

DEVELOPMENT OF ZERO TURNING RADIUS BY USING DIFFERENT INDEPENDENT TORQUE

Muhammad Asyraf SHAHROM
Faculty of Mechanical Engineering
Universiti Malaysia Pahang
Pekan, Malaysia
asyraf.edu93@yahoo.com

Mohamad Heerwan PEEIE
Faculty of Mechanical Engineering
Universiti Malaysia Pahang
Pekan, Malaysia
mheerwan@ump.edu.my

Abstract— This paper is about development of zero turning radius (ZTR) by using different independent torque that given to the all tires. The main objective in this thesis is to analyze the approximate or actual zero turning radius that can be achieved by vehicle and yaw rate when the different independent torque is given to the each tire. The ZTR is existed by applied the differential torque from the motor. Meanwhile, different of torque is mean the different of rotational movement or different of torque value given by the motor. The analysis is conducted by using Matlab simulation analysis because it is very important for EVs. By using the ZTR system the vehicle can move in the narrow space and time to change the position become less. This system (ZTR) also can be applying for the light and heavy weight electrical vehicles when going for changing position in narrow with less much time.

Keywords- Zero Turning Radius, differential independent torque, Matlab simulation analysis, narrow space, less time, light and heavy electrical vehicle.

I. INTRODUCTION

In recent years, research related to the electrical vehicles (EVs) became trending. The rapid development of EVs had led many researchers focus on this scope to develop more stable EVs. Many advantages had been proven by using the EVs such as eco-friendly [1] because it use the electrical energy source to generate the power rather than conventional Internal Combustion Vehicles (ICVs) that using fuel to generate the power by combustion system that cause air pollution [2]. The most important advantage from the EVs is able to achieve better maneuverability that cannot be achieved by the conventional ICVs. The maneuverability of EVs is because it used the independent driving. The independent driving is mean the vehicle is controlled by using two or four motors [3]. By using separate traction motors the driving torque can be controlled independently.

In conventional ICVs, the movement is limited. It can be seen when the vehicles need to change the position, the conventional ICVs will take a long time. This is because the vehicles need to moving forward and reverse until it change the position. The issue is when the vehicles at narrow space, this is hard for that vehicle to moving and changes the position unless for skilled driver. However, by using merit from the independent torque from EVs, the movement is become unlimited with using different rotation torque given to each tire.

II. ZERO TURNING RADIUS

To reduce or eliminate the turning radius of a vehicle, the zero turning radius (ZTR) has been introduced. ZTR means that the vehicle is does not making any radius when making the turning [4]–[6]. Common turning radius will produce when the car makes round about the Instantaneous Center Radius (ICR), while ZTR car also making the rounds but the turning radius and translation does not exist because the car was turning at ICR point itself.

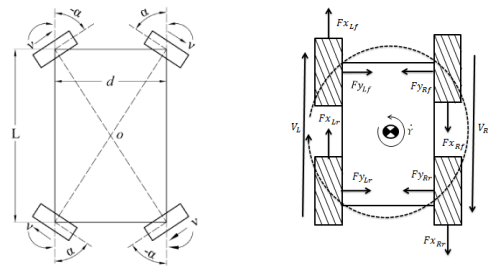
III. METHOD PRODUCING ZTR

A. Modification of steering angle (δ)

Normally, maximum of steer angle tire of normal car can be rotated at the certain angle, but in this case, the steer angle is modified of the all tires that can causes ZTR happened as fig. 1(a) [7].

B. Differential independent torque

Different torque method is by changing direction of the independent torque all tire as fig. 1(b) which mean the left side tire will rotate at clockwise and right side will rotate at counterclockwise or vice versa that cause different motion also known as ZTR was occurred [8].



(a) Modification steering angle (b) Differential independent torque
Fig. 1. Method to produced ZTR

IV. MODELLING OF VEHICLE

A. Vehicle Dynamic

Assume all forces is positive from figure 1(b), the 3-DOF dynamic equation of modelling vehicle can be define in equation 1, where F^x and F^y indicate as longitudinal (x-axis)