Design and Development of Smart Home Cleaning Robot

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September 13, 2021

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Abstract - This paper illustrates design and development of Smart Home Cleaning device. Purpose of paper is to design and develop a multitasking device to clean surface by preforming various floor cleaning operations, easy to operate, carry and cost efficient. The Arduino UNO, L298n motor driver is used to run motors & a dual axis joystick is used to provide directional stability. Machine uses a 12v DC power source and detachable Charging unit to provide portable charging. Vacuum Cleaner, Mopping Wheel, Floor Drying, Water spraying and A UV Sterilization Box are other available features.

Key Words: Arduino uno, L298n motor driver, Joystick, UV Sterilization.

1. INTRODUCTION

The Robot is design & developed for cleaning the floor having wet and dry surface. As per the studies and research conducted, single process device is available in market for each home cleaning process i.e. Floor cleaner, Vacuum cleaner, Dry and Wet Wiping. Those are available at the cost of starting from 3000rs to 20,000rs and more. There is no such device which will perform all cleaning processes in a single unit. Fully automatic and Semi-Automatic machines available in the market are of high ranges. So, keeping the focus on cost as well as, unfunctionally they are not affordable Hence there is need of designing a multitasking device for floor cleaning which is easy to operate, carry, and cost efficient. The concept is to design and develop a user friendly & multi-functional home cleaning machine. The device is automatic and semi-automatic consisting dual port vacuum cleaner, floor cleaning, automatic consisting dual port vacuum cleaner, floor cleaning, floor drying and water spraying. In addition, a UV-Sterilization box is also added as feature, unlike other method of sanitations such as liquid disinfectant spraying, or use of sanitizing wipes., UV-LIGHT sterilization can be used as most easiest and effective way of sanitization by killing viruses, bacteria, etc. which can helps to sanitize daily life utilities without being in contact with surface such as currency, ID and payment cards, spectacles & its case, cell phones, keys, pens, small couriers and parcels, packed food items, etc., It uses a UV lamp germicidal effect to sanitize the whole unit and the object to be sanitize placed in it . The device developed will be useful in houses, Flats, Shops and small offices.

1.1 SYSTEM ARCHITECTURE

Fig -1: shown below is the block diagram of smart home cleaning machine. Microcontroller ATmega 328p in Arduino uno R3 is used in combination with motor driver L298n to drive (Run) the DC motors. A dual Axis joystick is used to provide directional stability to machine wheels. A 12v dc water pump with tank is used to spray water required to wet the floor surface. Washer nozzles are used to spray the water. Dc 30000 rpm centrifugal fan assembly is used for vacuum cleaner & two separate ball valves are for both port so the vacuum cleaner can be used as per requirements.

12v Dc blower fan is used for floor drying. Phillips TUV 11w (G11 T5) UV germicidal lamp is used in UV sterilization box. A mopping wheel made of cotton threads is used for floor cleaning. SPDT switches are used to manually operate each function. A separate circuit for UV box is used as the lamp is designed to operate over AC power. To power the entire circuit a 12V DC rechargeable power source (Battery) is used, with 12v portable charger.
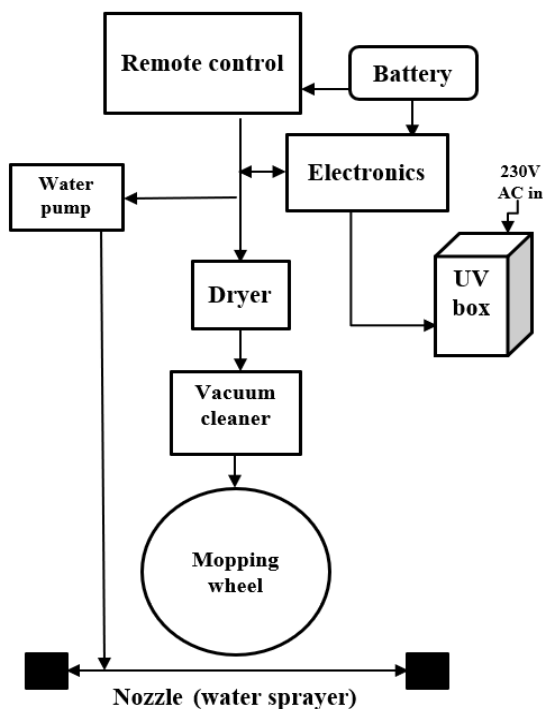

Fig – 1: Block diagram

A. Hardware used:

a) Arduino Uno / ATmega 328p –

The Arduino uno is a microcontroller board based on the ATmega 328p. It has 14 digital IO pins (of which 6 can be used as PWM outputs), 6 analog inputs, a USB connection, a power jack, an ICSP header and a reset button. Microcontroller in Arduino board is used and programmed to run the dc motor attached to it with motor driver. The Arduino is programed in such way to provide forward and backward linear movement, and left & right angular displacement to provide directional stability
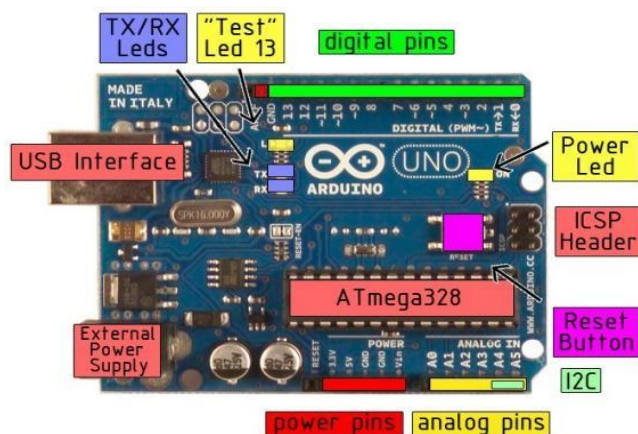

Fig -2: Arduino & pin description

b) Motor driver L298n –

The L298N Motor Driver Module is a high-power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.
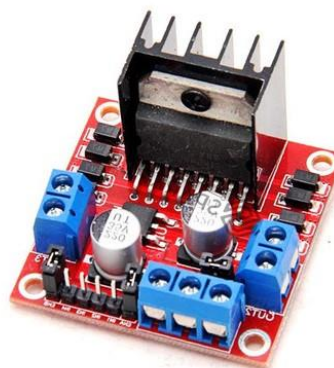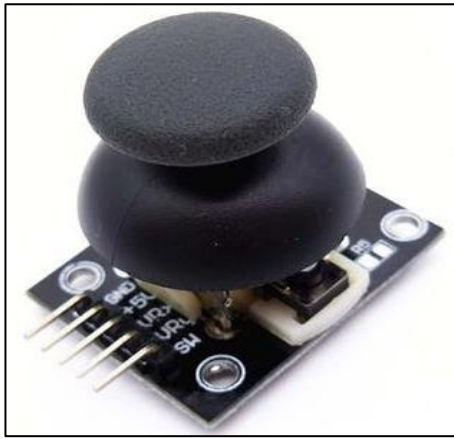

Fig – 3: Motor driver L298

c) Dual- axis Joystick-

Arduino joystick module: it uses a biaxial potentiometer to control the X and Y axis. When pushed down, it activates a switch. Based on the PS2 controller's joystick, it's used to control a wide range of projects from RC vehicles to color LED
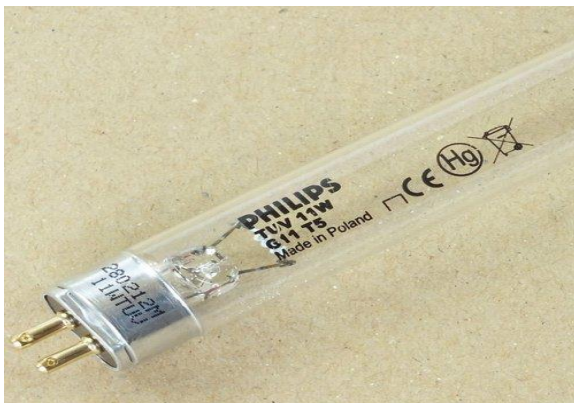
Fig – 4: Dual-axis joystick module

d) UV-C Germicidal Lamp –

The TUV 11w (G11 T5) has short-wave UV radiation with a peak at 253.7nm (UVC) for disinfection purposes. These are basically used for the deactivation of bacteria, viruses, and other micro-organisms and UV based water purifier, air cleaner, etc.
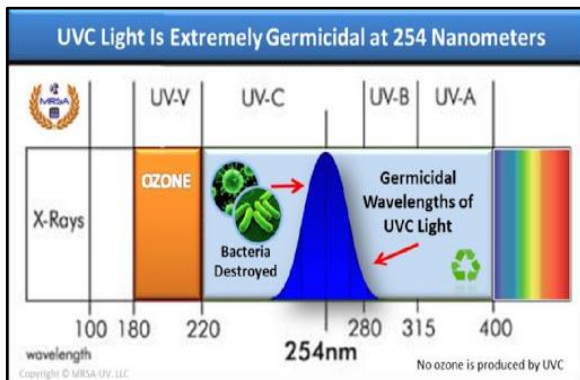
Fig – 5: UV Effective Wavelength Range

Fig – 6: UV- C (Germicidal) Lamp

e) 12v DC Lead acid Batter -

The 12v dc lead acid battery is a type of rechargeable battery. It contains grid construction of plates made of sponge lead (pb) and lead peroxide (pbo_2) dipped in Electrolyte of diluted sulfuric acid solution (H_2SO_4). The Positive terminal of battery is known as Anode; similarly Negative terminal of battery is known as Cathode. The Charging and discharging of battery voltage done chemically by exchange of molecule between lead plate and electrolytic solution.

f) Centrifugal fan –

A centrifugal fan is a mechanical device that moves air. It pulls the air inside the casing and then pushes it out at a 90° angle. Two main components of centrifugal fan are the motor and the impeller. An impeller sucks or pulls air, in contrast to a propeller which pushes air.

g) Mopping wheel –

A mopping wheel is a floor cleaning device. Mop is a mass or bundle of coarse string or yarn, etc., or a piece of cloth, sponge or other absorbent material attached or fixed on a circular disc used to soak up liquid for cleaning floors.

h) DC motors –

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

B. Software Description

a) Arduino IDE –

The programming of Arduino is done in Arduino IDE software which is free source available on internet by Arduino Officials. The IDE enable to writing a program which is a set of step-by-step instruction or commands uploaded to the Arduino. The Arduino programs are written and saved in sketches In Arduino the language is based on C/C++ and can even be extended through C++ libraries. Arduino carryout the uploaded instruction and interact accordingly with whatever it is connected to it.


```
                    Blink | Arduino 1.8.5

Blink §

  This example code is in the public domain.

  http://www.arduino.cc/en/Tutorial/Blink
*/

// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {$
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}

32                                          Arduino/Genuino Uno on COM1
```

Fig – 7: Arduino IDE software

1.2 Calculation for Prototype

a) Battery calculations: -

Battery specification: -

Voltage =12v, Current =9Ah

So, Power= V* I= 12 * 9 = 108 watts

Amount of energy that can battery supply in

1hours = V*I*t

=108*60 = 6480J

b) Calculation for Coefficient of Friction (between mopping wheel and floor surface)

T = 1.5 Kg-CM = 0.147NM

Normal force on mopping wheel = 10

Radius of mopping wheel = 10CM = 0.1M

Therefore,

for the coefficient of friction between mopping wheel and floor will be given by -

$$\tau = \frac{2}{3} \mu FR$$

$$0.147 = \frac{2}{3} \times \mu \times 10 \times 0.1$$

$$\mu = \frac{0.147 \times 3}{2 \times 10 \times 0.1}$$

$$\mu = 0.22$$

From, the research we found out that the standard coefficient of friction for

cotton fiber with ceramic floor is 0.24

c) Calculation for DC Motor Current: -

Torque = 30 kg-cm

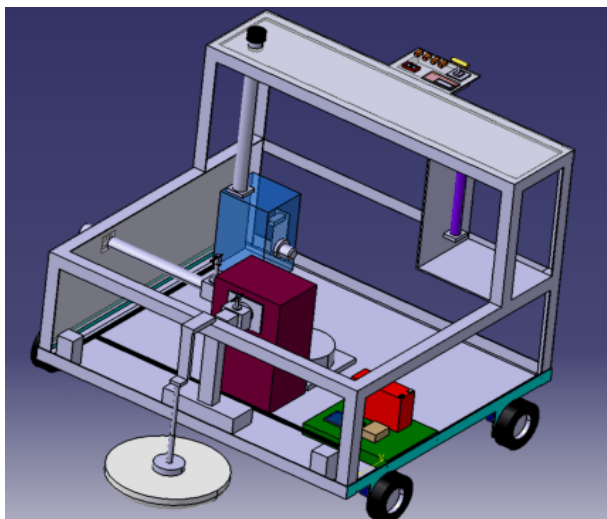No load current = 800 mA

Load current = 7.5 A

Voltage = 12v

Therefore,

Power = V * I

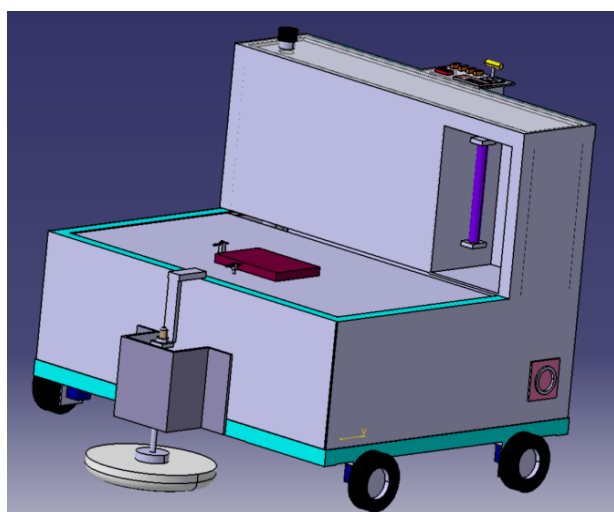= 12*7.5

= 90 watts

1.2 CAD MODEL

Fig – 8: Side View (Exploded)

Fig – 9: Final Assembly View of Prototype

1.2 WORKING

The smart home cleaning machine is design as one universal device which includes all cleaning processes. Machine is designed with Semi-automatic and automatic operations. Dc motor attached on wheels are driven by motor driver and Arduino UNO which programmed in Arduino IDE software. The motion and direction of wheels are controlled with a dual axis joystick provided in Remote control. SPST switches (single pole single throw) are used to operate other features such as Mopping wheel, Vacuum cleaner, floor dryer, water sprayer.

All electronics component is powered with a 12v DC power source (battery), as the concept it to design a portable device which can be operated without live electricity and plugging the cord. A step-down charger (230v Ac -to- 12vDC) is provide for charging the power source. A digital voltage meter is added to device to notify the live voltage and ampere rating. A mini circuit breaker (MCB) switch is provided to cutoff the supply damage by overcharging or high voltage fluctuation. The UV box is designed with a separate wiring unit as the UV lamp used it comes in AC power variant only. The UV circuit consists of a power choke, UV lamp, operating switch and power Cord.

2. FUTURE SCOPE

The smart home cleaner further can be designed as per future requirements such as AI based, voice command operated (voice recognit - ion mode), line follower, WIFI, GPS or can be operated with Bluetooth. A smartphone app for robot can be designed to operate and get valuable notifications of battery charging rate, battery life state, maintenance schedule or any hazardous activity occurred in device (fire/ short-circuit /water leak).

3. CONCLUSION

This work facilitates that floor cleaning can be done in easier way and more efficiently using home clean machine. Developed smart machine reduces cost and time required for home cleaning, ultimately result easy and quick cleaning operation. With simple programing and hardware, the machine developed is single device can perform all processes of cleaning such as vacuum cleaning, floor mopping, floor drying, water spraying. An effective and contactless sanitization can be achieved with UV germicidal lamp.

ACKNOWLEDGEMENT

REFERENCES

[1] M. Ranjit Kumar and N. Kapilan, "Outline and Examination of physically worked floor cleaning machine," IJERT ISSN: 2278- 0181 Vol. 4 Issue 04, April-2015.

[2] Kyle J. card, Dena Crozier, Andrew Dhawan, Emily Dolson Uv sterilization of personal protective equipment with idle laboratory biosafety cabinets during the COVID-19 pandemic. March 27, 2020

[3] Sandeep. J. Meshram, Dr. G.D. Mehta - "Design and Development of Tricycle Operated Street Cleaning Machine" - Journal of Information, Knowledge and Research in Mechanical Engineering ISSN 0975 – 668X| Nov 15 To Oct 16 | Volume– 04, Issue- 01.

[4] Liu, Kuotsan, Wang Chulun, A Technical Analysis of Autonomous Floor Cleaning Robots Based on US Granted Patents, European International Journal of Science and Technology Vol. 2 No. 7September 2013, 199- 216.Design and fabrication of floor cleaner robot (manual and automatic) International Journal of Computer Applications (0975 – 8887) Volume 97– No.19, July 2014.

[5] Uman Khalid1, Muhammad Faizan Baloch1, Smart Floor Cleaning Robot (CLEAR), Faculty of Electronic Engineering, Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Pakistan.

[6] D Karunakaran, B. Abhilash, V. Ananda prasanna, Design and fabrication of hybrid floor cleaner, international journal of engg research & Tech (IJERT) ISSN:2278- 0181, Vol.5 Issue 04, April 2016.

[7] Nirav Shah, Rohit Jadhav, Amogh Malekar, Hasim Shah, Chetan Thakur, Review Paper On Floor Cleaning Machine, IJSDR1810042 International Journal of Scientific Development and Research (IJSDR) www.ijsdr.org, ISSN: 2455-2631 © October 2018 IJSDR | Volume 3, Issue 10

[8] Madan Jagtap, Uttam Mourya, Suhas Deore, Akash Shrimandle Combined manual and automatic operation, Single passdry & wet cleaning May, 2019

[9] Nirav Shah, Rohit Jadhav, Amogh Malakar, Hasim Shah, Chetan Thakur Semi-operated floor cleaning machine,capable in cleaning wet &dry surface, low costOct,2018

[10] Raj Vishal, Raghavan P., Rajesh R., Sachin Michael, Mohan Rajesh Elore June, 2018 Cleaning module alone clean floor, EDF acts as vacuum cleaner with vacuum pump, Good efficiency