{10}{15} = 0.66667A$$

IX RECTIFICATION

During the positive half cycle diode D_1 and D_3 conducts while during the negative half cycle diode D_2 and D_4 conducts. The output of the secondary winding during the positive half cycle will be 13.6 volts because the diode breakdown voltage for germanium material is 0.7V by 2 i.e D_1 and D_3 or D_2 and D_4 0.7 x 2 = 1.4V

15v – 1.4v = 13.6v

The capacitor after rectification, helps to filter out AC ripples.

The diode used for rectification is (IN5604). This is because it can deliver up to 2A at its output and the charger is required to deliver up to 0.7A which is 10% of 7A for it to charge a 7A battery needed to power the system effectively.

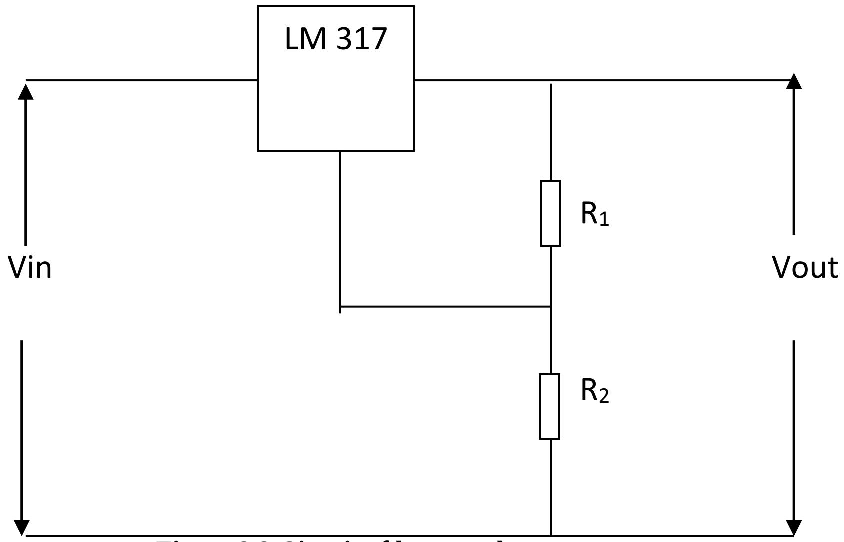


Figure 3.3 Circuit of battery charger

Calculation for LM317

LM317 is an adjustable voltage regulator which takes an input voltage of 3 – 40Volts and provides a fixed output voltage of 1.25 to 35vdc. It requires two external resistors to help adjust the output value. The output voltage V_{out} is dependent on the external resistors R_1 and R_2.

Equation:

$$v_{out} = 1.25\, x \left(1 + \frac{R_2}{R_1}\right) \quad 3$$

Where V_{out} is the value of the output voltage, R_1 and R_2 are the values of the external resistor

CALCULATION FOR CHARGING VOLTAGE

$LM317\ regulation\ equation$

$$v_{out} = 1.25\, x \left(1 + \frac{R_2}{R_1}\right) \quad 4$$

Where V_{out} = output voltage of the charger

R_2 = the value of resistors 2

R_1 =the value of resistors 1.

$$if\ R_2 = 100\Omega\ and\ R_1 = 11\Omega$$

$$\therefore V_{out} = 1.25\, x \left(1 + \frac{100}{11}\right)$$

$$V_{out} = 1.25\, x\, (1 + 9.0909)$$

$$V_{out} = 1.25\, x\, 10.0909 = \mathbf{12.61V}$$

This is the charging voltage for the 12volts battery used for the system operation.

Charging Current Relation

The charging rule states that for a battery to be well charged to maintain specified life span, the charger must be able to give out at least 10percent (10%) of the battery's ampere rating. Example for a battery of 100AH by 12V, for the battery to be well maintained, the charger must be able to deliver up to 10A which is 10% of 100AH. Our battery is a 7A by 12V so the designed charger is able to deliver up to 3.5A and the required current for the system effective operation.

Power Supply Section

The power supply section is made up of 12volts battery and 5volts voltage regulator (7805). The battery ensures a constant uninterrupted 12volts d.c. supply to the system. The microcontroller works effectively with 5volts d.c. To obtain that, a positive 5volts regulator is employed (7805). The regulator is made up of 4 digits number as follows 7805.

The first two digits specifies that the regulator is a positive type while the last two digits 05 specifies the output of the regulator. A negative voltage regulator 7906 starts with 79 and ends with output voltage number of 06.

X MICROCONTROLLER

The microcontroller unit is the unit in-charge of all system intelligent operation. The written instruction code is embedded in the microcontroller memory. The microcontroller used in this design is PIC16F876A. It is a 28 pin controller, it is used because of the number of actions required to be controlled. The microcontroller serves as the brain of the robot. More information on the microcontroller is as represented in the data sheet of the microcontroller as presented in this report. See Appendix D.

Figure 3.4: ULTRASONIC SENSORS (HC – SR04)

The figure above is an ultrasonic sensor device; the robot uses the ultrasonic sensor to detect obstacles along its path and maneuvers.

Table 1.2 Ultrasonic Sensor Pin Configuration

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

Ultrasonic sensor is a four pin module whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing object is required. The module has two eyes which projects in the front to form the ultrasonic transmitter and receiver. The sensor works with the simple high school equation that:

Distance = Speed x Time

The Ultrasonic Transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back towards the sensor, this reflected wave is observed by the ultrasonic receiver module. Now to calculate to the distance using the above formula , we should know the speed and time. Since we are using the ultrasonic wave at room condition which is 330m/s, the circuitry in-built on the module will calculate the time taken for the ultrasonic wave to come back and turns on Echo pin high for that same particular amount of time, this way we can also know the time taken.

Furthermore we can power the sensor using a regulated +5volts through the Vcc and ground pin of the sensor. The current consumed by the sensor is less than 15mA and hence can directly be powered by the on board 5volt pin. The trigger and Echo pins are both I/O pins and hence they can be connected to I/O pin of the microcontroller.

To start the measurement the trigger pin has to be made high for 10us and then turned off. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and receiver will wait for the wave to return. Once the wave is returned after it gets reflected by any object, the echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor. The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the sensor. Using this information the distance can be measured.

Ultrasonic Sensor is also used in the following ways;

1. Used to avoid and detect obstacles with robots like biped robots, Obstacle avoider robot and path-finding robots
2. Used to measure the distance within a wide range of 2cm to 400cm.
3. Can be used to map the object’s surrounding the sensor by rotating it.
4. Depth of certain places like wells, pits etc. can be measured since the waves can penetrate through water.

Control Unit

The control unit is the unit in-charge of implementation of microcontroller's instructions. The control unit starts from 1KΩ resistor connected to the microcontroller.

Calculation

Output voltage from microcontroller is 5volts, the current limiting resistor is 1000Ω

But

V = IR

I = $\frac{V}{R}$

Where V = 5Volts

I = $\frac{5}{1000} = 0.005A$

Therefore the current/voltage going to the transistor base for triggering is 5volts by 0.005A According to C9014 transistor data sheet, the biasing current range from 0.002A to 0.010A. Therefore, the value of 0.005A is in order.

Relay

The relay used is a 12volt by 10A relay while the battery is 12volt by 7.2A. This means that the relay is suitable for this work

Figure 3.5: Servomotor

X SERVOMOTOR

We have two types of electrical motor that can be used for this design:-

1. Servo motor
2. Stepper motor

Stepper motor is of two types

1. R-Stepper motor

L-Stepper motor

R-Stepper motor – This type can only rotate clockwise when powered or energized while the L-Stepper motor type can rotate only in anti-clockwise direction.

The choice of servo motor for this work is as a result of its dual function of rotating both in clockwise and in anti-clockwise direction depending on the connection at the control terminal.

Test on the Modelled Robot

Tests were carried out on different models and the simulation ran effectively well. The whole model was integrated to form a complete humanoid system.

XI RESULTS AND DISCUSSIONS

This research work 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 algorithm for motion senser detection was also implemented motorized robot with autonomous navigation was implemented.

Below are the results of the simulated robot.

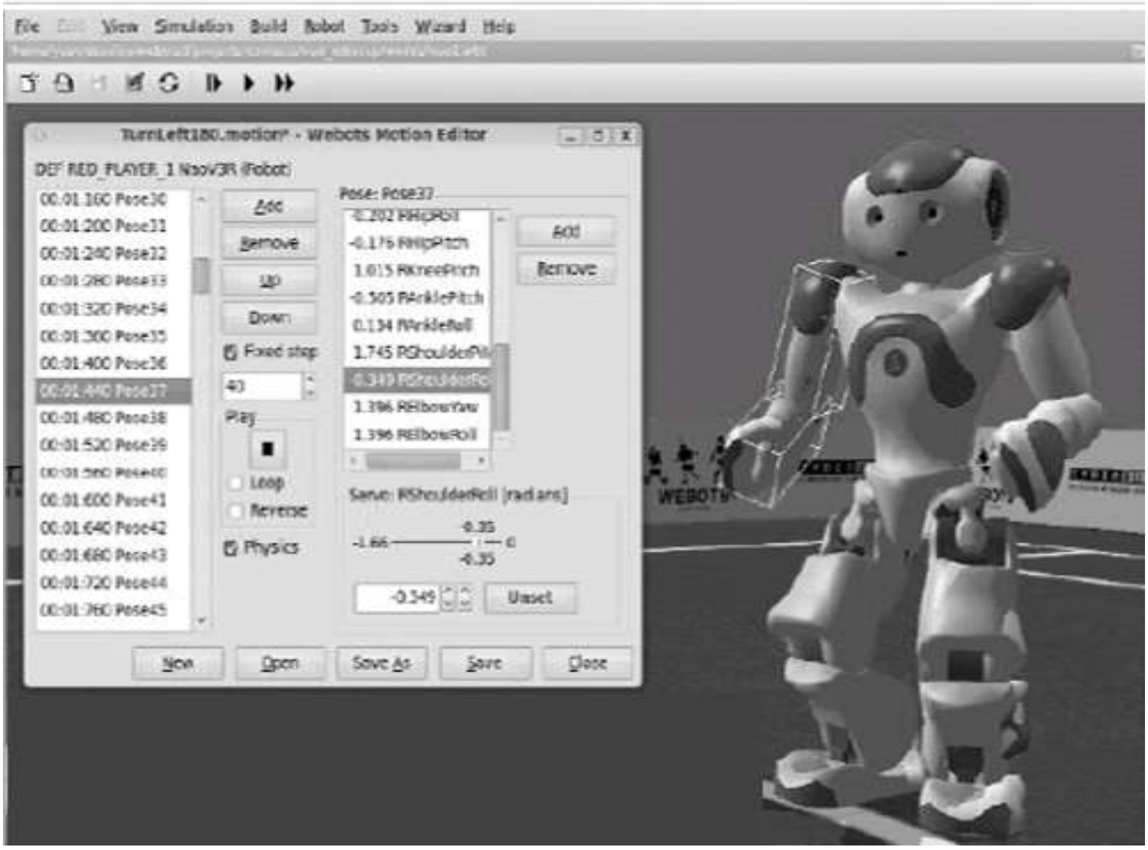


Figure 3.6: Simulation result of a humanoid robot

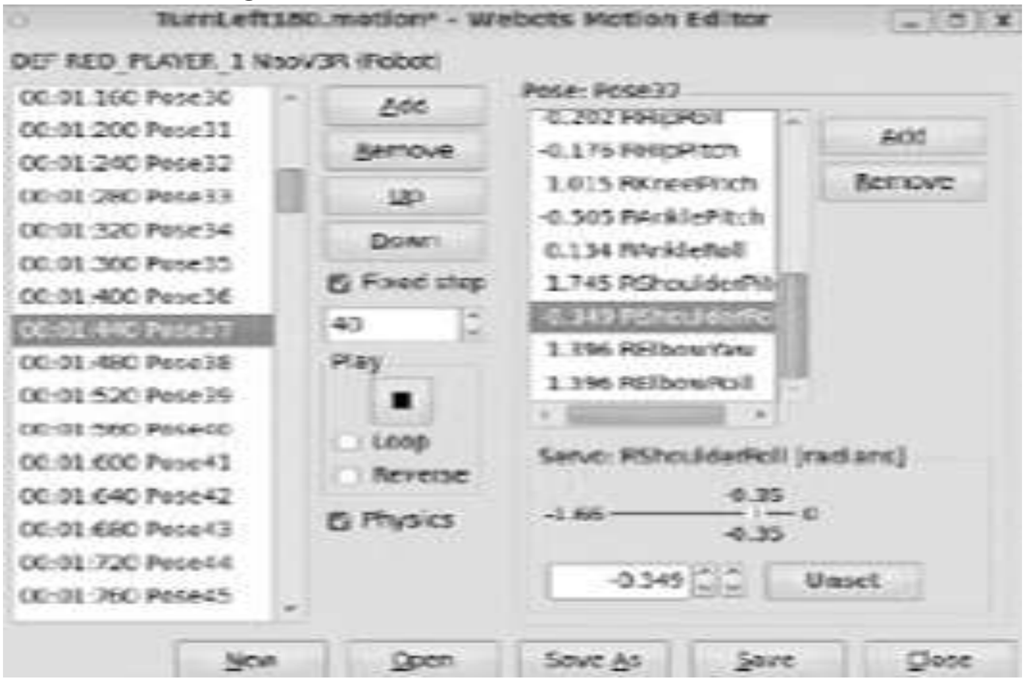


Figure 3.7: Motion editor

The figure above is a pose attribute of humanoid robot, showing different pose pattern.

The figure 3.6 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.

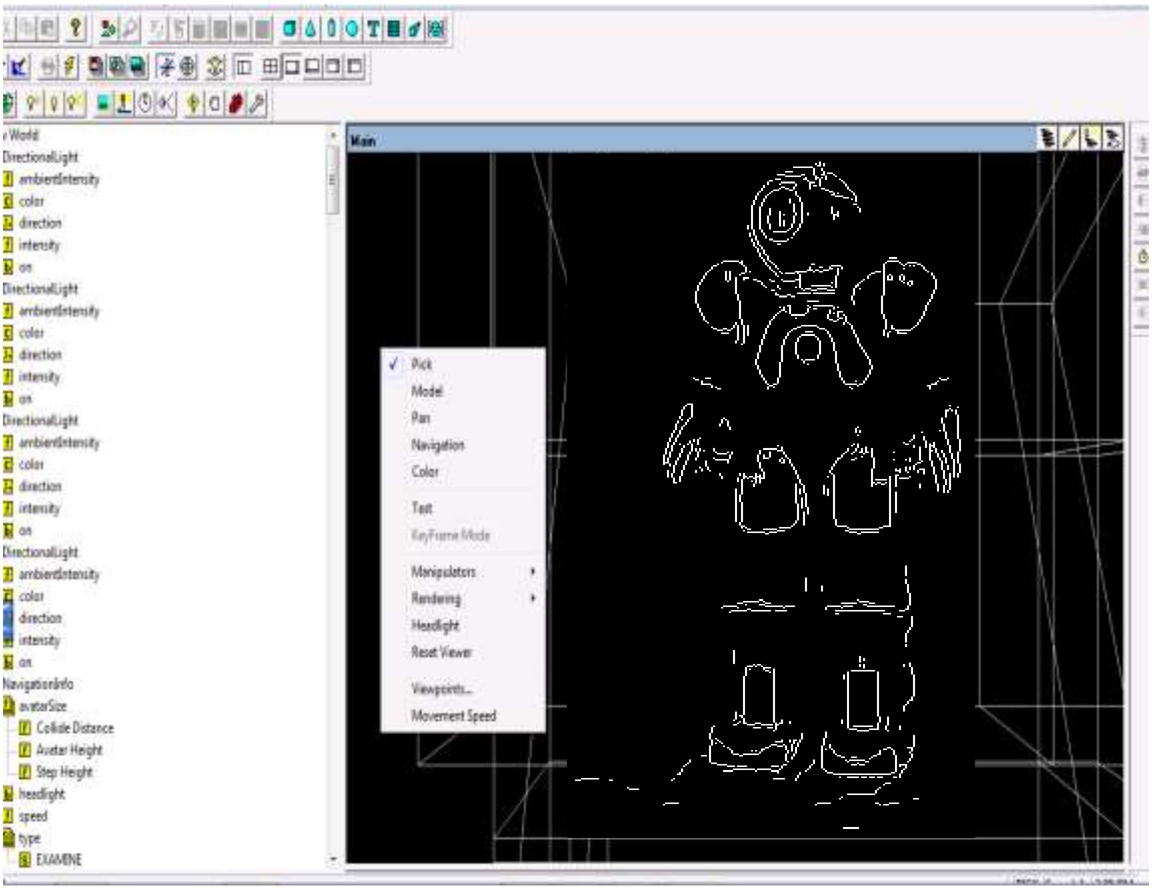


Figure 3.8: Humanoid Robot using Prewittedge detection

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.

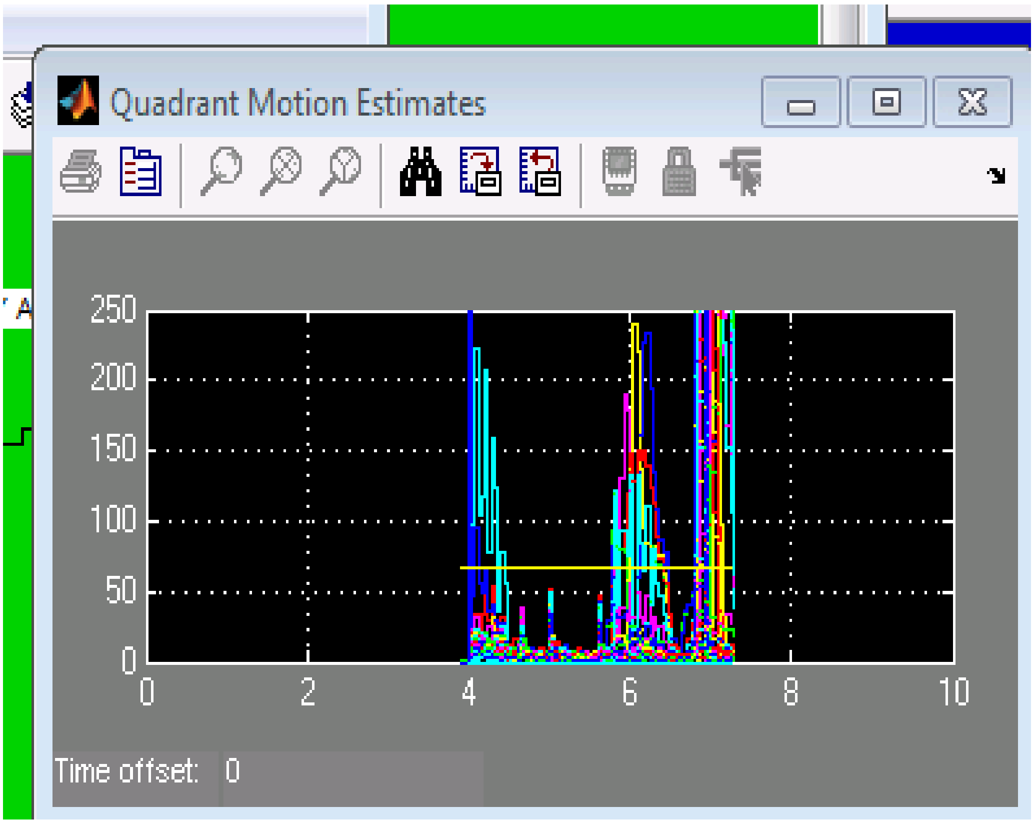


Figure 3.9: Robot with its quadrant motion estimate

The figure 4.2 above is the quadrant motion estimate. It shows the motion estimate of the humanoid robot. When the robot makes any movement, it reflects on the quadrant motion estimate showing all the actions of the robot.

XII Results on obstacle avoidance

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

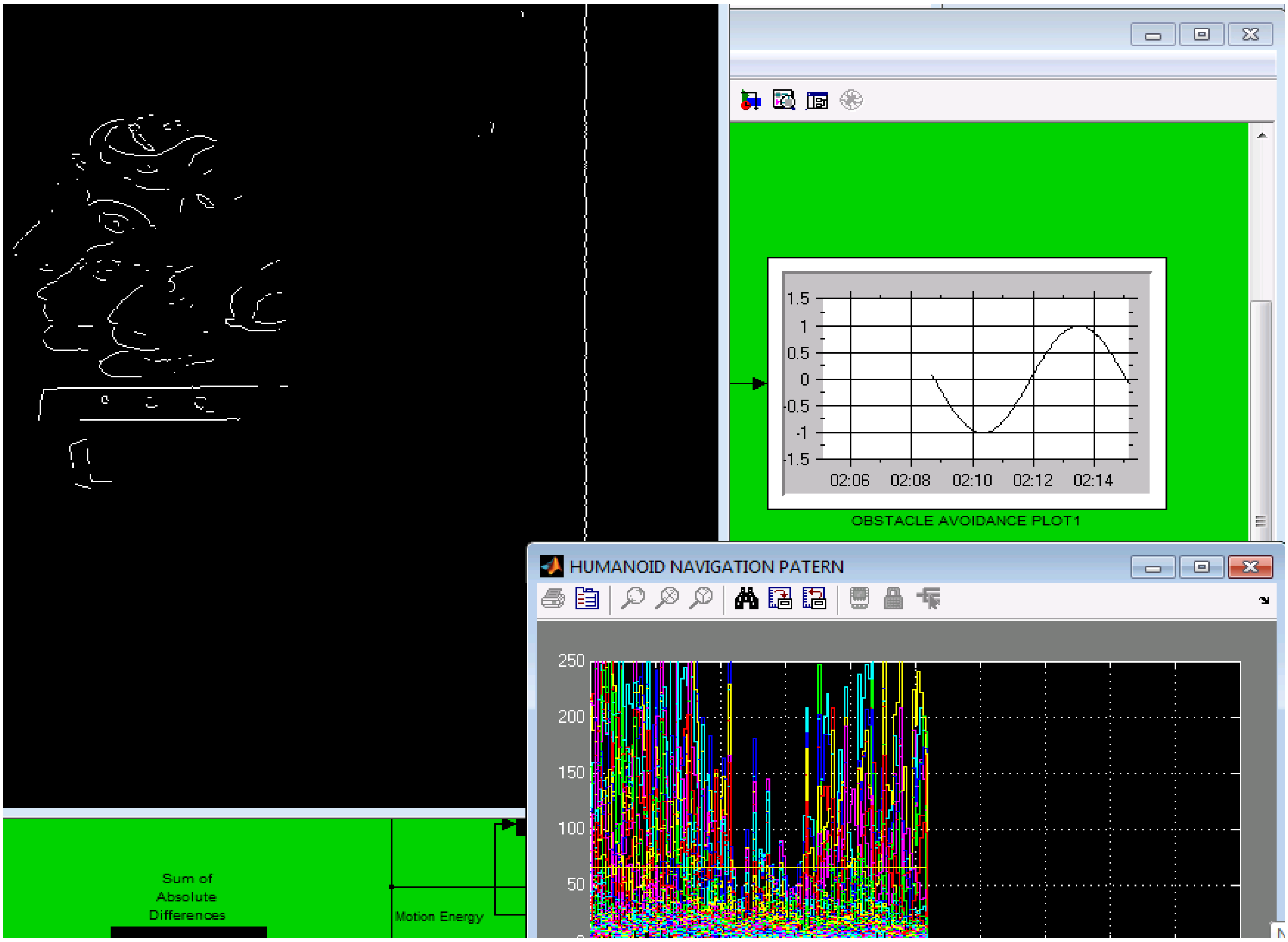


Figure 4.0: Implementation of obstacle avoidance

From the figure 4.3 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.

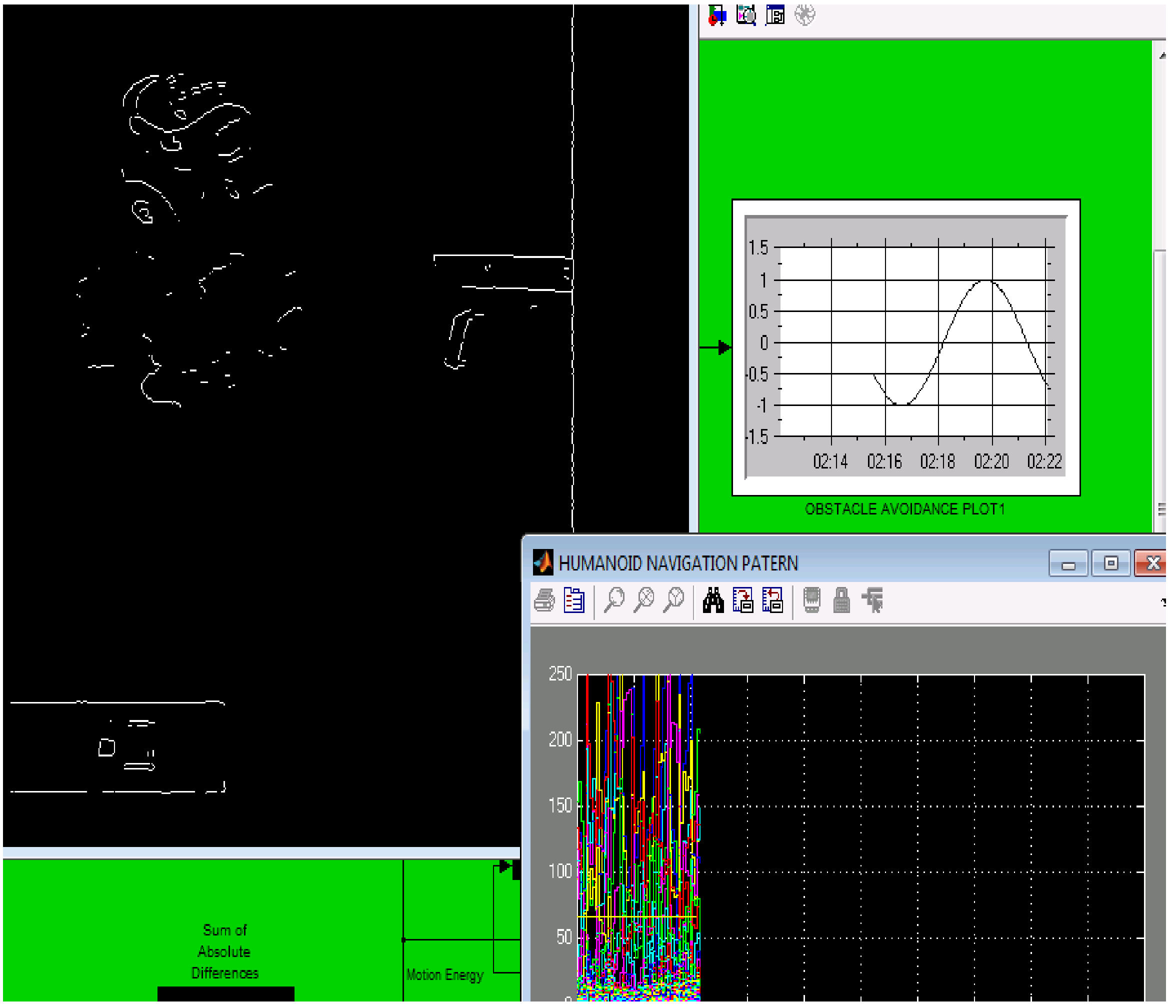


Figure 4.1: ROBOT OBSTACLE AVOIDANCE IMPLEMENTATION

The figure 4.9 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.

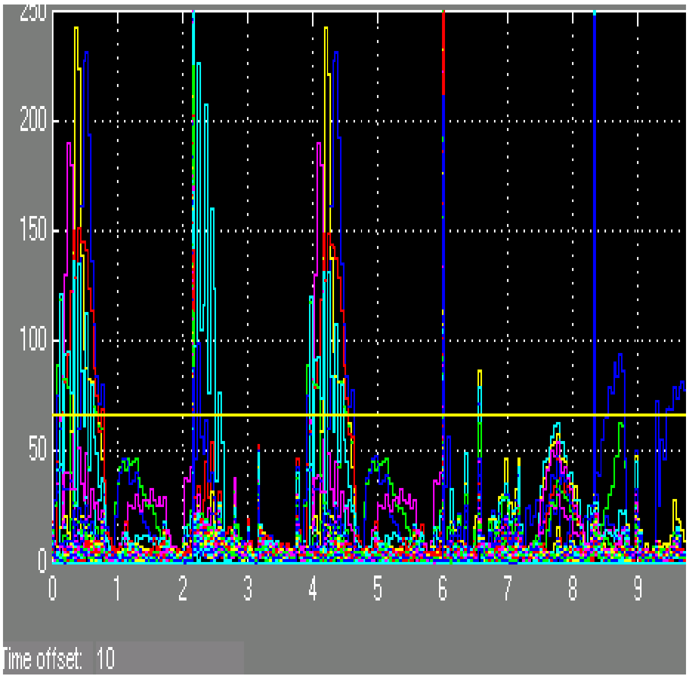


Figure 4.2: Pattern of Navigation and task scope

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 reflexive actions of the humanoid robot

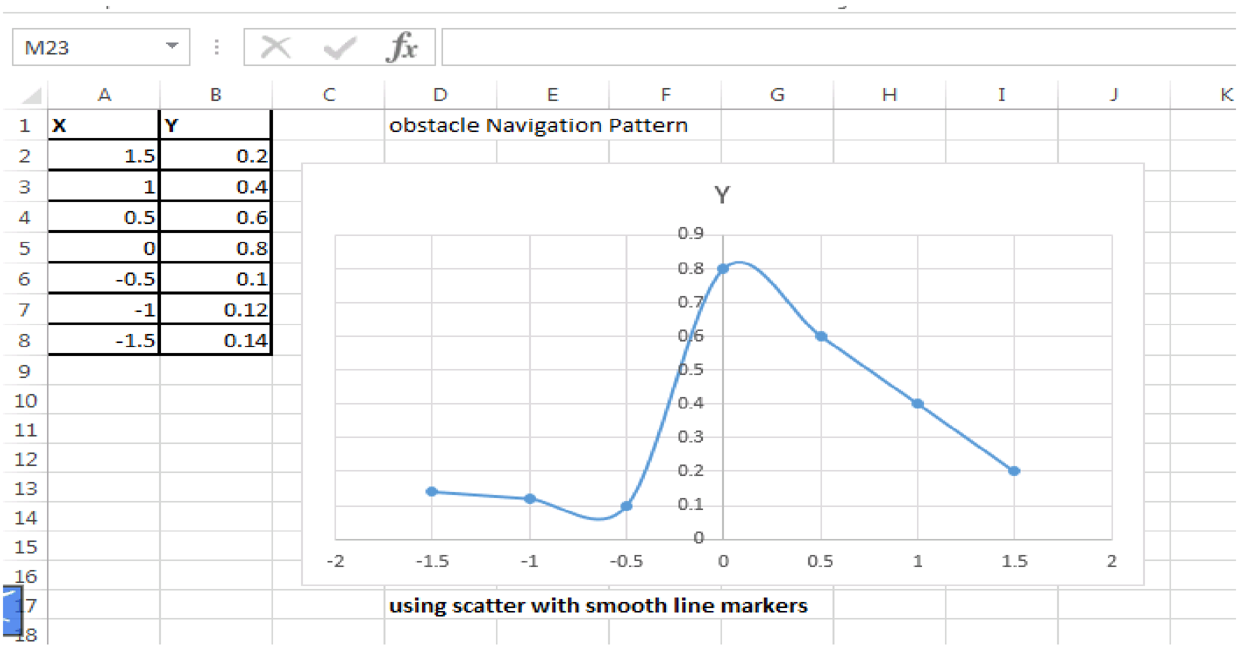


Figure 4.3: Obstacle graph plot using scatter with smooth line marker

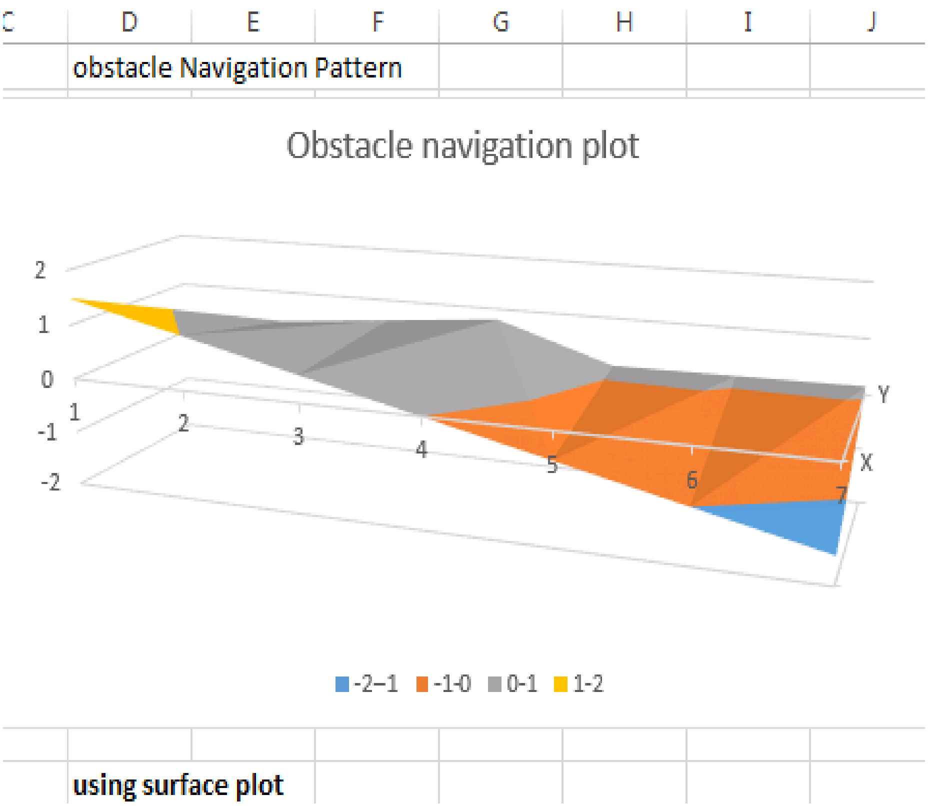
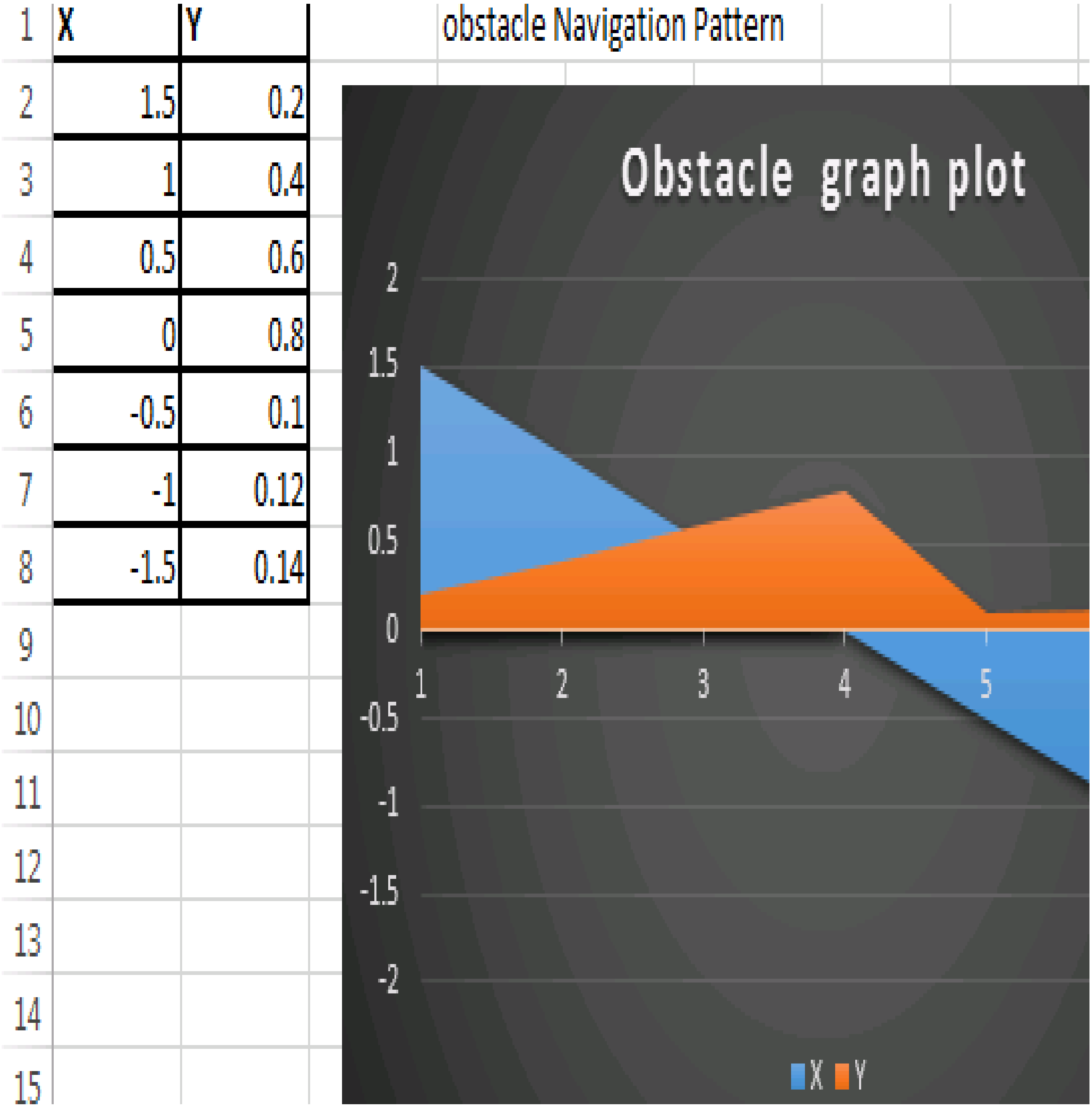


Figure 4.4: Obstacle graph plot using surface plot



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

Plate 4.5: Using area plot

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

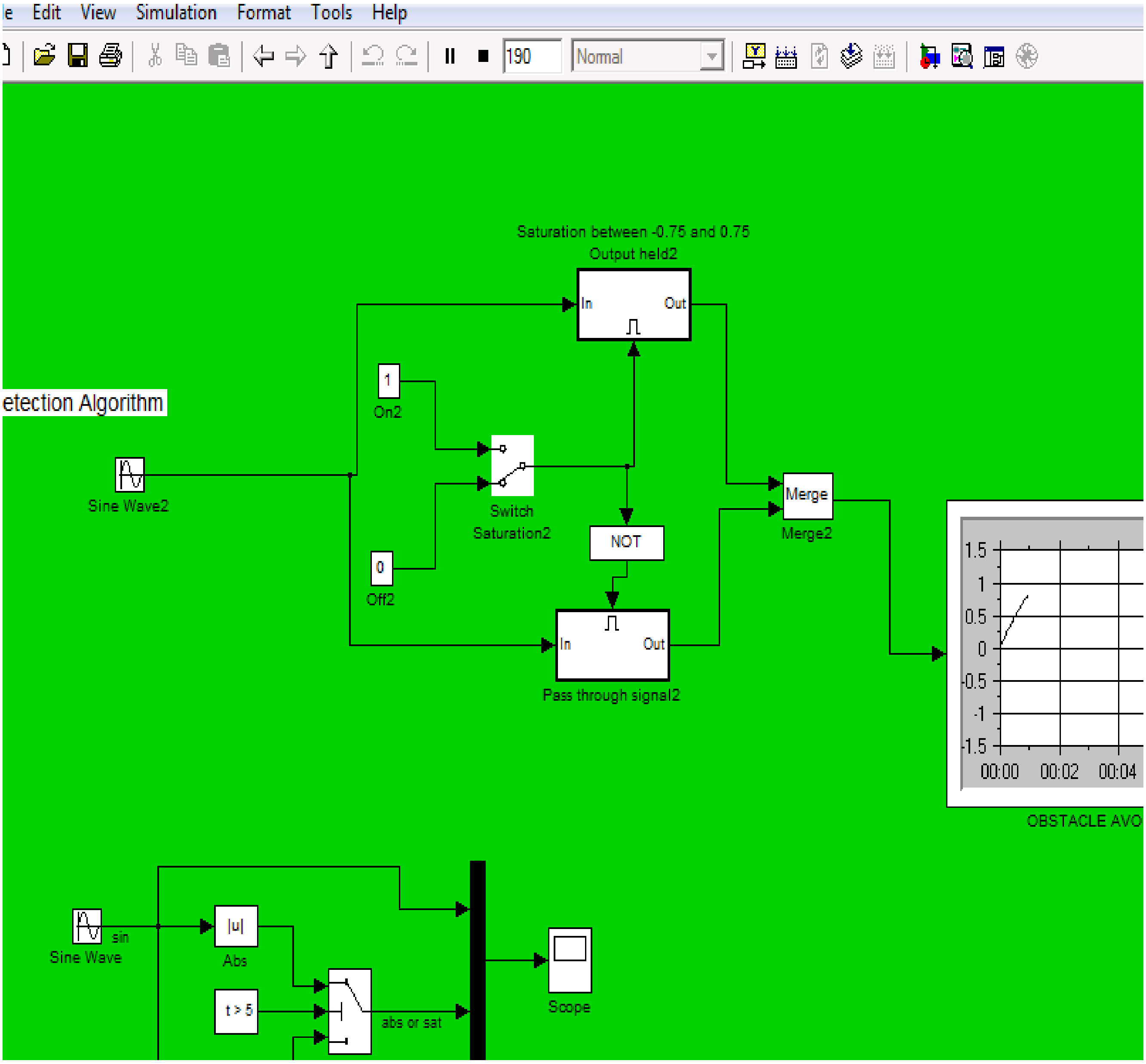
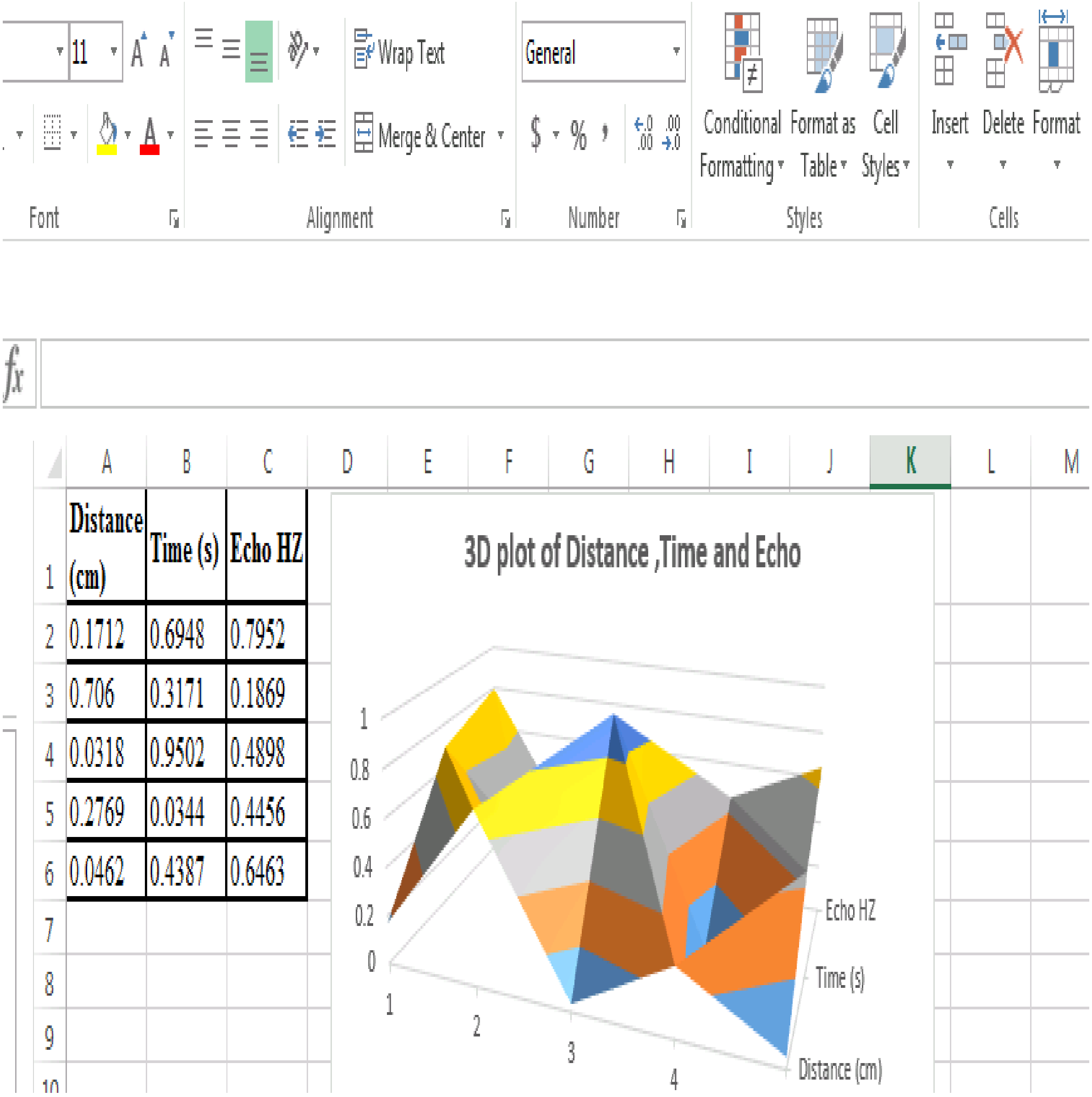


Figure 4.6: Obstacle Avoidance 1 at one Amplitude simulink blockset

The figure 4.14 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 4.7: 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.

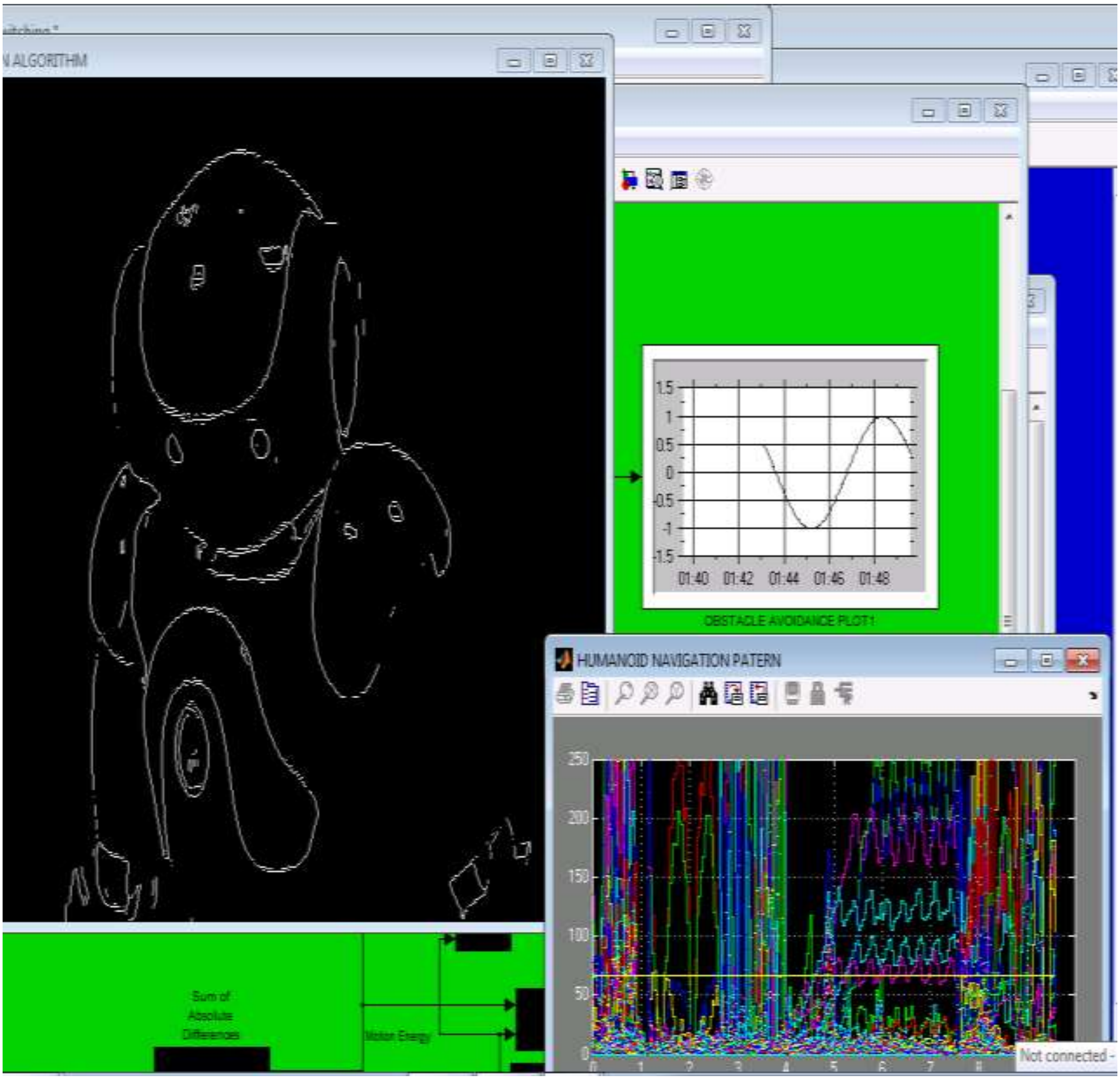


Figure 4.7: Implementation of task performance

The figure 4.7 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.

XII Result obtained from the constructed motorized robot

Below is the image of the constructed robot. The image was formated using joint photographic expert group (JPEG) format.

Figure 4.7: Constructed motorized robot

The figure above is the image of the constructed motorized robot. When the robot is switched on, it initializes after which it starts forward movement until it gets 30cm closer to an obstacle it then stops, reverse backwards and then change direction. When it moves 30cm close to another obstacle, it stops reverse backwards, then turns left or right to another direction, and will continue to behave that way until the power button is switched off.

XIII. CONCLUSION

In this research paper, we presented a simple and efficient humanoid robot using edge detection technique. A humanoid robot model was first developed using SIMULINK/MATLAB, and also a model of an edge detection system using Prewitt technique was equally developed through SIMULINK/MATLAB and both were linked together through the use of the inport and outport blockset of a subsystem handler in SIMULINK, 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.

Finally, we ensured that the conventional approach for analysis of stability of biped Swalking were implemented to enable the stability of the humanoid robot.

IXX CONTRIBUTION TO KNOWLEDGE

The major contribution in this research work was the development of humanoid robot using prewitt edge detector which selects features of the principal parts of the object, and eliminates parts that are not necessary. The developed prototype of the motorized robot shows that robots in real life exhibit some level of intelligence.

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