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Trashbot: A Beach Cleaning Robot

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Abstract *: Robotics is an emerging field in the world that brings drastic changes in Human life. This paper presents the improvement of a garbage pickup robot that operate on the sand. In this case, the proposed system can navigate and collect debris found on the beach. Autonomous trash-collecting robots have been considered the benchmark for mobile robot design. These include several tasks such as navigation, path planning, object detection, obstacle avoidance, task sequencing. In this type, the develop robot is manage to autonomously collect trash using an excavators like dotted hole claws. The picked-up trash is get separated into metallic and nonmetallic way and left off in a bucket attach to the robot which has separate partitions. In addition, in addition to detailing the system's design and construction, this paper presents the description of the developed embedded electronics modules, a motor closed-loop speed control system and the optical flow algorithms that allows the computer vision system to detect and avoid obstacles and track the cans to be collected. Also, it is connected to charging station through WIFI module. In this project, we have taken the ESP8266 wifi module as an antenna or we can say to developed a connection with the system. ESP8266 is a low-cost Wi-Fi microchip, with built-in TCP/IP networking software, microcontroller capability and strong connectivity with the microcontroller.*

Keywords – *Autonomous, Low Maintenance, Segregation, Waste Management, Wireless.*

I. INTRODUCTION

This work represents the development of a garbage pickup robot that operates on the sand. Due to incidents of high tide accured in Mumbai beaches which wash ashore 3 million tons of garbage of the seashore in recent years. 3 million tons is a big number, how this garbage did come from the sea? It's the garbage discarded by man itself. So, we are developing this protocol which will clean all man-made debris. In the presented configuration, the developed robot can be managed to autonomously collect trash.

Trashbot seaside cleaner robotic is a sturdy tracked seashore cleansing device based totally on electric vehicle system and powered by using fully-remoted Li-ION batteries with attached solar panel-based charging station. Its undercarriage is based on high-quality with 100% natural rubber material capable of provide an superb grip motion even on wet sandy surfaces.

These consist of numerous common responsibilities inclusive of navigation, direction making plans, object detection and discrimination, obstacle avoidance, task sequencing, and frequently multi-agent coordination. The development of trash pickup robot which operates on the sand and also discarded by itself. The developed system can autonomously collect trash using its own claws as an arm. In addition to detailing the system design and construction, this robot presents the description of the developed embedded electronics module.

II. PROPOSED ALGORITHMS

On the first the robot will start with the manual switch. When it gets started the sensor will come in contact or in working condition. With the use of a motor robot, it will collect the objects that fell down in its range. It will stop at the specific distance where the sensor will sense an object. Then servo motor which we have installed to control the arm movements.

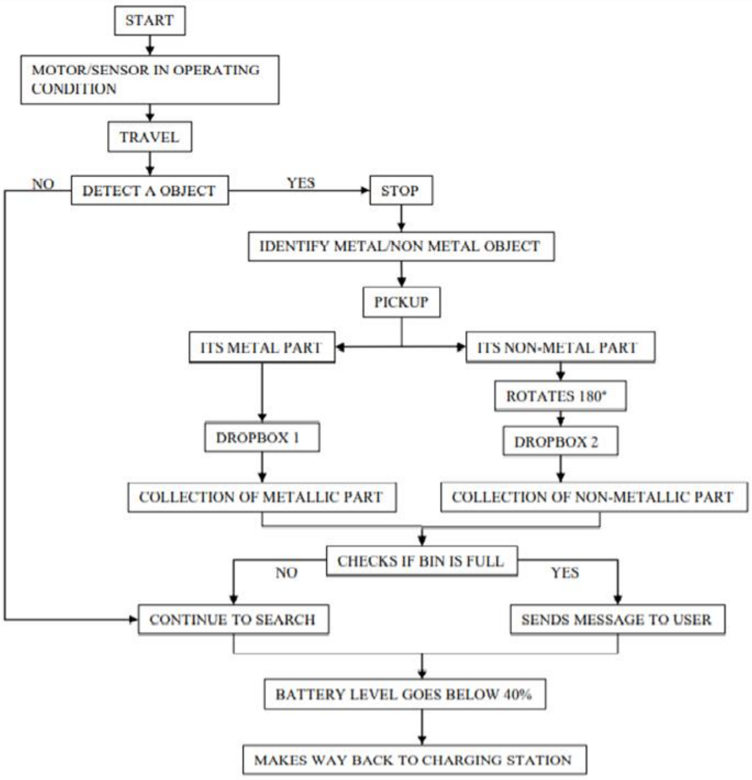

Fig.1: Algorithm of Robot

By the use of a servo meter, the arm picked up the object and will put it in the attached bucket which has 180-degree rotation for segregation (i.e., separate parts for metal and non-metal) if the pickup trash is a metal object, then the bucket will rotate to rotate part and trash will go down to the metal section, once it gets done it will rotate back to its normal position. Then again, motor will start within the forwarding direction and on every occasion the sensor will sense an object in its variety the robot will pass in that path and the same process will happen periodically; STOP-PICKUP-DETECT AN OBJECT-SEPARATE THE TRASH with the aid of this non-stop process if the bucket gets full or overloaded the user gets the notification message from the system.

III. METHODOLOGY

3.1 Block Diagram

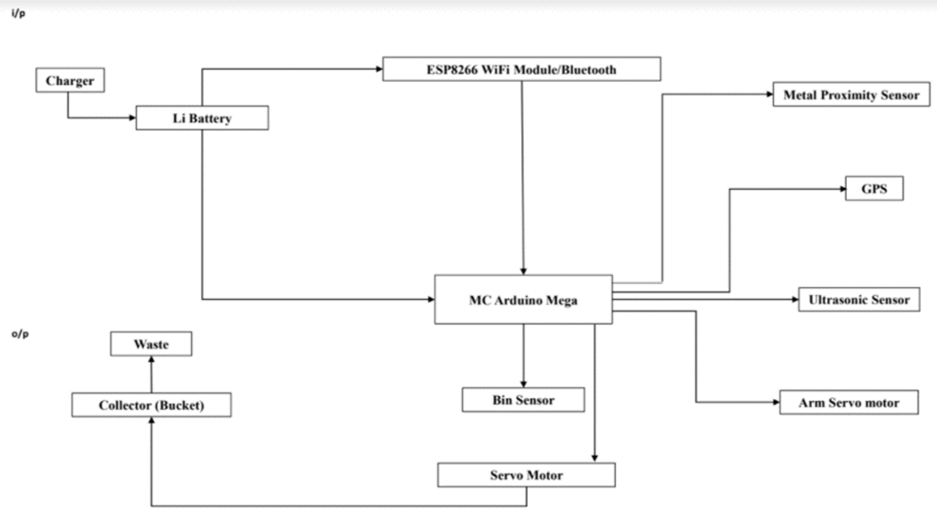

Fig. 2: Block diagram

3.2 Calculating Motor & Battery Based on Constraints

3.2.1 Vehicle Mechanical Calculations & Motor Selection

(1) Gross vehicle Weight = **GVW = 10 kg**.
(2) Gross Vehicle Mass = **GVM =** 10/9.81 **= 1.01 kg**.
(3) Radius of the tyre = **r = 0.055 m**.
(4) Circumference of tyre = C = 2 π r
C = 2 * π * 0.055 = **0.3455 m.**
(5) Velocity = **V = 1.8 km/hr = 30 m/min = 0.5 m/sec**.
(6) Acceleration: - $v^2 = u^2 + 2as$
u = 0 m/sec
Consider, s = 50 m
a = 0.0025 m/s^2
(7) Rolling Resistance Force = Fr = Cw = C*m*ag
C - Coefficient of Rolling resistance of road
Cconcrete= 0.002
Casphalt = 0.004
Csand = 0.3
(8) For concrete,
Fr = 0.002*10*9.81 = **0.1962 N.**
(9) For Asphalt,
Fr = 0.004*10*9.81 = **0.4 N**.
(10) For Sand,
Fr = 0.3*10*9.81 = **29.43 N**
(11) Aerodynamic Force = Drag Force = Fd = Cd12∗δ∗A∗V^2
Cd = Drag quantity= 0.9
δ = Density of Medium
δAir = 1.2 kg/m^2, at NTP
v = Velocity of object in m/sec
A = Exterior area of the object = 0.18 m^2 (assumed by curved dimension)
(12) Fd = 0.9*0.1.8*1.2*(0.5)2 *1 = **0.0486 N.**
(13) Acceleration Force = FAcc = GVM * acceleration
FAcc= 1.01 * 0.0025 = **2.525*10^{-3} N**.
(14) Ft = Summation of all forces
Ft = Fr + Fd + FACC
(15) For concrete,
Ft = **0.2473 N.**
(16) For Asphalt,
Ft = **0.4511 N**.
(17) For Sand,
Ft = **29.4811 N**
(18) POWER REQ. = Preq = Ft * V⁄ηm
ηm = Efficiency of Motor
v = velocity
(19) For concrete,
Preq = (0.2473 N* 13.88 m/s)/0.85 = **0.1454 W**
(20) For Asphalt,
Preq = (0.4511 N* 13.88 m/s)/0.85 = **0.2653 W**
(21) For sand,
Preq = (29.4811 N*0.5 m/s)/0.85= **17.34 W**
(22) Required Motor rpm of system = ΩM = Gear ratio * Wheel rpm (Ωw)
ΩM = 6 * 80.045 = 480.27 = 500 rpm.
(23) Required Torque of system = Ṫ = r × Ft
(24) For concrete,
Ṫ = 0.055 × 0.2473 = 0.0136 Nm.
(25) For Asphalt,
Ṫ = 0.055 × 0.4511 = 0.0248 Nm.

(26) For Sand,

T = 0.055 × 29.4811 = 1.62 Nm.

i. For Torque of motor, choose motor whose **RATED torque** is 1.8 <$\dot{T}$< 1.5 Nm.
ii. For Power of motor, choose motor whose **power rating** is 20 W < Motor power < 15 W.
iii. For RPM, choose motor whose **RPM** is 500< Motor rpm

3.2.2 Battery Calculations

a. Cell vtg = **3.6V**
b. Capacity = **2500mAh**
c. Charging Vtg = **4.2V**
d. Weight per cell = **45g**
e. Specific Energy Density = 9.13Wh

(1) Volume of cell = Vcc = (Π * Battery cell diameter * Battery cell length)/4
Vcc= (Π * 18 * 0.001 * 0.065)/4
Vcc= **0.00092 m^3**
(2) Battery Cell energy = cell capacity * cell voltage
Ce= 2.5 * 3.6
Ce= **9 Wh**
(3) Battery cell energy intensity = (Battery cell energy)/(Battery cell mass)
σ= 9/0.045
σ= **200 Wh/Kg**
(4) Battery pack total energy = Motor vtg *(Ampere drawn)/(speed (kmph)) * Distance
Tσ= 12*1.8/10*5
Tσ= **120 Wh**
(5) No. of cells in series = **3 cells**
(6) Energy content of line = Cells series * Energy of cell
ε= 3 * 9
ε= **27 Wh**
(7) No. of line of battery pack = (Battery pack Total energy)/(Energy content of each string)
= **3.2~4 (approx.)**
(8) Battery pack capacity = 4 * 2.5 = **10 Ah**
(9) Total no. of cells = 4 * 3 = **12 cells**
(10) Battery pack mass = 12 * 0.045 =**0.54 ~ 1 Kg**
(11) Peak c/n = crate * Battery cell capacity
A= 1 * 2.5
A= **2.5 A**
(12) Battery pack peak c/n = Peak c/n * No. of lines of battery
A= 2.5 * 4
A= **10 A**
(13) Battery pack peak power = Battery pack peak c/n * Battery pack vtg
P= 10 * 12
P= **120 W**

So a battery pack of 12 v, 10 AHr should be used in this model.

IV. FIGURES AND TABLES

4.1 Simulation and Modeling

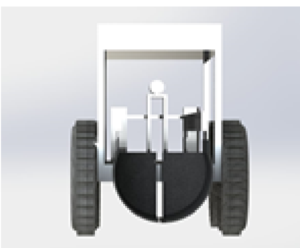

Fig.3(a): Front View

Fig.3(b): Right Hand Side View

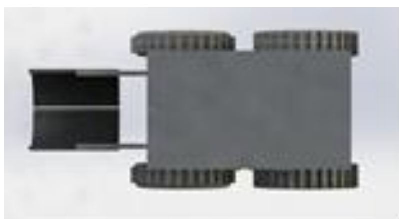

Fig.3(c): Top View

Table 1: Parameters of 18650 Li-ion cell

Nominal Vtg	3.7V
Rated Charge Vtg Range	4.1v (25ma)
Nominal Capacity	2500mah, 0.2c(500ma)
Energy Intensity	200wh/Kg
Charge Vtg (End C/N)	4.2v ± 0.05v(25ma)
Max Discharge C/N	2c(5000ma) 10℃≥T≥5℃,50℃
Cell Measurements	Length: 64.85±0.25 Mm Diameter: 18.35±0.15 Mm
Internal Resistance	≤35 M Ω(Ac Impedance, 1000 Hz)

Table 2: Parameters of 12V 10400mAh Li-ion 18650 Lithium ion Rechargeable Battery pack

Battery Type	Rechargeable Li-Ion Battery
Battery Pack Capacity	10400mah
Input Vtg	12.6v
Output Vtg	11.1 – 12.6v Dc
Output C/N	About 1 – 3a
Cell Configuration	12cell – 3 Sets In Series, 4 Sets In Parallel (3s4p)
Specifications	Built-In Bms Protection, To Fully Charge, To Fully Discharge, Blocked Short Circuit
Dimensions	Width: 5.5mm, Height: 68mm, Length: 75mm
Charging – Charge Mode	Cc Cv
Battery Charger	Lithium-Ion Battery Allocated Charger To Charge Up To 12.6v
Max Charge C/N	2a
Discharge C/N	5a 25℃,±10%

V. CONCLUSION

We check the system and it is working very efficiently and giving consistent results as we expected. As methodology shows it is having two working modes i.e., it can operate autonomously as well as by manually by the blink mobile app/software. Time is precious in terms of works, for this purpose we have introduced an autonomous mode in our project. We have checked the results and it is working in very fine way, on the other for the new users there is manual mode is also available which will ease the user to operate this and get used to it. It is having a massive 12 volts 10 Ampere battery pack which will give the minimum 60 minutes of run time with attached charging station. About the advantage we can give this project to panchayat of the village and rent it according to fixed percentage.

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