# Development of Autonomous Sweeper Robot for Badminton Court

M. F. Taher[1], M. H. Harun[1], K. A. M. Annuar[1], M. F. A. Halim[1], M. S. M. Aras[2], A. H. Azahar[1], A. F. Z. Abidin[3]
[1]*Faculty of Technology Engineering, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia.*
[2]*Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia.*
[3]*Faculty of Electrical Engineering, Universiti Teknologi Mara, 81750 Pasir Gudang, Johor, Malaysia*.
*haniff@utem.edu.my*

***Abstract*— Badminton court cleaner robot is one of the robots of the innovation project and yet being develops by other society. The most dominant reason of this creation, this project can ease badminton court practitioner organizer to clean up the court after match, instead of using the manual way which is individual clean up the court. In additional from the observation, interview section the organization agrees and felt satisfied with this project and welcome an innovative robot. This project created this robot with the fundamental of square shape for the body and combined the entire element such as microcontroller, actuator, vacuum, sweeper, and DC motor. This automatic vacuum robot of badminton court can just be switch on by click one button and the robot will make a move to start their cleaning job in a short time. In a nut shell, this robot can reduce labor cost and time concern and as well as the challenge of vision 2020.**

***Index Terms*— Microcontroller; Actuator; Square shape.**

## I. INTRODUCTION

This project is based on basic vacuum cleaning and robot movement. Those concerned with the design of an autonomous sweeper robot for a badminton court by using Arduino mega as its brain. It constitutes a smooth, less noisy and user friendly [1]. This idea have been developed an autonomous sweeper robot for badminton court which is designed to clean a badminton court by using a basic principal of vacuum, the Arduino system as an operating system, a line following concept and basic linear motion as an arm for cleaning purposes [2]. Basically, this autonomous sweeper robot moving principle based on the line guided at badminton court. This project also used a motor driver to drive a motor vacuum and arm robot. By using Arduino microprocessor works as a brain to control all mobilization and process of the robot. DC motor is used to propel the robot vacuum and the vacuum. However, DC motor spins too fast and has little torque to drive the loads. Thus, gear reduction is required to slow down the rotational speed and increase the torque of the motors. The robot senses the obstacles through the infrared sensor. These sensors are installed at the arm of the robot.

## II. RESEARCH BACKGROUND

This innovation is based on basic vacuum cleaning and robot movement. Those concerned with the design of an autonomous sweeper robot for a badminton court by using Arduino as controller. It constitutes a smooth movement, silent and easy to use. With this reason, this idea have been developed an autonomous sweeper robot for badminton court that designed to clean a badminton court by using a basic principal of vacuum, the Arduino system as an operating system, a line follows and basic linear motion as an arm for clean. Basically, this autonomous sweeper robot for badminton court move guided along by the line at badminton court. This project also used a motor driver to drive a motor vacuum and arm robot.

By using Arduino Microprocessor would control all mobilization robots. This microprocessor would make as a brain of this system. DC motor will be used to propel the robot vacuum and the vacuum. However, DC motor spins too fast and has little torque to drive the loads. Thus, gear reduction is required to slow down the rotational speed and increase the torque of the motors. The robot senses the obstacles through the infrared sensor. These sensors are installed at the front of the robot.

Autonomous sweeper robot for badminton court construction can be divided into four main parts. There are brain, actuator, sensor and vacuum. Figure 1 below shows the overview of the system inside the autonomous sweeper robot.

## III. RESEARCH METHODOLOGY

### *A. Vacuum System*

Vacuum used is 12 volt with direct current supply. The concept is these machines move autonomously while collecting the dust on the surface area of the badminton's floor. The speed of vacuum motor are controlled using Pulse Width Modulation (PWM). Use spinning brushes to reach tight corners. Referring to [3], brushless motor is suitable use in this project. Others combine a number of cleaning features is simultaneous to vacuuming, thus rendering the machine into more than just a robot "vacuum" cleaner. This can suck the dust in high power and storage the dust at container.

### *B. Line Following Concept*

The Line follower robot is a mobile machine that can detect and follow the line drawn on the floor. The path is predefined and can be either visible like a black line on a white surface with a high contrasted color [4] or it can be invisible like a magnetic field. Transmitter will bulb infrared light while

receiver receive infrared lights. Infrared sensors require filter system to filter out the uncertain voltage level of IR receiver. IR is transmitted out of sensor unit. If the IR is reflected back, it is picked up by the IR receiver transistor.

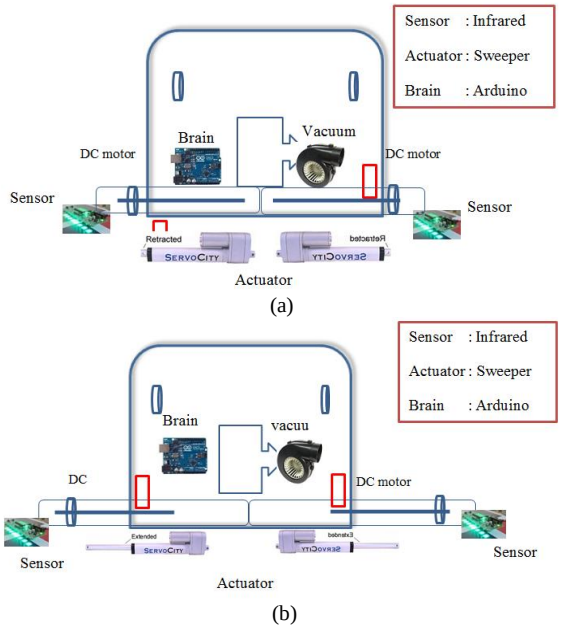



Figure 1: (a) Overview during off process (b) Overview robot during cleaning process

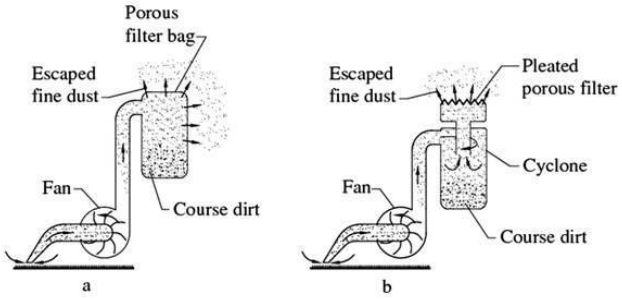



Figure 2: Vacuum Concept

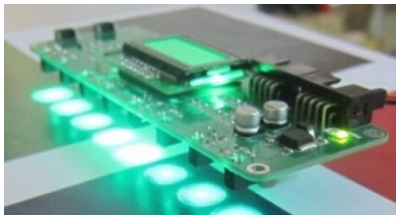


Figure 3: Line Follower

### C. Controller System

For controller, this project use Arduino microcontroller according to [5] it analyze the working principle of an Arduino. These days many people try to use the Arduino because it makes things easier due to the simplified version of C++ and the already made Arduino microcontroller that can be programmed, erased and reprogrammed at any given time.

### D. Linear Motion System

An actuator is a type of motor that is responsible for moving or controlling a mechanism or system. To active the motor, this motor must get 7.2 volt supply and this motor will rotate depend on rotation that has been set. Actuator used to extend the sweeper until the end of line and electrical signal powered used by motor to convert electrical energy into mechanical torque. The electrical energy is used to actuate equipment such as multi-turn valves

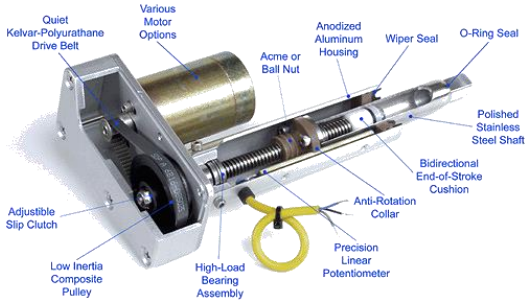



Figure 4: Linear Motion for Arm

### E. Micro Fiber

Microfiber is synthetic fiber finer than one denier or decitex/thread. This is smaller than the diameter of a strand of silk, which is itself about 1/5 the diameter of a human hair. This project used fiber cloth at sweeper to clean on the floor and pick a dust.

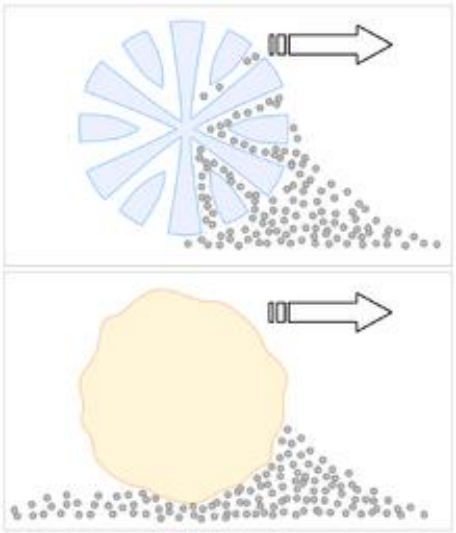


Figure 5: Microfiber Cloth (a) and Cotton Cloth (b)

### F. Type of Floor

Badminton court mainly comprises of the net, the posts and the floor. The court specifications are stipulated in the rules of badminton. The most common floors are PU / PVC, wooden board, acrylic and concrete; in badminton halls, court floors made up of layers of different materials. Wooden board courts have relatively good shock absorption but are more slippery than PU/PVC courts.

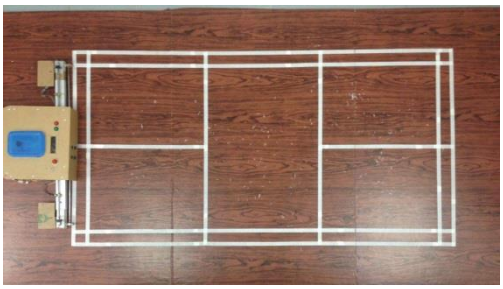


Figure 6: Wooden Board

## IV. RESULTS AND DISCUSSION

The result and analysis of this project have been done in study and finalize the part used in this project. The experiments have been done more focus on the current, voltage and the cleanliness of the floor. This project used two type of source which is 11.1 volt and 7.2 volt. For the 11.1 volt supply are used for vacuum motor, dc wheel motor, and to activate the Arduino. The 7.2 volt supply used to activate the sweeper motor and actuator motor. As stated in the methodology, this project used actuator as arm to extract and retract vacuum tube and roller. This actuator generated by electrical which are dc motor because compare to hydraulic, dc motor is clean and no need the pump. This actuator used 2 dc micro motor.

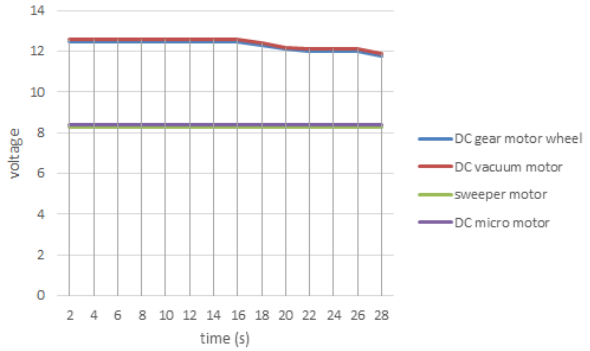



Figure 7: Voltage vs time for each device

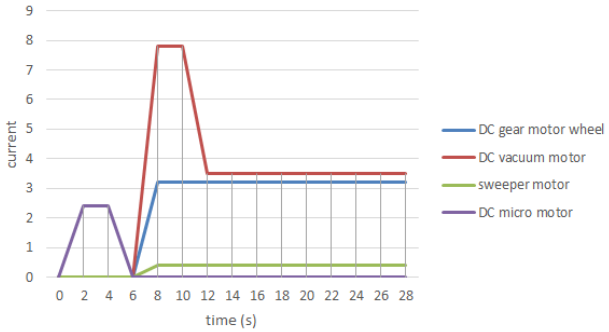



Figure 8: Current vs time for each device

As shown in Figure 7 and Figure 8, the rating of the voltage and current versus time each component. The starting current of actuator is high until 2.4 ampere and will drop to 1.4 ampere. Next, for wheel drive, dc motor with gear used to move this robot forward and reverse. This is because this motor is high torque but low speed. This speed is suitable for movement of the robot,

For the simulation part, this project used Matlab software to analyze the data of dust. As we can see in figure 8 below, this software was found the object that has been detected. This project has completed to analyze the hygiene level of floor. After take the picture and insert the data, the program was run by using function in Matlab. Next this software is read the images that that have been set and the image will display as we selected. Firstly, inversed the picture to grayscale image and make a negative image. This is because negative image are easier to find the object that has detect.

This software will segmented the image and as user need to insert the threshold image. The threshold image depends on the gray plane histogram of the graph. This program will removed the noise and fill the image any hole. Next is removed any blobs on the border of the image and removed blobs which is smaller than 20 pixels [6]. Lastly apply labels for each connected component in 2-D binary image as shown in Figure 9.

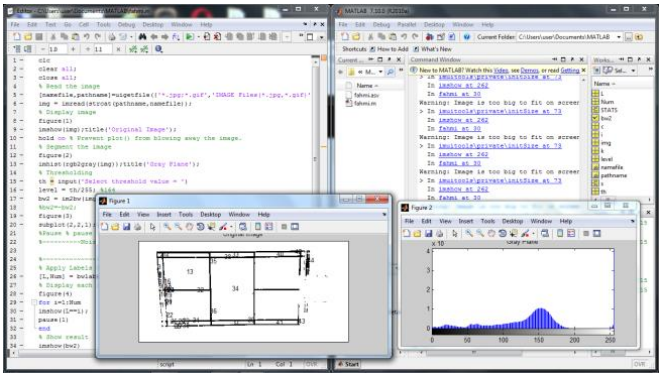


Figure 9: Simulation data using Matlab

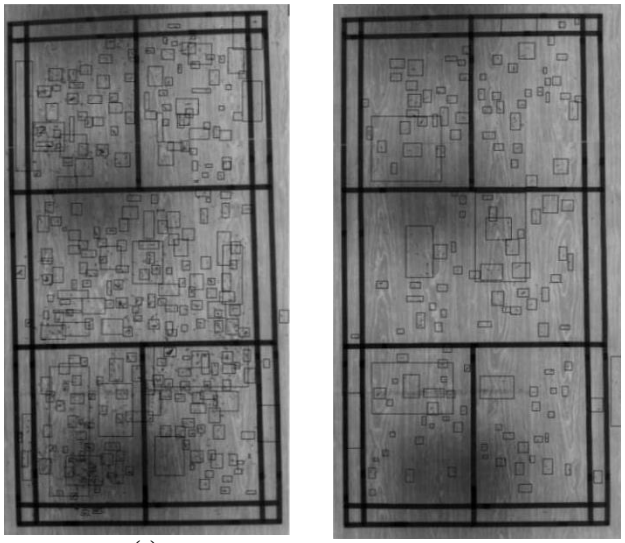
These projects have been done with 5 time of analyzed and finalized the 5 difference data as reference. This all result used camera to take an image of the condition of floor and will using Matlab to processed the image and get the result for average value of dust. We compared this in 2 type of result which is negative image, and object that detect. By using PWM controller, these projects are run in 5 condition of speed which is in full speed 26rpm, 19.5rpm, 13rpm, 6.5rpm, and 3.2 rpm. Every stage of analysis showed the difference result.

Figure 10 and 11 shows the result using sweeper robot with difference speed. Figure 8 using 26 rpm and it takes about 10 seconds Figure 9 using 3.2 rpm and it takes about 40 seconds in completing the task. According to the result shows that by using lower speed resulting in good in cleaning the badminton court. The higher speed makes the sweeper less effective.

Figure 12 shows the object detected vs speed that has been transfer from table to graph. The red line shows the total of dust that has been detected. The value object 1550 was constant and the variable is vacuum suck at the floor. The result at 26 rpm shows that the value of dust is still high. The result shows the object detected will decrease until the optimum result effect on the speed of motor. When the speed of motor is decrease, the object or dust will decrease. As the

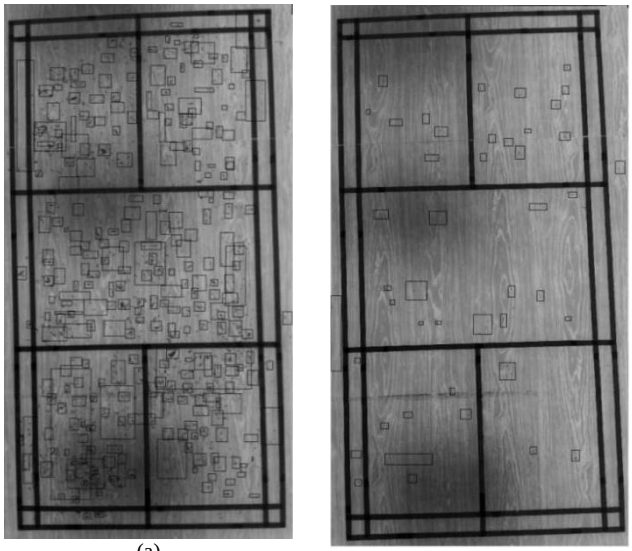
conclusion, the best performance of this project is by using speed 3.2 rpm.

From this experiment, the data has been collected and recorded. This data that has recorded insert into table to make easily make a comparison and discussion as shown in Table 1.



(a) (b)

Figure 10: (a) output image before cleaning (b) output image after cleaning using 26 rpm



(a) (b)

Figure 11: (a) output image before cleaning (b) output image after cleaning using 3.2 rpm

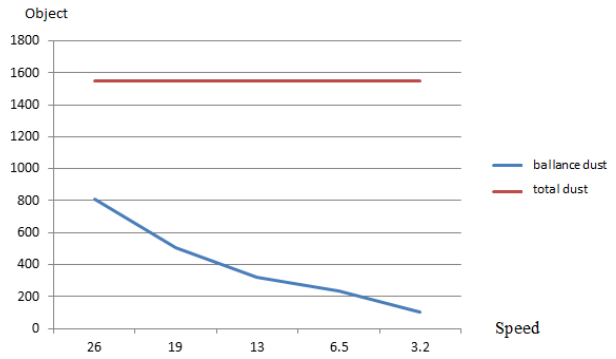



Figure 12: Object Detected Vs Speed

Table 1: Comparison between speed and object detected

| Speed (RPM) | Object detected (Before) | Object detected (After) |
|---|---|---|
| 26 | 1550 | 813 |
| 19 | 1550 | 590 |
| 13 | 1550 | 321 |
| 6.5 | 1550 | 233 |
| 3.2 | 1550 | 103 |

## V. CONCLUSION

The conclusion that can be made from this project is this autonomous sweeper robot for badminton was successful design and implement. This robot can develop same like planning. It work based on basic vacuum cleaning and robot movement using line follower concept. Those concerned with the design of an autonomous sweeper robot for a badminton court by using Arduino as controller. It constitutes a smooth movement easy to use. This autonomous sweeper robot for badminton court that designed can clean a badminton court by using a basic principal of vacuum, the Arduino system as an operating system, a line follows as a sensor to move and basic linear motion. Future work for the future experiment we propose that this project hopefully will be continued in the future different interest and more part will be covered such as hardware that will be developed. This project still need but improve especially the movement concept of robot. This project has high potential to be patent and will be a part of robot cleaning that has in the market today. These challenging future steps will contribute towards intelligent autonomy of service robots.

## ACKNOWLEDGMENT

The authors appreciate the support granted (PJP/2014/FTK(1B)/S01297) by Universiti Teknikal Malaysia Melaka (UTeM) in pursuing this research.

## REFERENCES

[1] Hasan, K. M. & Reza, K. J. 2014. Path planning algorithm development for autonomous vacuum cleaner robots. *International Conference on Informatics, Electronics & Vision (ICIEV)*. IEEE, 1-6.

[2] Jones, J. L., Mack, N. E., Nugent, D. M. & Sandin, P. E. 2009. Autonomous floor-cleaning robot. Google Patents.

[3] Krishnan, R. 2009. Permanent magnet synchronous and brushless DC motor drives, *CRC press*.

[4] Chen, C.-H. & Song, K.-T. 2005. Complete coverage motion control of a cleaning robot using infrared sensors. *IEEE International Conference on Mechatronics*. IEEE, 543-548.

[5] Badamasi, Y. A. 2014. The working principle of an Arduino. *International Conference on Electronics, Computer and Computation (ICECCO)*. IEEE, 1-4.

[6] HM Haniff, M Sulaiman, HNM Shah, LW Teck. 2011. Shape-based matching: Defect inspection of glue process in vision system. *IEEE Symposium on Industrial Electronics and Applications (ISIEA)*, IEEE,53-57.