

Design Improvement and Computer Assisted Fabrication On The Impact Wrench For Car Wheel Nuts Puller In Automotive Industry

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ARTICLE INFO	ABSTRACT
Article history:	The reduction of time is the significant factor in increasing the quality of the product
Received 20 November 2013	innovation. The generation of solid modelling in design give a lot asisstance in
Received in revised form 24	fabrication and assembly of final product. The aim of this project is to design and
January 2014	fabricate the four in one (4 in 1) motorized tyre nut puller. This tool will dismantle four
Accepted 29 January 2014	nuts simultaneously and power up by a car battery. In this study, it will carry out the
Available online 5 April 2014	application of 3D design concurrently with fabrication process by combination of rapid
	prototyping and CNC machining for time reduction. This concurrent process with
	assistance of Computer Assisted Manufacturing will overcome the technical and
	engineering problems that occurs in the traditional method of manufacturing. For some
Key words:	situation, this improvement will provide optimum solution in part assembly. This
Concurrent, Solid Model, CAD/CAM,	project is more focusing to facilate the automotive owner with simple acsesories that
Rapid Prototyping	will give helpfull hand when facing situation on car tyre replacement.

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INTRODUCTION

Replacing the new or spare tyre when tyre was punctured is difficult task especially nowday tyre was fit using air gun with high torque. The high force required to loose the wheel nut manually and sometime required extension bar attached to the wrench to overcome the load. This situation consume lot of time and expose to injury especially when someone stand on the wrench to push the nut. Lot of car accessories manufacturer concentrate on producing wheel nut puller using a single tool to loose the nut one by one. The problem they faced are longer time consumption. Therefore it is crucial to have a tool that can perform a similar task in one time. For this purpose, the new tool will be produce by applying a computer approach of design and manufacturing. This project also will be more focusing on the integrating 3D design with CNC and rapid protyping fabrication with concurrent solutions.

Problem that occur during the journey using a vehicle is a problem with tire puncture (A. R. Abd Aziz, 2008), (M. F. Abd Rahim, 2007). Tires should be replaced with a spare tire. Drivers must have a minimum basic knowledge and skills in tire replacement procedure if a problem occurs. Almost every car has a tire replacement tools such as L-shaped nut remover and a jack that was supplied by the manufacturer (R. Abdul Rahman, 2003).

The project objective is to assist and helped individual in replacing the car tyre by inventing a new wheel nut puller that can loosen four nut simultaneously, power up by car battery. In this study, it will carry out designing new improvement and fabrication to the wheel nut impact wrench into to 4 in 1 wheel nut impact wrench. This tool is expected can reduce time used to dismantle wheel nut during the car tyre replacement process. The process will be included the design, machining and assembly process. The other processes which include electrical wiring or mechanical analysis of the part were not discussed. The objective of the project is to produce 4 in 1 motoried tyre nut puller for car with PCD 100mm with assistance of CADS, CAM, CNC and Rapid prototyping concurrently to reduce time in part assembly and achieved optimum time in finish product. This product is expected to give a benefit to car owners in overcome the problem with difficulty to replace the tyres manually with comsumption of lot of energy and time.

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2. Product Design And Fabrication:

The project was started with design process, for the design pro/E wildfire 3.0 software was used to make 3D view of the project. The product has been designed with explode and assembly views to get the approximate dimension of the actual parts. The 3D model was also to be used to guest the best fitting for product assembly.



Fig. 1: product part design process

After the design process is done, the drawing of custom made part drawings will be issued to serve as a guide for the next process of machining. Most of part made by CNC milling, turning and wire cut machinings (as in figures 2,3,and4).

In this project most of the movement generated by the gear tranmission. Gear transmission, as the main form of mechanical transmission, is widely used in important transmissions in equipment and vehicles. Damage and failure of the gear transmission and its components affects the reliability and security of the gear system, and can lead to a serious breach (Kramberger J *et al.*, 2004). Fractures can also occur on the gear but it is difficult to investigate. As states by V. G. Sfakiotakis *et al.*, (1997), thermal and mechanical reason enforcing cracking failures of gear teeth are not definitely known and need to be investigated in detail, as such types of failure are difficult to monitor and repair. The method to classify the different levels of gear cracks automatically and reliably, the proposed method is applied to identify the gear crack levels and the applied results demonstrate its effectiveness (Yaguo Lei and Ming J. Zuo, 2009) .Various dynamic models of a steel gear pair have been introduced over the last 30 years (O[°] zgu[°] ven HN and Houser DR, 2003). To get the right gear movement one need to know how to calculate the dynamic responses of steel gear pairs. The effects of nonlinear parameters, such as tooth errors, mesh stiffness, damping factor, friction coefficient and load sharing alternation, on dynamic responses of a steel gear pair have been widely investigated by Yang DCH and Lin JY, (1987) and Arikan MAS and Kaftanoglu B., (1988). Therefore, it is crucial to simulate the gear with CAE to observe the tooth engagement efficiency.



Fig. 2: Machining process using CNC milling machine (bracket holder)



Fig. 3: Machining process using lathe machine (gear shaft)



Fig. 4: Machining process using Wire cut EDM process (gear modification part)

3. Product Assembly:

A finish parts will be assembled on home made bracket holder that attached with DC motor. The drive gear was fixed to motor shaft with custom made mounting. Then four driven gears will be fit toward drive gear for syncronise motion. Lastly, the bolt wrench will be fit on driven shaft as in Fig. 8 shown that part after assembly process.



Fig. 5: Product Part Assembly

4. Product Casing Process Using Rapid Prototying:

Product casing is used to cover components and provide the casing for electronic part circuits. The 3D solid model casing has been designed using PRO/E CADCAM software(as in Fig. 6). The CAD data then convert to STL file for rapid prototyping application. The Fig. 7 shows step of process for rapid prototyping.

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Fig. 6: Product Casign Design

The data is transfered into the programmed. The programmed is set the location of the part into the table of machine. The location is important because of the correct supporter materials. The model was constructed based on layer by layer. The casing was produced by 3D printer using the powder and the Z-bond liquid gum. The liquid gum is function as the supporter and strengthens parts.



Fig. 7: Rapid Prototyping step process

Result:

The product has been tested for its function effectiveness and usefulness. The test was conducted on local car manufacturer. The project objective has been achieved when successfully pull out four nuts from the car's rim simultaneously. Furthermore, its reduce time and physical challenge on the activities.



Fig. 8: (a) and (b) Product (4 In 1 Impact Wrench)

Recommendation:

After go through application test on the product. It is found that this product needs to be improved. Toward that, several proposals and suggestions have been proposed for future development. Here, several recommendations to improve this product:

i.Use another material type such as polymers for creating the product casing

ii. The bracket holder diameter size should be made in adjustable type that can be used in various types of cars that have different PCD (change to the flexible different pitch diameter: 100mm, 114mm for various car models)

iii.Weight of the product should be changed to a lighter weight by introducing non metal material that has high strength such as ceramic.

iv. Have a stopper to stop the movement of the gear

v.Have speed controller to control speed of the gear movement for an easier operation.

vi.Provide hammering mechanism that can give an impact on loosening the nuts.

Conclusion:

The 3D solid modeling software certainly has brought up the innovativeness of the industrial designer and even to the product designer to be more advanced in their line of work. In addition, the application of CADCAM software and Rapid Prototyping have drive the concept design more faster toward producing actual product. This concurrent activities proved the important of data exchanges amongs every process. Simulation now play important role to get raw data for product functionability. The data then used as a guide for ongoing product development.It takes creativity and innovativeness of the individual to be able to produced better design and improvement product in the market.

Hopefully, this project was able to generate a product that can be used as car basic accessory that compulsory included when you buy a new car.

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