Asian Journal of Electrical Sciences
ISSN: 2249-6297 (P) Vol.10 No.2, 2021, pp.1-5

DOI: https://doi.org/10.51983/ajes-2021.10.2.2948

Recreation of Conventional Tonga

Beena Puthillath[1], Abishek Jose[2], Aswin S. Kumar[3], M. S. Shibin[4] and Shojo Johnson[5]
[1]Assistant Professor, [2,3,4&5]Student,
Department of Electrical and Electronics Engineering, SCMS School of Engineering and Technology, Kerala, India
E-mail: beena.ajit1998@gmail.com
(Received 4 May 2021; Accepted 28 June 2021; Available online 5 July 2021)

Abstract - **This paper focus on designing of Electric Tonga gives emphasis on two domains namely electrical and mechanical. It scrutinizes all available technologies to find solutions to all issues to above mentioned domains. The major focus was to recreate the conventional Tonga by replacing the animal mode of transportation to electro-mechanical mode of transportation which can be run using Renewable energy. This recreated Tonga is eco-friendly, less cost, and creates less pollution. The three major components are a rechargeable battery, motor and wheels. Battery supplies electrical power to the motors which converts this electrical power into mechanical power and gives them to the wheels via a shaft. The Tonga could carry two to three passengers at a time from one point to the other. It is possible to incorporate a solar panel which can provide a secondary source of energy input other than battery, as well as an Arduino with line follower to control the Tonga. The paper aims to promote tourism and to use Tonga available without torturing animals.**
Keywords: **Tonga, Recreation, Renewable Energy**

I. INTRODUCTION

Recreation of Conventional Tonga is to convert the current conventional Tonga carts into electric Tonga there by reducing cruelty to animals and make it eco friendly. Due to the advancements in technology and modernization lot of Tonga are dumped in the sheds of Northern and North Eastern parts of India. This paper focuses to recreate a low cost electric Tonga cart and implement this technology on the conventional Tonga. For recreation the usable scrap motor and other electrical and mechanical parts are used. It is also possible use a solar panel to collect solar energy and power up the motor, the electrical energy from the battery or solar panel is then used to power up the wheels of the Tonga using a motor via shaft. The electrical energy from battery is converted to mechanical energy using motor. Use of renewable energy helps to reduce pollution. The Tonga can be modified to attract tourist, can be used for entertaining visitors in museum or zoo or park or beach. It can be used for advertisement purpose.

II. LITERATURE REVIEW

Due to the rapid development, urbanization and increasing population there is a large demand for the need of energy. The conventional resources are consumed at faster rate and are at the verge of extinction. In order to avoid depletion losses this study focuses to find alternative sources of energy to replace the conventional sources. Also the cost of electricity rates from conventional sources is higher. The rural and semi urban areas are the major victims, as fossil fuels are depleting and prices are increasing. Due to this there be will be shortage of electricity. So there is a need for a system which provides electricity at cheaper rates. The various alternative sources of energy include energy from wind, energy from solar, tidal, biomass, energy as a by product of chemical reactions. These energy sources have zero amount of pollution and more eco friendly, they are available in plenty and will not get depleted. The only barrier is to find and discover appropriate technologies to explore them. The solar energy is the simple one to exploit. It can be as simple as using sun solar panel for household or domestic purpose as well as it can be used for supplying power to a large scale industry or company. Rural areas could take easy benefit of it. Unlike the other sources that require big appliances and circuits solar power excavation basically need solar panel which works on photo electric effect. The light energy (photons) from the sun is converted to electricity through the photovoltaic effect.

Electric vehicle was introduced in 1884. The electrical engine was used since 1911. Electric vehicles help to reduce carbon emission [1,2,3]. The lead acid battery which can be recharged was developed by Gaston Plante in 1859 [4]. Later by conducting research in battery, many batteries like Zebra battery, Nickel Metal Hydride battery etc. were developed [5,6].

The electric motor uses electrical energy to store in battery for giving power to Electric Vehicle. This power helps the vehicle to run smoothly. Depending upon climate and schedule of maintenance the life of battery varies. The life of Li Ion battery is 8 to 12 years. The battery thermal management system controls temperature of battery cell. The challenges include efficiency at low and high temperature, reliability, direct effect on performance, protection of vehicle, cost and safety related to thermal runaway. The optimum working temperature of battery is 25 ^{o}C to 40 ^{o}C for Li Ion battery. As temperature rises above 50 ^{o}C, the life of battery degrades [7].

The emerging technologies are Electric Vehicles and Solar Photovoltaic Grid Interactive System since there is cost reduction in energy as well as minimum emission level [8]. The Lithium ion batteries have high energy density, smooth operation and high life cycle but are highly sensitive to temperature and their operation will be affected by overcharging and over discharging beyond maximum value [9].

Waste electrical and electronics equipment is a growing concern for many of the countries. The waste management of electrical and electronics equipment helps in growth and improvement of all countries. By reusing electrical and electronics equipment, the waste accumulation and cost of the equipment will be reduced.

III. MATERIALS AND METHODS

The major components of the system are

1. *Motor:* Motor is one the major component of this system, the brushless dc motor (BLDC) was accepted since it was widely used in electric vehicles due to its high performance and high efficiency. The motor available in the market that we used was 250 wattage 48 V BLDC motor, which was an acceptable choice of design. Weight of the motor was 4.5kg.
2. *Battery:* The battery is the critical component of any electric vehicle, it supplies the required power and has sufficient load bearing capabilities. Many considerations that must be satisfied when choosing a battery option are cost, ampere hours, voltage, cycle life, depth of discharge, size and weight in the design of the e-rickshaw/Tonga are cost and range; therefore, the chosen battery must reflect that. The battery used here was 12v, 7.2 Ah, we connected 4 such batteries in series to get the required output.
3. *Control Unit:* Control unit is the one which controls all the other components. It is the one responsible for connecting all the devices together. The various devices such as break, accelerator, speedometer, battery, motor, key are connected to the controller. The modern controller today available in the market is more advanced and easy to use. They are quite flexible too.
4. *Accelerator/Speed Controller:* The accelerator cable was obtained from an unused electric scooter, it was dismantled from it and the cable was connected to the respective terminals of motor controller. Speed control is the most important function of any vehicle.
5. *Brake Cable:* Brakes where obtained as such we obtained accelerometer. It was then connected to the terminals of controller. These can be connected between the structure and tyre directly. Disc brakes are commonly employed in E-vehicles.
6. *Structure:* The structure is similar to 'Tonga cart', it had one wheel to which motor was connected and two supporting wheels of same diameter to support the vehicle balance and drive. The structure could be made more creative and attractive to make it more aesthetic.
7. *Solar Panel and Charge Controller*: The solar panel was the main source of energy to drive the motor. We used two panels of 250W each. Charge controller is a device that is used to control the voltage limit of solar as well as battery. We can set the voltage limit in the charge controller, so when the solar voltage drops the power will be taken from the battery automatically. Also a solar panel cannot be directly connected to a source.

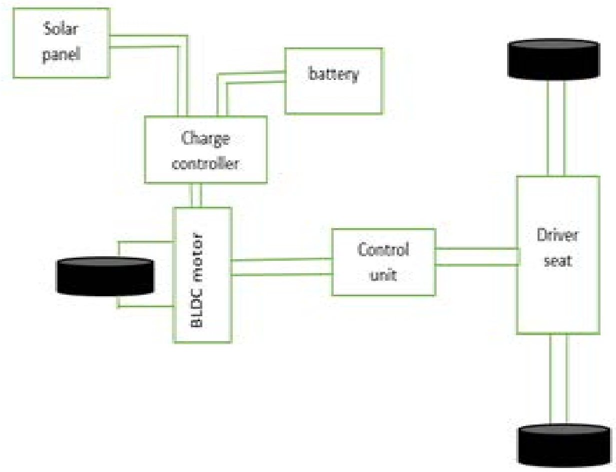

Fig. 1 Block diagram of the proposed model

The proposed model of Tonga, electrical-mechanical part is shown as block diagram in Fig. 1. Since we focused on reducing the cost of the proposed project, the strategy used was to take maximum recycling and collecting of usable and fixable parts that were thrown away as waste. Some of the major components we could collect were BLDC motor that was obtained from a destroyed 'Romai Hawk E-scooter', along with a motor controller, accelerator throttle and brake cables. So by this it was possible to cut the cost of the project and this can be a tool for recycling solid waste which is a major concern in the cities.

The wheels and hardware were first connected to the structure. The structure was made similar to a 'tonga cart'. There were 2 wheels which were unpowered for supporting the motion of cart and provide balance to the body of cart. The powered motor was in built with the wheel. The supply to the motor was given through a charge controller. The charge controller was given with two kind of supply, a main supply and auxiliary supply. The main supply was from a renewable source (solar panel) and auxiliary supply from four batteries connected in series. Charge controller was set to a reference voltage so that if the solar panel did not meet the required voltage level the supply will be taken from the battery. Another advantage of charge controller is that it prevents intake of charge into the panel.

IV. RESULTS AND DISCUSSION

The designing of structure or the main frame to where we fix the hardware had numerous possibilities. The first focus was to design it to similar to a 'Tonga cart' which were earlier used to carry men and good. The second idea of modelling was similar to a bicycle as it is one of the easiest design structures. Another idea was to construct a frame that would look like a rickshaw model.

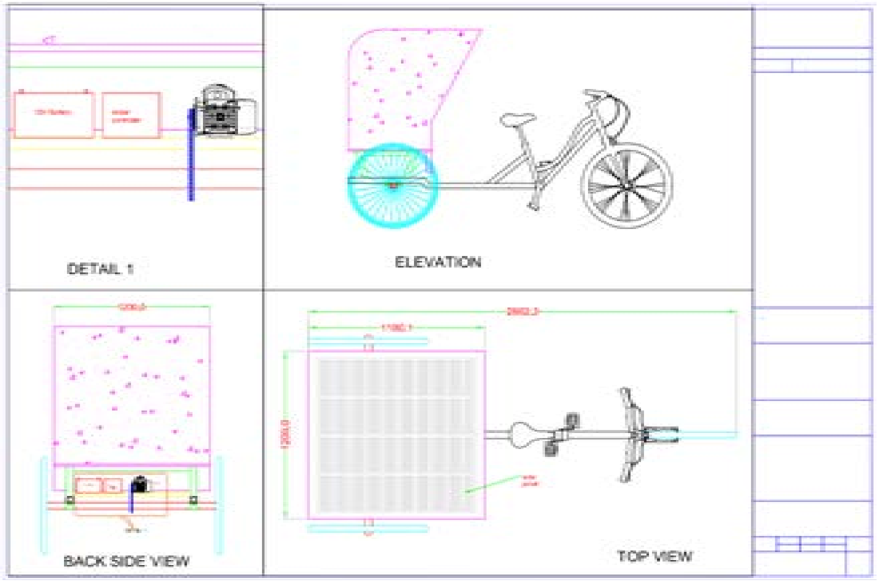

Fig. 2 Auto CAD drawing of structure

Fig. 2 shows auto cad drawing of a possible design structure is shown above. Fig. 3 is the completed structure of a recreated 'Tonga' using reusable materials (the wood left out from wood industry and construction sites were used as a raw material for building frame). By this it is possible to create the frame without no raw material cost. It is also possible to create small electric vehicles from scrap. The leftover electric scooters and bikes are one of the cheapest and easiest resource for implementation of our idea as it would require only the additional cost of battery and frame, also it is important to note that this system uses energy from sun that is solar energy. Use of solar energy is to recharge Lithium ion batteries which act as a source for the powering of motor. Since solar energy is used it is renewable in nature and free from pollution. It is possible to make e-child walker by adding Arduino control to the system. The line follower based control algorithm was used for this, as it was able to control the wheels by IR sensors so that the walker could be run on a fixed path which is predetermined. The simulation result is shown in fig. 3.

The prototype tonga was made using scrap wood, tyre and motor as shown in fig. 4.

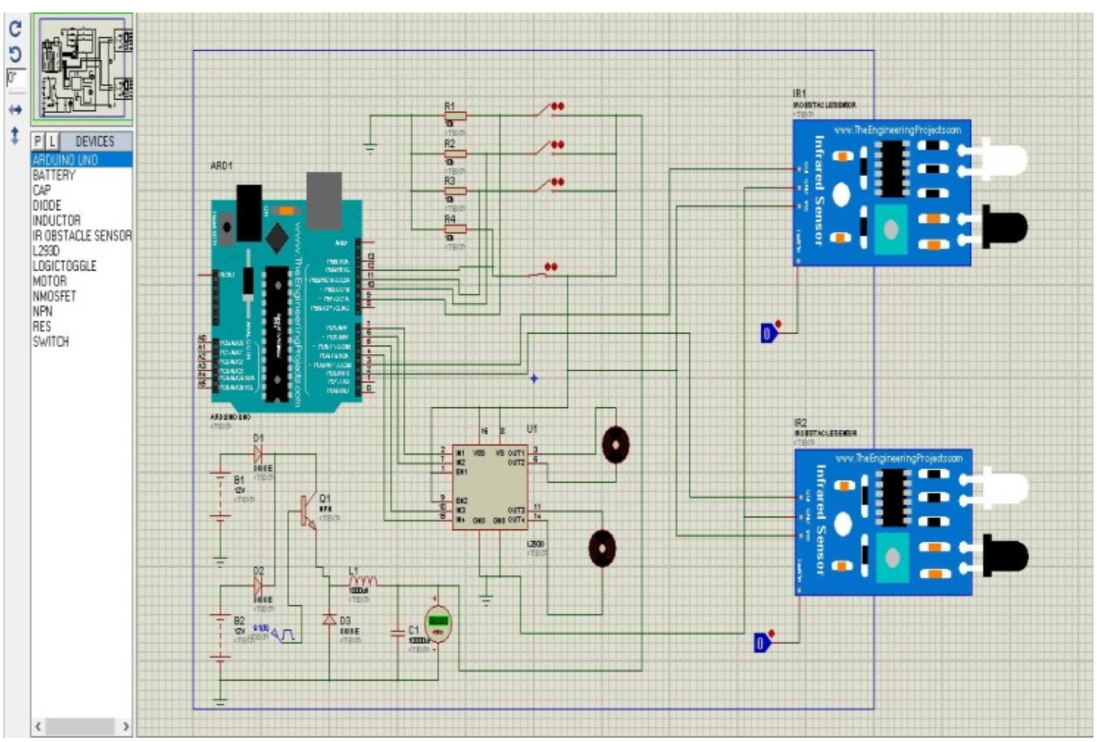

Fig. 3 Simulation Result

Fig. 4 Prototype Tonga

TABLE II RESULT OF TESTED TONGA

Parameter	**Recreated tonga**
Max speed (kmph)	45
Pedaling requirement	No
Operating cost	Nil
Type of energy used	Battery/Renewable
Maximum travelling distance at a stretch in km	40-45
Charging time(hours)	4
Parameter	Recreated tonga
Max speed (kmph)	45
Pedaling requirement	No
Operating cost	Nil
Type of energy used	Battery/Renewable
Maximum travelling distance at a stretch in km	40-45
Charging time(hours)	4
Parameter	Recreated tonga
Max speed (kmph)	45
Pedaling requirement	No
Operating cost	Nil
Type of energy used	Battery/Renewable
Maximum travelling distance at a stretch in km	40-45
Charging time(hours)	4
Parameter	Recreated tonga
Max speed (kmph)	45
Pedaling requirement	No
Operating cost	Nil
Type of energy used	Battery/Renewable
Maximum travelling distance at a stretch in km	40-45
Charging time(hours)	4

V. CONCLUSION

The main objective of this paper was to redesign the current Tonga and make them run with electric power. As well as it was possible to create small vehicle similar to 'Tonga' models from the scrap scooters(electric) we can reuse the different parts like motor, break, accelerator cable, tyre etc. we found, the possibilities of utilizing solar power. by research and testing. It was found there are design issues, health and safety issues, comfort, ergonomics. All problems found were addressed by upgrading design. The recreation of conventional Tonga was done to ease the effort of man power, avoid using of animals such as horses on Tonga and bulls on bullock carts which were used conventionally in many states of India. Moreover, this project aims to the benefit tourism in our county. Recreated Tonga carts can be used in eco-tourism areas, parks, zoo, museums, advertisement purposes etc. The vehicles conventional or electric bikes that are destroyed in accidents and damaged electric vehicles can be used by redesigning a vehicle by using their own parts.

VI. SCOPE FOR FURTHER STUDY

The future modification is to incorporate is a line follower-based Arduino controller. That is by this mechanism we are able to control the wheels of vehicle and align them to a line in the desired direction.

REFERENCES

[1] Yu Miao, Patrick Hynam, Annette Von Jovanne, and Alexander Yokochi, "Current Li Ion Battery Technologies in Electric Vehicles and Opportunities for advancements", *Energies*, Vol. 12, pp. 1074, 2019.

[2] C. Samaras, K. Meisteeing, "Life cycle assessment of Green House gas emission for plug in Hybrid Vehicle: Implications for policy," *Environmental Science and Technology*, Vol. 42, pp. 3170-3176, 2008.

[3] A. R. Holdway, A. R. Williams, O. R. Inderwildi, and D. A. King, "Indirect emissions from electric vehicles: Emissions from electricity generation," *Energy Environment Science*, Vol. 3, pp. 1825-1832, 2010.

[4] M. Morimoto, “Which is the first electrical vehicle?”, *Electrical Engineering JPN*, Vol. 192, pp. 31-38, 2015.

[5] J. M. Tarason, M. Armand, “Issues and Challenges facing rechargeable Li batteries,” *Nature* Vol. 414, pp. 359-367, 2001.

[6] J. L. Sudworth, “The Sodium Nickel Chloride (ZEBRA) battery,” *Journal of Power5 Sources,* Vol. 100, pp. 149-163, 2001.

[7] Sonali Goal, Renu Sharma, and Akshay Kumar Rathore, “A Review on barrier and challenges of Electric Vehicles in India and Vehicle to Grid Optimization,” *Transportation Engineering,* Vol. 4, pp. 100057, June 21.

[8] Mujahid Irfan, Shriram S. Rangarajan, E. Randolph Collins, and Tomonobu Senjyu, “Enhancing the Power Quality of the Grid Interactive Solar Photo Voltaic Electric Vehicle System,” *World Electric Vehicle Journal,* Vol. 12, No. 3, 2021.

[9] V. M. Dileepan, and Jayakumar, “Analysis of Performance Improvement in Energy Storage System for Electric Vehicles: A Review,” *International Journal of Electric and Hybrid Vehicles,* Vol. 12, No. 4, 2020.

[10] Dolores Queiruga, and Araceli Queiruga Dios, “The Reuse of Waste Electrical and Electronics Equipment (WEE): A Bibliometric Analysis,” *International Journal of Waste Resources,* Vol. 5, No. 2, pp. 1000177, 2015.

[11] D. Goswami, Understanding the Socio-Economic Condition of Rickshaw Pullers: After Arrival of E-Rickshaw; University of Delhi: New Delhi, India, 2017.

[12] C. Ranjan, S. J. Akhtar, A. K. Tiwari, N. K. Choubey, R. Kumar, L. Rajwar, N. Kumar, R. Kumar, Desing and fabrication of tri rickshaw with solar charging station. *Int. J. Mech. Eng. Technology,* Vol. 8, pp. 358-366, 2017.

[13] S. D. Attri, and A. Tyagi, Climate Profile of India; India Meteorological Department Ministry of Earth Sciences: New Delhi, India, 2010.

[14] *European Bicycle Market,* edition Industry & Market Profile (2016 statistics), 2017.

[15] E. Fishman and C. Cherry, “E-bikes in the Mainstream: Reviewing a Decade of Research”, *Transp. Rev.*, Vol. 36, No. 1, pp. 72-91, 2016.

[16] Emadi, “Transportation 2.0”, *IEEE Power Energy Mag,* Vol. 9, No. 4, pp. 18-29, 2011.

[17] Muetze, and Y. C. Tan, “Electric bicycles - A performance evaluation”, *IEEE Ind. Appl. Mag.*, Vol. 13, No. 4, pp. 12-21, 2007.

[18] W. C. Morchin, “Battery-powered electric bicycles,” *Northcon/94 Conference Record,* pp. 269-274, 1994.

[19] M. Corno, F. Roselli, and S. M. Savaresi, “Bilateral Control of SeNZA - A Series Hybrid Electric Bicycle,” *IEEE Trans. Control Syst. Technol.*, Vol. 25, No. 3, pp. 864-874, 2017.