Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 5, No.5, May : 2024

DESIGN AND FABRICATION OF BUGGY FOR TRANSPORTATION OF INJURED PERSON

Mr. Shreyas M, Assistant professor, Department of Mechanical Engineering, Vidyavardhaka college of Engineering, Mysuru-570002
Sujan K, B.E student Department of Mechanical Engineering, Vidyavardhaka college of Engineering, Mysuru-570002
Ullas B, B.E student, Department of Mechanical Engineering, Vidyavardhaka college of Engineering, Mysuru-570002
Rahul, B.E student, Department of Mechanical Engineering, Vidyavardhaka college of Engineering, Mysuru-570002
Sujan A S B.E student, Department of Mechanical Engineering, Vidyavardhaka college of Engineering, Mysuru-570002

Abstract
The aim of this project is to design and fabricate a buggy that can transport injured person from the sports field and disaster area to the medical facility in a safe and efficient manner which required medical assistance. The buggy will be controlled using Bluetooth, and to be powered by an electric motor. The project aim is designing a reliable buggy frame using CAD software and fabricating the frame using suitable materials. The design criteria include stability, user friendly, cost efficiency. The proposed outcome of this project is a technological demonstration model of the Bluetooth controlled buggy that show performance in various scenarios. This project helps in advancement in technology and innovation in the field of sports and medical emergency by using suitable materials. The 3D modelling and the analysis of the buggy is carried out using Autodesk inventor.

Keywords:
Buggy, Bluetooth, Frame, Scoop stretcher, prototype, injured person.

I. Introduction

Safe and reliable evacuation of injured people is important in the high-stakes discipline of providing immediate medical services. It is tedious in many cases of immense physical risk or an uneasy environment. Conventional types of transportation are helpful in these conditions, but they are mostly employed improperly and cannot effectively address specific issues. This project seeks to close that gap by creating a completely new form of transportation. One of the key components of this solution is the Bluetooth-controlled buggy. With remote control operation, this buggy will be far more adaptable and flexible when it comes to managing various situations.
The primary focus of the project will be to cover every aspect of emergency medical response and shorten all decencies and defects that can affect the system's effectiveness and efficiency. The target realization is a buggy with specifications suited for emergency response to bridge the current transportation system while setting a new standard for emergency response and transportation. The project hopes to affirm every person’s well-being and safety and assure easy and fast access to a safe response in all emergencies.

II. Literature review

J Basri Lenjani et al. have investigated the injuries occurred in football match and reported that, sports injuries are very costly, and according to the pathology with diseases were 15 cases or 21.4 %, injuries were 55 cases or 78/6 %. Injured by age. The largest number of injured with injuries in the field of football sports the most affected age was the age of 21-25 years with 28 cases or 40.00%, over 25 years were 27 cases or 38.58% and with a smaller number were aged 15-20 years15 cases or 21.42%.[1]

Gianluca Del Rossi PhD et al. have investigated about are scoop stretchers suitable for use on spine-injured patients and came to conclusion that, although not statistically significant, the execution of the log roll maneuver created more motion in all directions than either the lift-and-slide technique or with scoop stretcher application. The scoop stretcher and lift-and-slide techniques is restricting the motion to a comparable degree.[2]

Mihirraj Thakor et al. This project demonstrates Bluetooth connection with a car, specific Bluetooth technology attributes, mobile and robot elements, as well as how to operate a car using a mobile device. We provide a summary of robots that may be moved forward, backward, left, or right by means of an Android app like Arduino or Bluetooth. Bluetooth has changed how people use digital gadgets at home or at work by converting cable-based ones into wireless ones.[3]

III. Summary of literature survey

The literature review summarizes the studies on the design, analysis, of go-karts and other automated systems. Papers showcase the advantage of the use of AISI 1018 for the chassis frame[4] and the significance of 3D modelling and analysis.[5] Some research papers focus on developing lightweight chassis, efficient systems controlled through Bluetooth modules and explore the use of Android applications for cost-effective semiautomated solutions.[6] Sander Klomp's thesis focuses on improving the process of transporting injured athletes from the ground and recommending the use of a scoop stretcher and scooping technique.[7]

IV. Objective

The objective of this project is to fabricate prototype of Bluetooth controlled Buggy for Transportation of Injured Person. The primary focus is to address the challenges associated with handling injured Person and provide an efficient and user-friendly solution for transportation.

V. Methodology

The methodology involves understanding project needs and risks through a preliminary investigation, followed by building the Bluetooth-controlled buggy in the system development phase. User satisfaction is ensured through acceptance testing, feedback collection, and iterative improvements, concluding with the finalization of the system for deployment.

VI. Buggy design

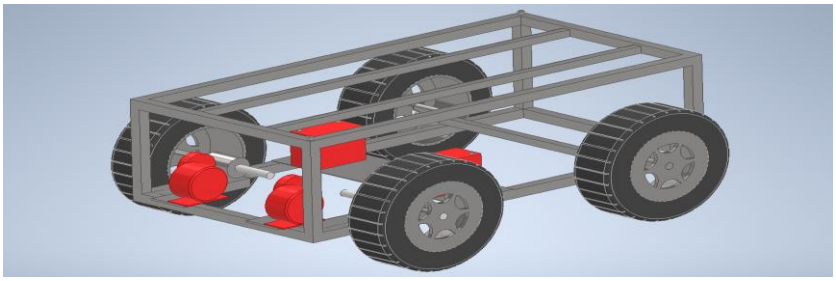

Figure 1: Model of Buggy (ISO view)

A buggy is a small, open-air vehicle built for outdoor use, and is typically equipped with big, robust tires. Our medical transportation concept is lightweight and Bluetooth-controlled, with a focus on simplicity with no suspension system. The buggy's stability and safety must be carefully considered during design. On top of this model a stretcher will be placed to carry the injured person and suitable locking mechanism will be incorporated to make sure the stretcher is stable.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 5, No.5, May : 2024

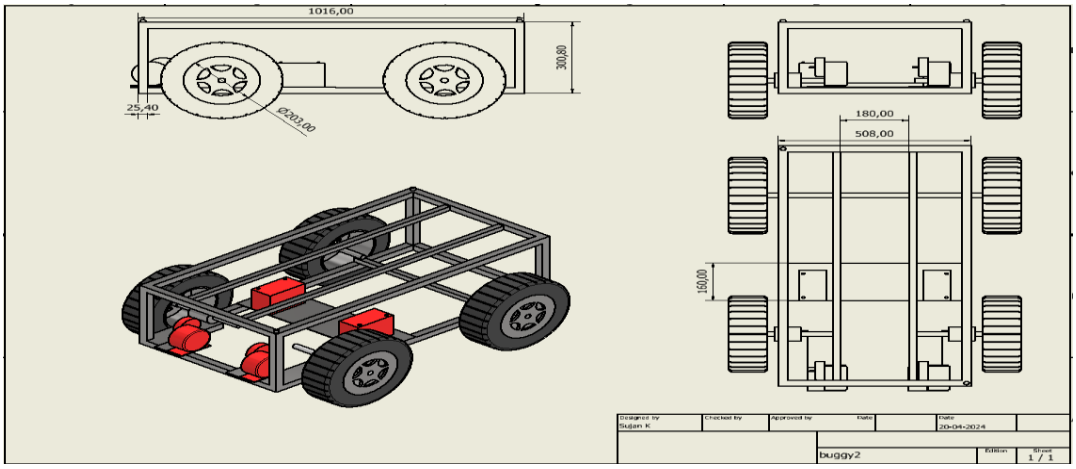

Figure 1.1: Buggy draft

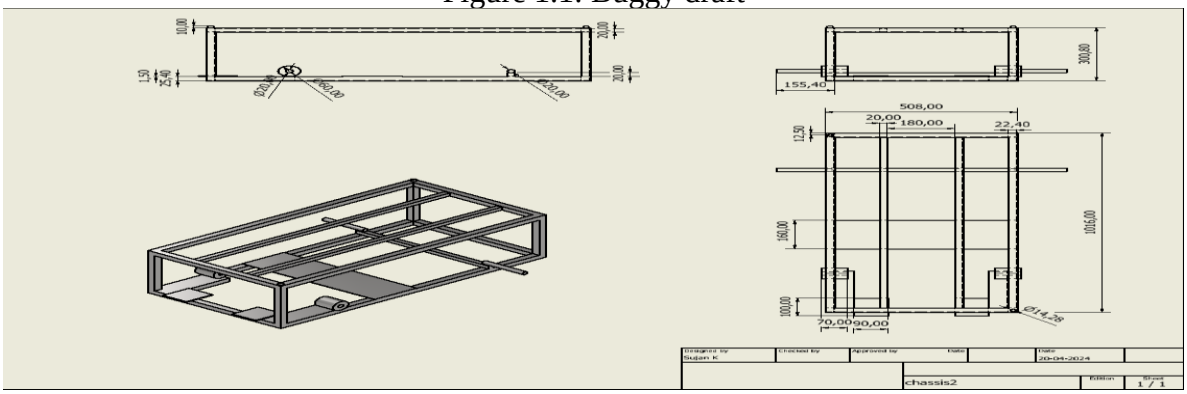

Figure 1.2: 2D draft of chassis

For maximum performance and safety, the square MS pipe chassis integrates easily with other parts, providing a strong and flexible base. We have chosen a 25.4x25.4x1.5mm-dimension pipe considering the availability and cost. The dimensions that we are employing to create the buggy's chassis are shown in Fig. 1.2

VII. Analysis done on chassis

Load :1000N
Displacement: 0.8859
VON Mises stress: 46.11Mpa (max)
Safety factor: max=15ul
Min=4.49ul

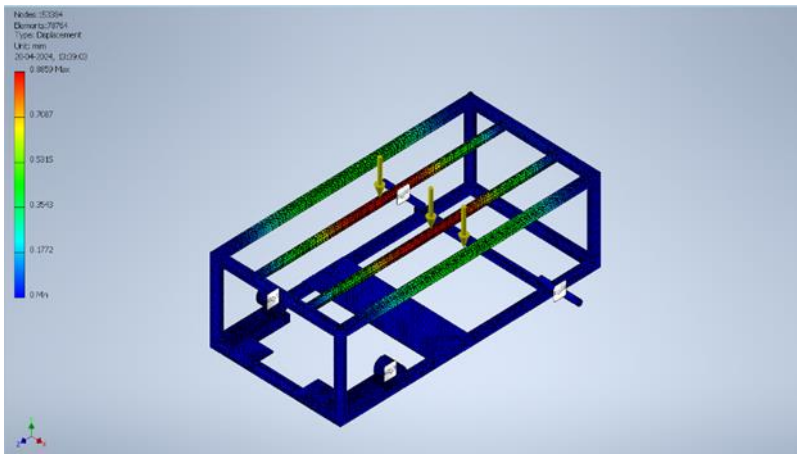

Figure 1.3: Buggy Chassis Analysis

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The static analysis for chassis is carried out using Autodesk Inventor software and the results are obtained.

VIII. Calculation

We require buggy to move at **5km/hr** (Human walking speed)

Weight calculation of chassis

Formula: $\frac{weigth}{meter} = volume \times density$……. (1)

$= (volume1 - volume2)density$

$= (0.0254 \times 0.0254 \times 1 - 0.0224 \times 0.0224 \times 1)7850$

$= \mathbf{1.2257}\frac{\boldsymbol{kg}}{\boldsymbol{m}}$

Total length of pipe used to build chassis: **7.7216m**

$\boldsymbol{Total\ weight} = total\ length\ of\ square\ pipe \times \frac{weight}{meter}$……. (2)

$= 7.7216 \times 1.2257$

$= \mathbf{9.4643}\boldsymbol{kg}$

$\boldsymbol{Kerb\ weight} = chassis\ weight + wheel + components\ weight$……. (3)

$= 9.4643kg + 12kg + 5kg$

$= \mathbf{26.46}\boldsymbol{kg}$

$\boldsymbol{Gross\ weight} = specimen\ weight + kerb\ weight$……. (4)

$= 18kg + 27kg = \mathbf{45}\boldsymbol{kg}$

To find wheel travel

Tyre diameter = 0.33m

$circumference\ of\ tyre = 2\pi \times r$……. (5)

$= 2\pi \times \frac{0.33}{2}$

$= \mathbf{1.03}\boldsymbol{m}$

Speed at which human walk(doctor) = 5km/hr

Velocity = 5km/hr = 1.38m/s

Rpm required

$RPM = \frac{speed}{wheel\ travel}$…… (6)

$= 1.38 \times \frac{60}{1.03}$

$RPM = 80rpm$

To calculate total force and torque

$f_t = f_r + f_d + f_g$……. (7)

f_r: $rolling\ force$

f_d: $drag\ force$

f_g: $gradient\ force$

Drag force and gradient force experienced is negligible so, its zero.

$f_r = mgC_r$ …….. (8)

Where: m=45kg

$g = 9.81\frac{m}{s^2}$

$coeffecient\ of\ rolling\ resistence\ C_r = 0.02$

$f_r = 45 \times 9.81 \times 0.02$

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$$f_r = 8.9N$$
$$f_t = f_r$$

Total force=8.9N

Power

$power = f_t \times v$……. (9)

$= 8.9 \times 1.38$

$P = 12.3621W$

To find torque required

$P = \frac{2\pi NT}{60}$……. (10)

$$T = \frac{12.3621 \times 60}{2\pi \times 80}$$

$T = 1.475Nm$

Gear ratio of sprocket:

$gear\ ratio = \frac{output\ rpm}{input\ rpm} = \frac{80}{60} = 1.33$……. (11)

We have selected two 12V 5A 60rpm DC wiper motor and a chain sprocket to transmit power and increase the rpm from 60 to 80 speed based on our findings of calculation. Two 12V 7.5Ah rechargeable lead acid batteries are utilized to power the motor and electrical parts.

IX. Components used

1. 12V 5A 60RPM DC geared motor: In this project we are using two geared motor to move the buggy. Geared motor has high torque and less power consumption.

Figure 1.4: 12V 60rpm geared DC motor

Table 1: Motor Specification

SL No	FEATURES	DESCRIPTION
1	Voltage(V)	12
2	Speed(rpm)	60
3	Current(A)	5
4	Motor Diameter(mm)	44

2. 12V 7.5Ah Lead acid Battery: The lead acid batteries we utilized for our project are 1kg in weight and have a voltage of 7.5 Ah. The motors are powered by two rechargeable batteries that we have. These batteries are built using mountable gel AGM types VRLA. These batteries are dependable, economical, and have a long lifespan.

Figure 1.5: 12V 7.5Ah lead acid Battery

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3. 13-inch wheels: Four 13-inch wheels have been employed for maximum stability and traction. Their tread design improves grip, giving you more control when you're moving. The purpose of selecting these wheels was to enhance overall performance and manoeuvrability, guaranteeing a more controllable and comfortable riding experience.

Figure 1.6: 13-inch wheels

4. MS AISI 1018 steel pipe: For the fabrication of the chassis, 25.4 mm x 25.4 mm x 1.6 mm square pipe will be used. MS square pipe is shown in Fig. 8.4. The standard grade of low-carbon steel, also referred to as mild or low carbon steel, is AISI 1018. This steel is the most often used grade and is very versatile, machinable, and weldable. "AISI" refers to the American Iron and Steel Institute, which establishes steel grade standards.

MS steel AISI 1018:

• Chemical Make-Up:
Carbon (C): 0.15–0.20%
Manganese (Mn): 0.60 to 0.90 percent
Maximum Phosphorus (P): 0.04%
Maximum Sulphur (S): 0.05%

Figure 1.7: 25.41mmx25.4mmx1.5mm MS square pipe

5. ESP 32 module: ESP32 is 5V operated a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC low-power 40 nm technology. It provides input for relays. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios. Advantage of using esp32 module is that its small in size and can perform the task much faster and consumes less power and it can be easily programmed using Arduino IDE.[8]

Figure 1.8: esp32 module

6. 2 channel Relay module: In this model, the direction of the motor is controlled by four relay modules, which are used to operate high voltage motors. It can switch between 250VAC, 30VDC, and 10A of voltage and current at its maximum.

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Figure1.9: 2 channel relays

7. Buck Converter: The fundamental switched-mode power supply topology is a Buck Converter. A DC-DC converter known as a "buck converter" lowers a greater voltage to a lower level. The switch of the converter is driven by a pulse width modulation (PWM) signal produced by this microcontroller with a constant duty cycle. To create controlled voltage, the switch will then alternately turn the converter on and off. Since the esp32 operational voltage ranges from 3.3V to 5V, we are utilizing buck converters to lower the voltage from 12V to 5V DC.

Figure 1.10: Buck convertor

8. Chain Sprocket: A mechanism called a chain sprocket is used to move power from the motor to the drive wheel. In our project, two wheels are driven by two chain pockets. Power is transferred to the wheel through the chain pocket configuration on the free wheel. The chain sprocket's great accuracy and efficiency of 98% increases the buggy's overall efficiency. We are employing a gear ratio of 1.33 for this project.

Figure 1.11: Chain sprocket

9. Scoop stretcher: One kind of stretcher used to carry injured people is called a scoop stretcher. After reading through numerous research papers, we came to the conclusion that using a scoop stretcher is simple and requires the least amount of personnel.

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Figure 1.12: Scoop stretcher

X. Fabrication details

1. Buggy iso view

Figure 1.13: ISO View of fabricated buggy

Iso view shows glimpse of all the parts used in the fabrication. Which helps in understand the design and how the model look in a single view. In the top the model a scoop stretcher will be placed to carry injured person and suitable locking mechanism has been implemented so that the stretcher can have stability and the injured can be carried without any disturbances.

2. Top view of buggy

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Figure 1.14: Top view of buggy

Top view shows the placements of the components mounted on the chassis and helps to better understand the model.

3. Side view of buggy

Figure 1.15: Side view of buggy

XI. Buggy with stretcher assembled

1. <u>Top view</u>

Figure 1.16: Top view with stretcher

From this view we can easily understand the scoop stretcher assembled on the buggy.

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2. Side view

Figure 1.17: Side view of buggy with stretcher

XII. ELECTRICAL PIN DIAGRAM

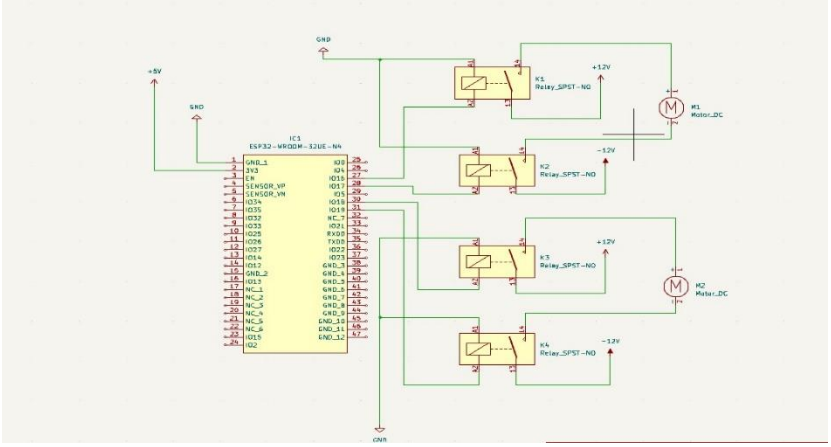

Figure 1.18: Electronic connection

In this electronics connection one ESP 32, one Buck convertor, four 2 channel relay, jumper wires for connection and two 12V DC motor are used. Two 12V 7.5Ah batteries are used to power the electronic components Electrical pin diagram helps to understand the electrical connection made in the model. ESP 32 operates only at 3.3V to 5V so, to reduce the voltage from 12V DC to 5V DC a buck convertor is used. Four 2 channel relays are connected to ESP 32 and the output of the relays are connected to motor and battery.

XIII. Project expenditure

Table 1.1: Expenditure

SL NO	COMPONENTS	MATERIAL	QUANTITY	PRICE IN Rs
1	Square pipe	Mild steel	9 meters	900/-
2	Flat bar	Mild steel	2 meters	500/-
3	20mm Shaft	Mild steel	2 meters	500/-
4	13-inch wheel	Rubber	4nos	2800/-
5	Wiper motor	12V DC 5A	2nos	2400/-
6	Wires	Copper	3 meters	100/-
7	Battery	12V 7.5Ah lead acid	2nos	2500/-
8	Sheet metal	Galvanized iron	8 sq. ft	800/-
9	Battery clips	Metal	4nos	40/-
13	Nuts and bolts	Metal		50/-
14	ESP 32		1nos	600/-
15	2 channel relays		4nos	800/-
16	Buck convertor		1nos	200/-
17	Jumper Wires			100/-
18	Connector		1nos	50/-
19	Scoop stretcher		1nos	2000/-

20	Miscellaneous			5000/-
	TOTAL			19,340/-

The cost breakdown for the project is as follows:
Structural components such as the square pipe, flat bar, and 20mm shaft, all made of mild steel, cost a total of 1900/-. The mobility components, including the 13-inch rubber wheels and the wiper motor, amount to 5200/-. Electrical components, which include the wires, battery, ESP 32, 2 channel relays, buck converter, jumper wires, and connector, come to a total of ₹5850/-. The body components, comprising of the galvanized iron sheet metal and battery clips, cost 840/-. The assembly components, including the nuts and bolts, cost 50/-. The scoop stretcher costs 2000/-. Lastly, there are miscellaneous costs amounting to 5000/-.
So, the total expenditure of the project is calculated to be 19,340/-.

XIV. CONCLUSION

The project design and fabricate a Bluetooth-controlled buggy for the transfer of injured person was completed successfully. The design of the buggy focused on the injured safety and comfort. It can be easily controlled using Bluetooth from an Android device. It has numerous significant properties. The buggy's movement is assured by a 13-inch rubber tire and a wiper motor, which provide quiet and effective movement. The buggy can be controlled through Bluetooth, unlike the Arduino which requires a separate Bluetooth device. An ESP 32 has an integrated Bluetooth module which gives output to two-channel relays and controls the movement of the buggy. The buggy is powered by two 12V 7.5Ah lead-acid batteries, which provide sufficient power for the operation of the device. The assembly of a scoop stretcher on buggy focuses on the stability of the injured individual, providing a secure and comfortable space. This project shows how technological improvement can be made in the field of medical emergencies by providing a user-friendly, reliable, cost-effective solution for the transportation of the injured. For this project future enhancements such as an incorporating suspension system for rugged terrain and a gyroscope for stability in difficult terrain. This project can be converted into a fully unmanned transportation device in the military application which can autonomously navigate and a real-time health monitoring system can be implemented. Overall, this project provides advancement toward improving medical accessibility and can reduce emergency delays.

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