Automated Drawing Robot

Said Kafumbe[1], Ravichandran Danthakani[2], Emad Abd-Elrady[3]
Faculty of Engineering Technology and Science
Higher Colleges of Technology, UAE
skafumbe@hct.ac.ae[1], rdanthakani@hct.ac.ae[2] , eabdelrady@hct.ac.ae[3]

Fatema Al Marzouqi, Maitha Al Hosani, Mezna Al Ameri
Electronic Engineering Technology, Abu Dhabi Women's Campus
Higher colleges of Technology, UAE
H00323641@hct.ac.ae, H00323820@hct.ac.ae, H00302839@hct.ac.ae

Abstract

In this ongoing project, a robot is used to automatically draw with multi-color markers on a whiteboard or on more than one surface. The robot can have an existing image uploaded or can receive and acquire an image using a camera, or through voice and text guidance. The robot works by extracting the line traces from the image, then scaling the drawing to fit into the defined area of the whiteboard or any other surface. The image is reproduced by moving the markers along set paths to draw the image. The system uses an intelligent controller, a motor shield, dc motors, encoders, servo motors, as well as whiteboard-hanging strings. The system finds its application in industrial automated machines used for marking and engraving, industrial art portrait drawing, or as an education robot able to replicate programmed instructions on the board.

Keywords
Automatic engraving, Drawings, Voice and text Activation, Bluetooth and Scaling.

1.1 Introduction

People with disability and special needs, who cannot draw by themselves, this project can serve them to draw animation or represent information. It can assist teachers to explain in the form of bullet points and assist the transport department by drawing road lines. This project can be used by road engineers, cartoon makers, artists, teachers and special needs people with a passion for drawing. At present human hands are used extensively for drawing but take long, have less satisfactory results yet not accurate, and face difficulty in undertaking minute details.

Previous work in this area has been done and reported. The first one was a robot with human being size called NAO H25 was made that had a vision system and fingers to hold a drawing brush, take instructions from a human to paint an object as shown in Figure 1. Its painting process started by obtaining the complete status of the image of the object and would start painting the image step by step following the painting instruction. It used a simulator powerful tool to program and carry out design setup [1].

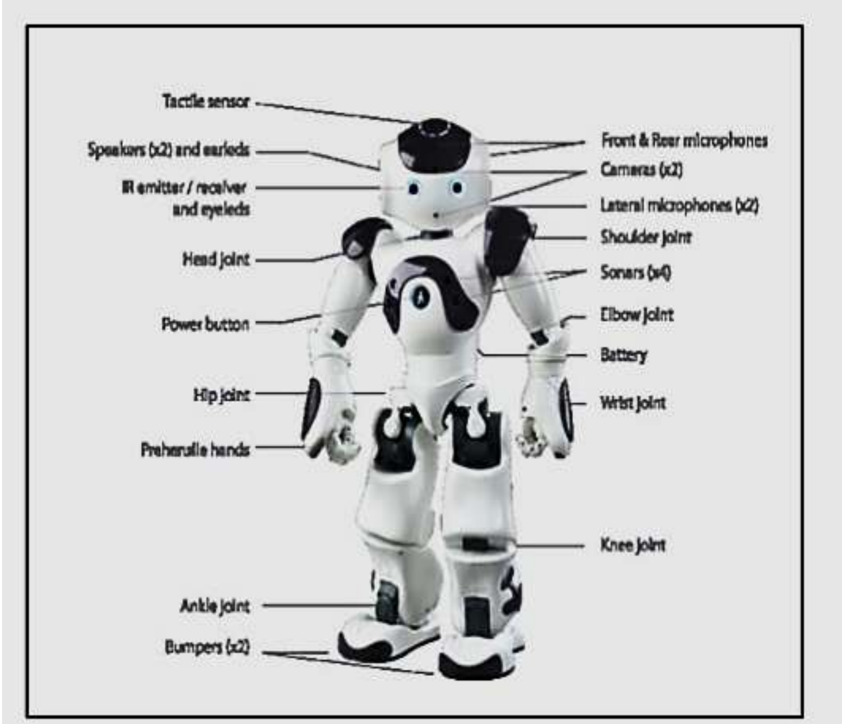

Figure 1: NAO H25 drawing robot

The size of the robot is similar to a human being and it is fitted with various types of sensors, cameras. It is able to take instructions from the human being, interpret and carry out the task as instructed. However the robot need to be programmed correctly to do any complicated task similar to human being.

The second one was a robotic hand with the capability to self-draw as shown in Figure 2. The robotic hand can be applied to gradually develop the drawing pattern using suitable functions. This project involved implementations and theory of converting the visual information into drawing, painting or into pictorial view. Using inverse kinematics it was possible to declare the same aspect. An image was given as an input by the user. The robot first sketched the contours similar to the image on the paper. The robot which was built using servo motors, controller and corresponding feed input to the hand. The location of the servos was calculated and the angle between the servos was calculated by using mathematical equations [2].

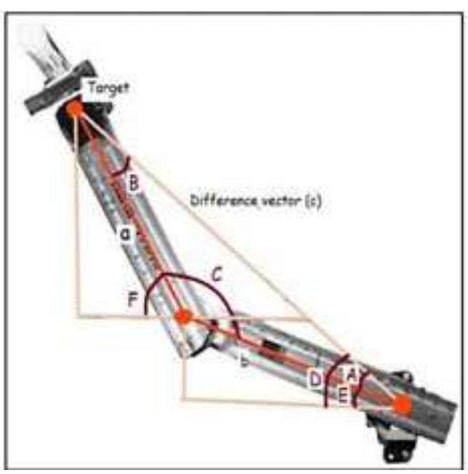

Figure 2: Hand drawing robot

Now a day there is an evolution and development in the field of artificial intelligence and world of robotics. In this article modern techniques were used in artificial hands that will help us apply them to our robot. Our robot depends on the skill of drawing and hand is the most important part of the robot body. So, we should to focus on this part and use new application and use the latest current techniques, including the use of remote sensing and use of certain types of materials for the fingers to avoid slipping or falling objects from the hand of the robot. Also, this article shows and focused on actuation and control systems of the devices. The goal of this article is to provide a comprehensive survey of the sensors for artificial hands.

Figure 3: Artificial hand robot

The new designed robot will be moving by itself and the user requirement is just to power it up, Also it's good for the environment. The robot is easy to use even the children can handle it, flexible, light weight and high quality. In addition, the manufacture constrains readily available components will be used in the project implementation. Moreover, the budget will be not exceeding 2000 AED.

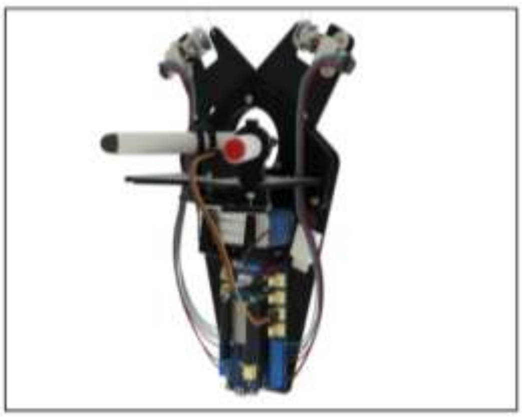
Figure 4: Automated Drawing Robot

2. Methods and Materials

The methods and materials followed are discussed in the paragraphs that follow.

2.1 System Block Diagram

The complete project system summarized on this block diagram to understand the project system easily and clearly. As shown in Figure 5: Inputs (Camera, Ultrasonic sensor, Pressure sensor and Microphone), Controllers (Mk1000 microcontroller, Motor shield and Power supply battery) and Outputs (Servomotor, DC motor A and B). The camera is responsible for capturing the image into the system. The ultrasonic sensor is responsible for sensing any obstacles ahead of the robot so as to avoid it colliding with the ends of the drawing sections. The pressure sensor and the microphone can used for other inputs that can be controlled by the system. The microcontroller is used for processing commands that determine the movement of the robot as it performs the drawing. The motorshield is a motor driver that is used to control the movement of two dc motors and one servo motor during the drawing by the robot. The battery was used to provide enough power required by the system. The dc motors are used to move the drawing robot around the drawing area. The encorders on the motors were used to count the rotations and there the distance covered by the robot as it moved between different positions. The servo motor was used to move the move the drawing markers or pens up and down depending on which one would be used in the drawing.

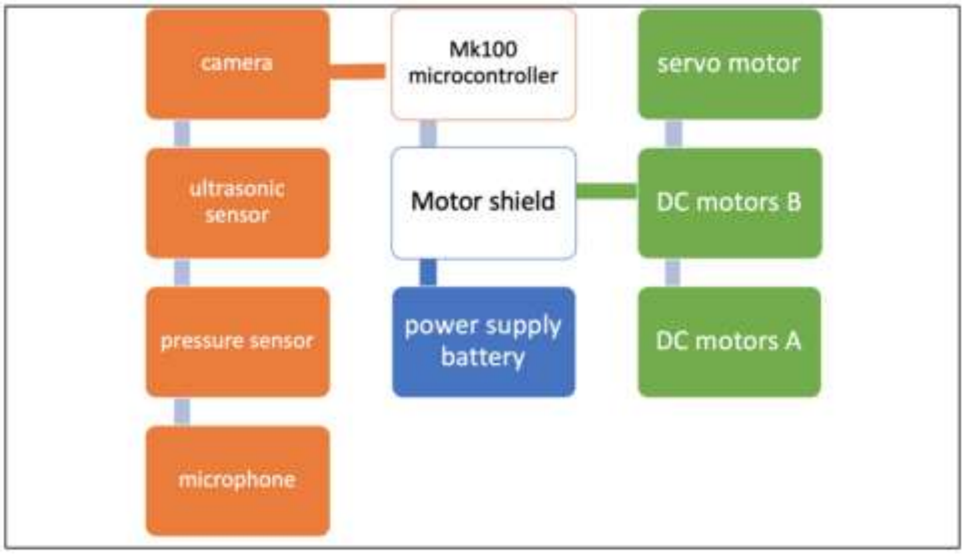

Figure 5: Block diagram

2.2 System Circuit Connection

A connection circuit is shown in Figure 6 with all the components connected for simulation using generic devices.

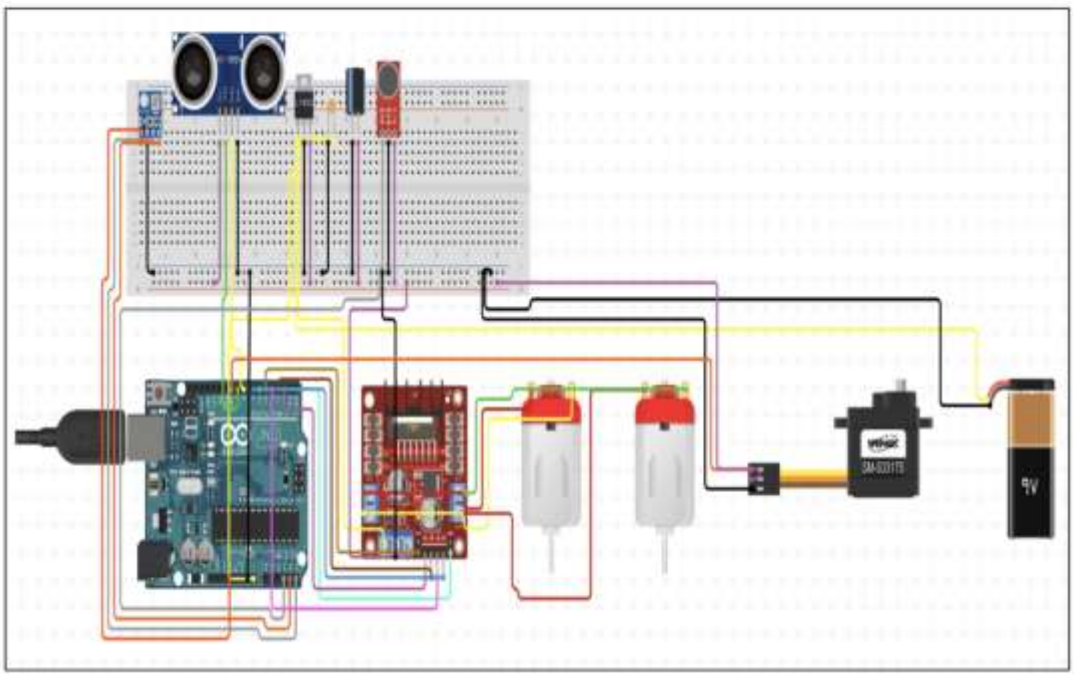

Figure 6: Circuit Connection

2.3 System Flowchart

The system flowchart shows the simplified steps involved in the drawing process. At the start, the initial position of the robot is defined as well as the positions and heights of the markers, and the size of the drawing area. The motors are then moved to a specific position using the encoder counts required to move between specific points on the drawing board. These counts are then turned into distance and the robot moves to those points. The robot then inputs the image from a camera or an existing image. The image is read and processed to extract lines and pixels which are then transformed into counts that the robot can move to. The robot finally draws according to the counts or points on the board that constitute the robot. These steps are then repeated each time an image is input ready for drawing.

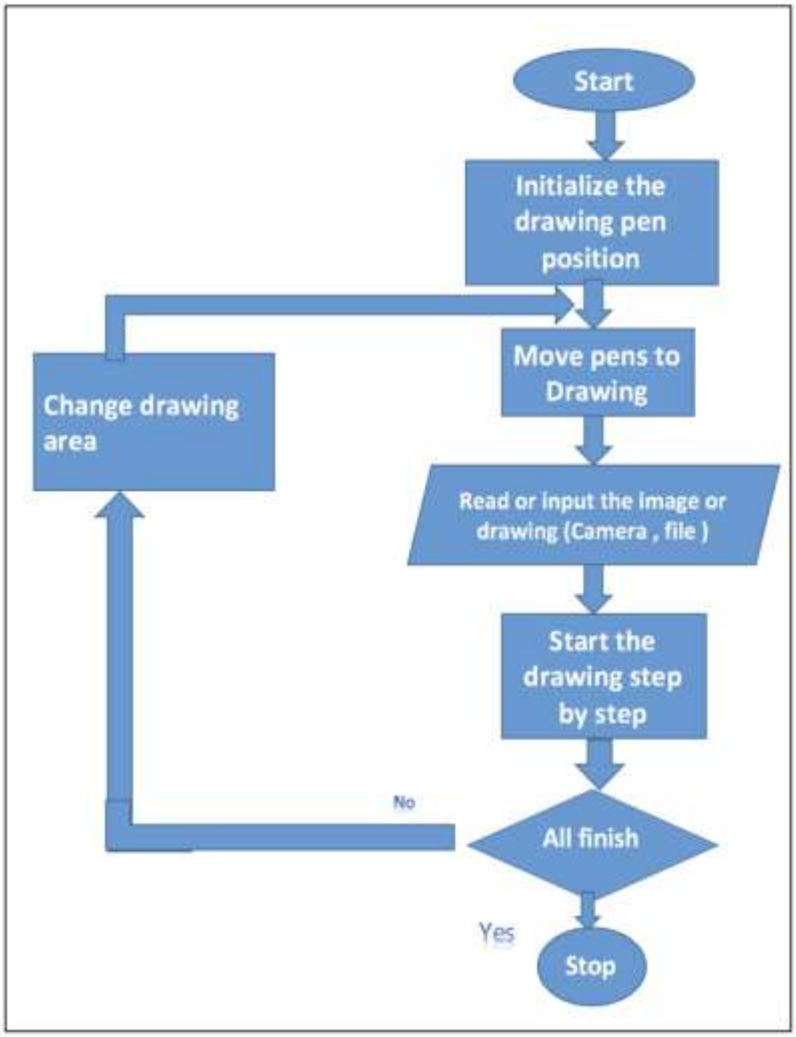

Figure 7: Flow Chart

2.4. Testing, Modeling and Simulation

Several testing, modelling and simulations were performed on the system to ascertain its performance. Initially the individual components were tested to ensure they were operating properly. The assembled system was also tested under as it captured images and drew them onto the drawing board. In general the nature of testing involved component testing, assembling parts from 3-D printout and system assembly, system modelling and simulation as well as testing as shown in Figure 8. Most of these are in progress and ongoing with available results that will be discussed in the sections to follow.

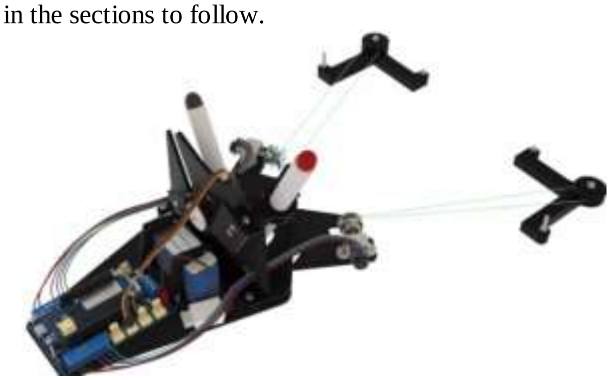

Figure 8: System testing

3. Result and Discussion

The results from the various testing, modelling and simulations are shown in the figures as well as the discussions that follow by positioning the robot on the whiteboard using strings as shown in the Figure 9. The drawing area is also defined as shown in Figure 10 with obstacle areas removed. Sample processed drawings are also showed in Figure 11.

Figure 9. Drawing robot positioning using anchored strings

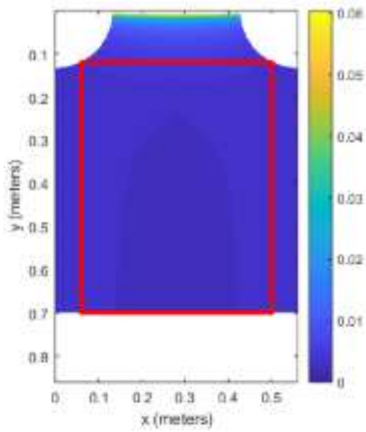

Figure 10. Drawing area after eliminating obstacle regions

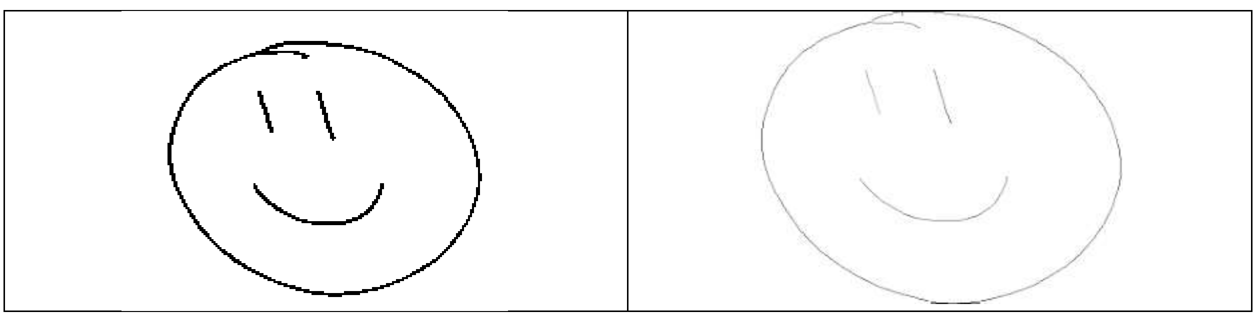

Figure 11. Sample image processing of captured drawing

3.1 Motor test

This was done to ensure the motors were operating as expected. This was done by generating pulse signals using pulse width modulation from a microcontroller port and applying these to the motors. The speed of the motor was varied by varying duty cycle of the pulses, and the direction of rotation was changed back and forth to check the maximum achieved speed.

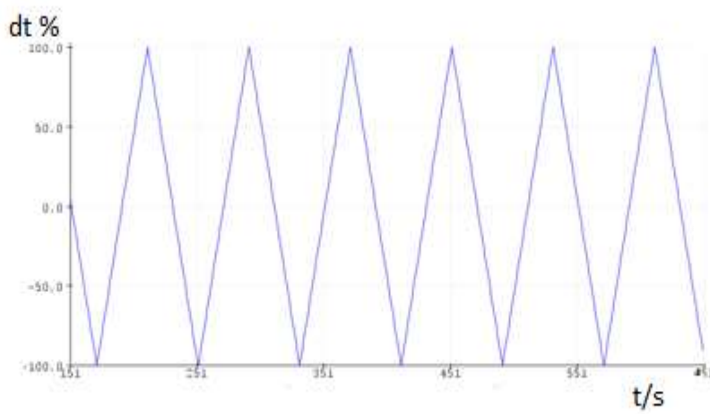

Figure 12. Motor speed in % duty cycle (d.t) and direction test over time (t) in seconds

The change in duty cycle (d.t in %) with time (t in seconds) as DC motors are swept back and forth are shown in Figure 12. From the plot the motor starts at low duty cycle or zero speed rising to the highest duty cycle of 100% when the speed is highest. This was done both in the forward and backward directions (100% to -100%). The behavior was the same for both motors.

3.2 Motor encoder reading test
This was done to determine encoder readings and counts done as the motor rotates, and to use these in determining the motor speed in counts per second as shown in Figure 13.

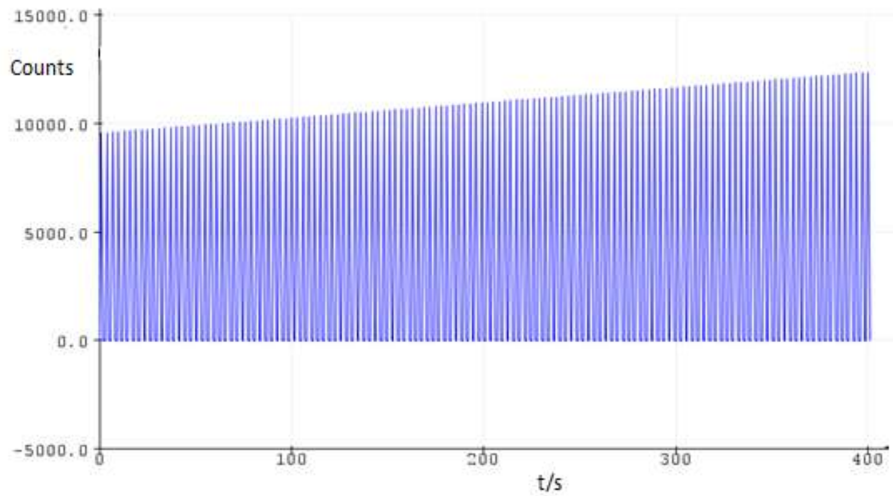

Figure 13. Encoder counts per second as the duty cycle of motor speed is varied with time in seconds (t)

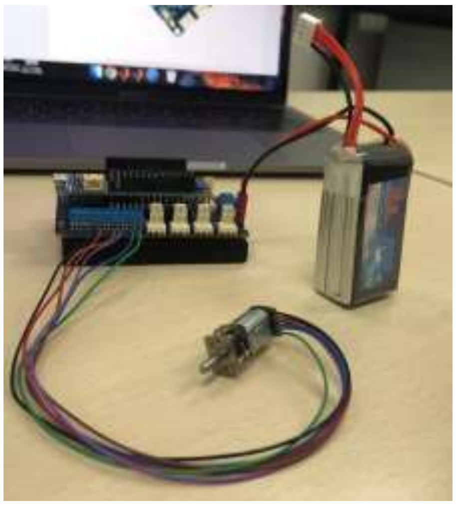
Figure 14: Testing Motor

The encoder reads and counts how the motor rotates and is able to measure the speed of the motor in counts per second, for different duty cycles. The motor connections were made in such a way that the motor turning direction is forward or positive resulting in positive encoder counts and positive motor speed counts per second. These could also be reversed for negative readings.

3.3 Servo test
This was done to measure the angular rotation of the servo motor when pulsated signals are applied to it. The servo was able to move in short angular rotations of 5 degrees sweeping from 0 degrees to 180 degrees as shown in Figure 15.

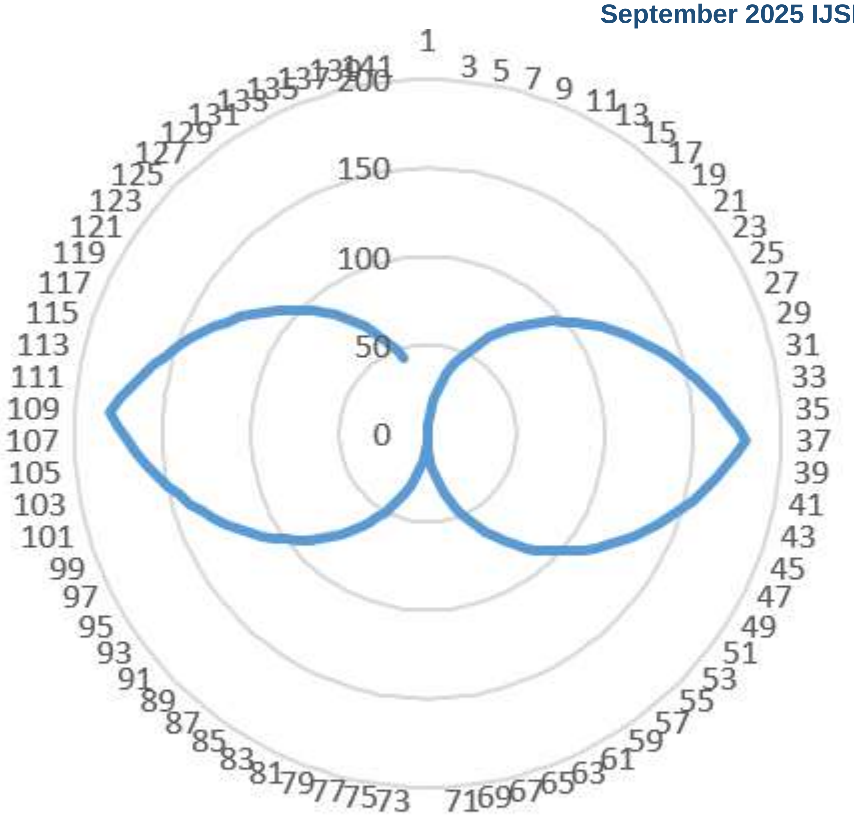

Figure 15. Servo sweep from 0 degrees to 180 degrees

3.4 Hall counts

The hall sensor was tested for its detection of the magnetic field density around the inertia wheel which has inbuilt magnets spinning with the wheel. The sensor was placed next to the inertia wheel to detect its speed. When the hall sensor was close to the magnets the hall counts measured were higher compared to having no magnet around as shown in Figure 16.

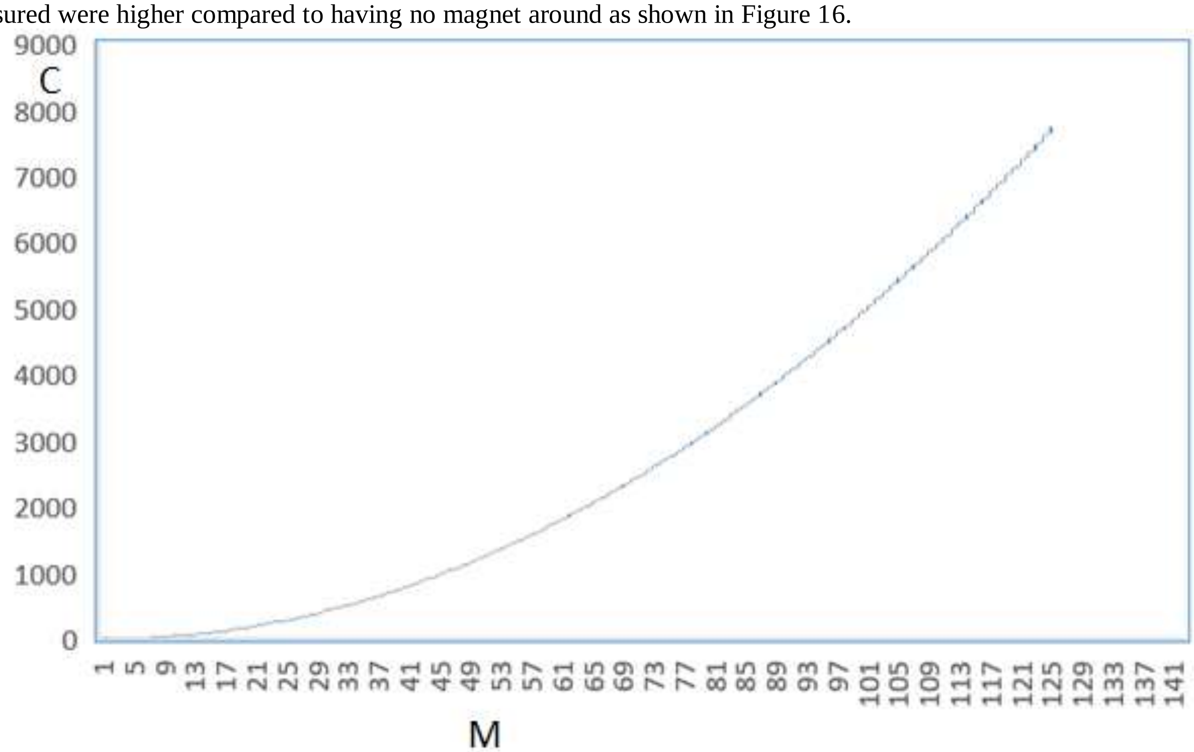

Figure 16. Hall counts C were higher the closer the hall sensor was to the magnetic intensity M in the spinning inertia wheel

3.5 Inertia measurement

The behavior of the minibike was tested under different conditions of acceleration, rotation and magnetic field using an accelerometer, gyroscope and magnetometer module.This was done to note the speed, orientation and effect of the magnetic field on the device. The values in the x, y, z axes were measured to show when the orientation of the bike was so large that it would fall. The magnitude of all the values with time was then plotted in Figure 17 as the minibike orientation was varied.

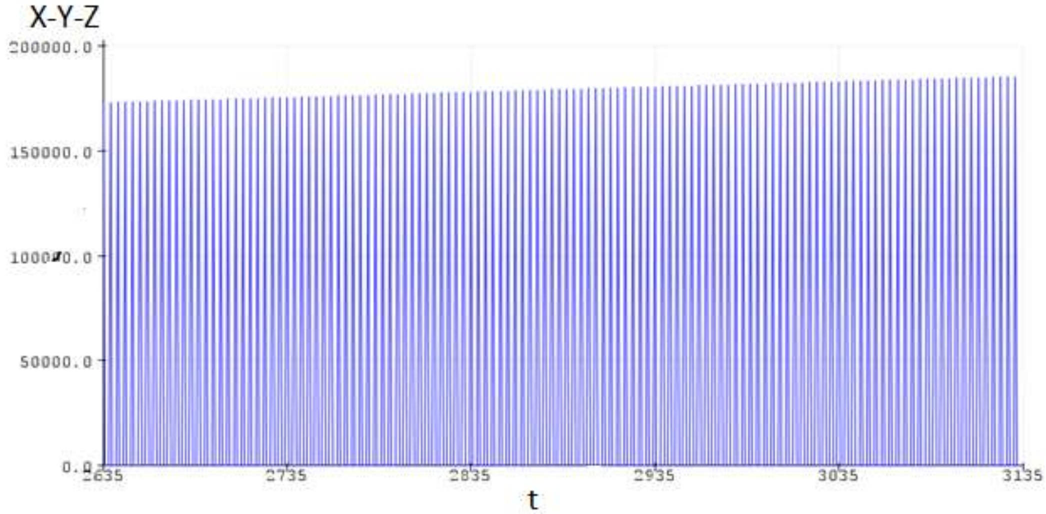

Figure 17. Motorcycle acceleration, orientation, and magnetic measurements magnitude varied with time

3.6 Obstacle test

This was done to detect obstacles infront of the minibike so that motors can be stopped or turned away from the obstacle. The ultrasonic sensor was connected to the microcontroller in search a way that it generated a pulse to the trigger pin setting active the echo pin of the sensor. As such any obstacle infront of the minibike would reflect back the sound waves as echo enabling the microcontroller to measure the flight time and thus the distance of the obstacle from the motorbike. Several obstacles were detected in front of the robot and different sensor reading were taken as shown Figure 18.

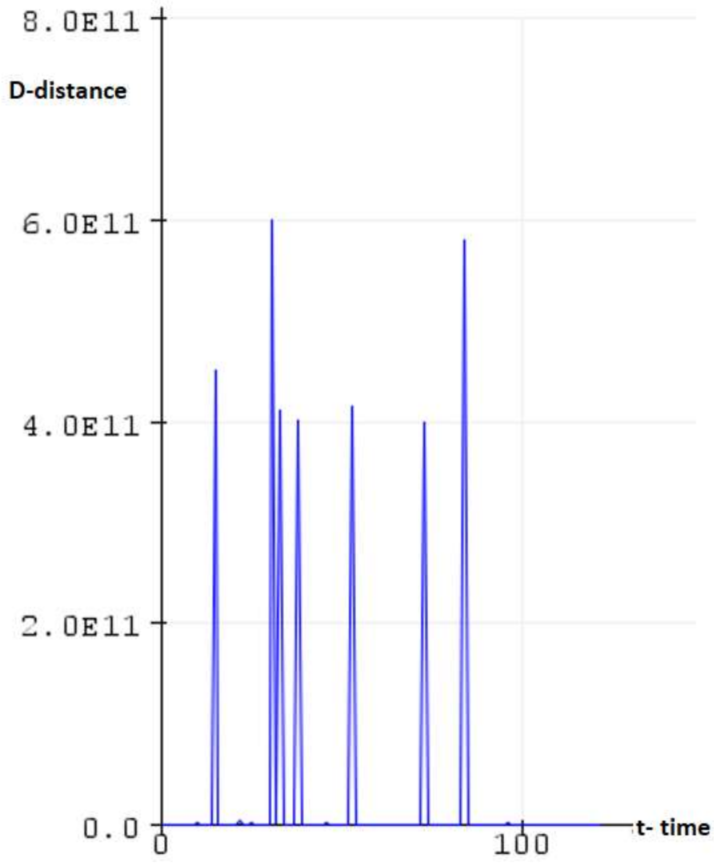

Figure 17. Obstacle detection infront of minibike varied with time

4. Conclusion and future work

In summary the drawing robot automates the drawing process with capabilities beyond just drawing. The robot works by extracting the line traces from the image, then scale the drawing to fit into the drawable area of the whiteboard or any other surface. The image is reproduced by moving the markers along set paths to the draw the image. The proposed system will use an intelligent controller, motor shield, dc motors, encoders, servo, whiteboard-hanging strings.

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Biographies:

1- Said M. M. Kafumbe of the Higher Colleges of Technology in Abu Dhabi, United Arab Emirates, is a Faculty of Electrical Engineering with over 25 years of industrial and academic experience. His research interests lie in the fields of autonomous systems development, micro-electro-mechanical systems (MEMS), nanotechnology, and semiconductor technology integration, as well as embedded wireless sensor systems development.

2- Ravichandran Danthakani is currently working as Faculty in Electrical and Electronics Engineering Department at Higher colleges of Technology, Abu Dhabi. His 30years of expertise is blended with industrial and academic experiences. His research interest includes control systems, automation, instrumentation and sensor technology.

3- Emad Abd-Elrady received his BSc and MSc degrees in Electrical Engineering from Ain Shams University, Cairo, Egypt, in 1993 and 1997, respectively. He received his Licentiate and PhD degrees in Electrical Engineering with specialization in Signal Processing from the Division of Systems and Control, Uppsala University, Sweden, in 2002 and 2005, respectively. From January 2006 to March 2009, he was a senior researcher and project leader at the Christian Doppler Laboratory for Nonlinear Signal Processing, Graz University of Technology, Austria, where he was working in a cooperation project with Infineon Technologies. From March 2010 to January 2011, he was a research fellow at The University of Edinburgh, UK. Since February 2011, he has been electronics engineering faculty at Abu Dhabi Women's College, United Arab Emirates. His research interests include adaptive filtering, system identification, adaptive, nonlinear and distributed signal processing, dynamical system modeling, distributed and convex optimization, and wireless sensor networks.