Design and Fabrication of Universal Driving Wheel with the application of Forklift: A Review

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Abstract: Universal driving wheel is a centered wheel with angled rollers around the periphery of the wheel which enables the load carrier to shift sideways as well as diagonally without changing the direction of the wheel. This paper gives the review of different article paper which includes the design of different universal wheels, their specifications, kinematic analysis etc. Conventional wheels' drawbacks are overcome by designing of the universal driving wheel which can perform the task with the more efficiency and less space constraints.

Keywords: **Universal driving wheel, Omni wheel, Mecanum wheel, Kinematic analysis, Jacobian matrix.**

1.Introduction:

Mecanum wheel is a multidirectional wheel. It can be used for many application like military field, medical field & industrial field. In our project we are going to make low cost prototype model of mecanum wheel with industrial application of forklift.

Mecanum wheel was designed and invented in Sweden, in 1975, by Bengt Ilon, an engineer withthe Swedish company Mecanum AB. Mecanum wheel is based on the principle of a central wheel with a number of rollers placed at an angle around the periphery of the wheel. The angle between rollers axis and central wheel axis could have any value, but in the case of conventional Mecanum wheel it is 45°. The rollers are shaped such that the silhouette of the omni directional wheel is circular. The angled peripheral rollers translate a portion of the force in the rotational direction of the wheel to a force normal to the wheel direction. Depending on each individual wheel direction and speed, the resulting combination of all these forces produces a total force vector in any desired direction, thus allowing the platform to move freely in direction of the resulting force vector, without changing the direction of the wheel.

There are many types of wheel which can be used for different application. But mecanum wheel can give omni-directional movements which other can't do. In industry , space may be constrain for the transportation of the load. We can use mecanum wheel in forklift for easier transportation & saving the time of transportation.

2. Literature Survey

Akira S. et al [1] this paper introduces a position corrective feedback control method

using a vision sensor on mecanum-wheel omni-directional vehicles. Recently, this omnidirectional vehicle has been developed, and it is sometimes employed in wheelchairs. Jefri S. et al [2] this paper presents the processes the mecanum wheel developed consists of nine rollers made from delrin. All mecanum wheels are independently powered using four units of precision gear DC motors and the wheel/motor assemblies were mounted directly to the robot chassis made using an aluminium frame. Jong-Jin Bae et al [3] This paper presents the dynamic characteristics of a mecanum wheel, prototype and performed experiments to measure the vertical vibrations, the vertical accelerations were asymmetric with respect to the average value of signals; the peak-to-peak and RMS values of the displacements and accelerations were calculated to investigate the effects of the curvature of rollers on the vertical vibrations of the vehicle. Furthermore, it proposes a mecanum wheel having a spring to attenuate the vibrations. Shipla M. et al [4] the presented paper is concerned with simulation based designing of a low-cost, easy to use, intuitive interface for the control of a slave anthropomorphic tele-operated robot. Tele-operator “masters”, that operate in real-time with the robot, have ranged from simple motion capture devices, to more complex force reflective exoskeletal masters. Shuai Guo et al [5] in this paper, an Omni-directional mobile industrial robot drilling system for aerospace manufacture is introduced. Mecanum wheels are used for the robot's maneuverability in congested workspace. An industrial robot is applied to complete the drilling work for a rocket shell. Jonathan J. et al [6] conventional training simulators commonly use the hexapod configuration to provide motion cues. While widely used, studies have shown that hexapods are incapable of producing the range of motion required to achieve high fidelity simulation required in many applications. Jefri E. et al [7] in this paper, we review researches on omni-directional mobile robot design which Mecanum wheel as component in mobile robot propulsion. Omni-directional mobile robot has vast advantages over conventional design likes differential drive in term of mobility in mobile robot for educational purposes. There bot has full omnidirectional motion capabilities, thanks to its special Mecanum wheels. The present chapter provides some information about conventional and special wheels designs, mechanical design aspects of the Mecanum wheel and also of the robot, kinematic models, as well as electronics and

control strategies: remote control, line follow , autonomous strategy. Gracia et al [8] it presents the kinematic models of the four common types of wheels (fixed, centered orientable, castor and Swedish) a classification of wheeled mobile robots. Afterwards, it is proposed a kinematic control scheme with three nested loops: dynamic, kinematic and planning. Sushil L.et al [9] paper discusses about a new type of automated drive using mecanum wheel that will bring upon a revolution in the emerging market of AGV‟s, parking system and some practical industrial application. This paper introduces an omni-directional drive composed of mecanum wheel. Florentina A. et al [10] In this paper a literature review concerning practical applications for mobile robotic platforms based on special wheels (in this case, Mecanum wheel) is presented. Mobile robots equipped with four Mecanum wheels have the omnidirectional property, which means, they have the ability to move instantaneously in any direction, from anyconfiguration. Therefore, compared to conventional platforms, these vehicles possess multiple advantages in terms of their mobility in narrow spaces or crowded environments .Olaf D. et al [11] this paper proposed an improved design of mecanum wheel for omni-directional robots. The design improve efficiency of robots by means of reducing frictional losses and improving the performances. B. Chu [12] in this paper through intensive experiments, performance evaluation of the developed omni-directional mobile robot was conducted to confirm the feasibility for industrial purposes. Velocity performance and straightness for each directional motion were selected as performance indices to assess the omni-directional mobile robot. A Gfrerrer [13] in this paper Mecanum wheels consists of set of rolls arranged around the wheel axis , it describes in details the geometry of rolls, canonical parameterizations of the roll generates curve and kinematics of wheel. H. Asama et al [14] in this paper new driving mechanism for holonomic omni-directional mobile robots is designed which enables 3 DOF motion control by three component actuators in a decoupled manner with no redundancy, kinematics and simulation is being calculated for the design of the wheels. Leow et al [15] in this paper focusses on the kinematic modelling, mobility analysis and design of an omni directional wheeled mobile robots (OWMR’s). It composites kinematic models of WMR, which is a collection of the platform and wheel sub systems equipped with three omni-directional wheels.Jae-Bok Song et al [16] in this paper movement in an

arbitrary direction without changing the direction of the directions of the wheels can be achieved. Various types of omnidirectional mobile robots have been proposed of which universal driving wheel, ball wheels, off-centered wheels are popular among them. Also redundancy is used to change wheel arrangement. Mark Ashmore et al [17] in this paper operation of individual wheels is done by using torque in one direction in the same way as regular wheel , also able to slide freely in another direction (often perpendicular to torque) . The key advantage id that translation and rotation is decoupled for simple motion. Guclu [18] in this paper automation is being focused for solving the problems in the horticulture in which the vehicle uses the wheel consisting of mecanum wheels powered by stepper motors. Tomation is the process which aims at solving the problem of autonomous leaf cutting robot, involves path to path movement of the vehicle that rides of the rail. Hamid Taheri et al [19] this paper introduces omnidirectional mecanum wheels and discusses the kinematic relations of a platform used four Mecanum wheels. Forward and Inverse kinematic as well as experimental and analytically results are obtained and 8 different motions without changing the robot's orientation is achieved.Shruti Deepak Kamdar [20] an AndyMark Mecanum Wheel has been re-designed for better performance and utilization by Helical Robotics. Mecanum Wheel is a complex "Omni-Directional" wheel that currently contains several drawbacks. The drawbacks include complex design, usage of hobby grade material, bumps in rollers, etc. A comprehensive design of the Mecanum wheel is being presented using Computer Aided Software, CAD and analysis tools, such as Finite Element Analysis, FEA. Patrick F. Muir et al [21] this paper formulates the kinematic equations-of-motion of wheeled mobile robots incorporating conventional, omnidirectional, and ball wheels ,approach parallel to the kinematic modeling of stationary manipulators, that extend the methodology to accommodate such special characteristics of wheeled mobile robots. Sanket Soni et al [22] in this paper, Sing four of mecanum wheels provides Omni directional movement for a vehicle without needing a conventional steering system, slipping is a common problem in wheel as it has only one roller with a single point of ground contact at any one time. Due to the dynamics of the mecanum wheel, it can create force vectors in both the x and y – direction, creates constraints associated with

the mecanum wheel as some of controller is required to produce satisfactory ion.Nkgatho Tlale et al [23] this paper introduces Automated guided vehicles (AGVs)/ mobile platforms are used extensively in reconfigurable manufacturing systems (RMS) for materials handling.. The mobile platform used in this project implements mecanum wheels, which are special wheel designs that are based on a concept that achieves traction in one direction and allows passive motion in another. Martin Udengaard et al [24] in this paper, an investigation of the design and control of an omnidirectional mobile robot for use in rough terrain is presented. Kinematic and geometric properties of the active split offset caster drive mechanism are investigated along with system and subsystem design guidelines. An optimization method is implemented to explore the design space. Ananda Sankar Kundu et al [25] in this paper the modifications in the usage of wheelchairs are been discussed along with the ease of control, application specific human machine interface and smooth mobility. Also, electric wheelchairs are becoming a popular indoor navigation vehicle. A. Ramirez-Serrano et al [26] in this paper studies have reveal the main problems associated with such wheels when traversing on different grades of dirt (e.g., clay, sand) under diverse loads and roller angles. The biggest challenge has been found to be the inability to overcome obstacles during the lateral motion and their inability to move laterally in sand and different methods applicable to overcome the problems have been discussed. J.A. Cooney et al [27] in this paper an undergraduate solution to the problem involving both hardware and software developments has been described. With a path following behaviour as the aim, the research focused predominantly upon; sensors for dead-reckoning, motor drive, closed-loop feedback control, and microcontroller interfacing and programming. Tianran Peng et al [28] in this paper, Automatic Guided Vehicles (AGVs) are widely used in production line, but they rely on fixed trajectory also material conveying mobile robots are intelligent moving platforms which are used to convey materials by automatic navigation. Material conveying mobile robots are widely used for flexible manufacturing systems, intelligent factories, automated storages and logistic systems and different types of AGV'S have been discussed.

Conclusion:

The efficiency of the wheels can be achieved by utilization of the design of different types

of universal driving wheel in which the inclination of rollers helps to achieve the desired direction in any degree in the constraint space. The main problem is of maneuvering of loader vehicle in constrained space in industry, Absence of remote controlled feature in current loaders which is achieved in the universal driving wheel it also increases the efficiency of material movement by reducing travelling distance.Universal driving wheel allows vehicle to move at any degree translation when moving at a certain speed and rotation direction. It is a low cost proto type model which allows high mobility in complex environment.

Future scope:

Applications in the various field such as industry, military, medical, etc. can be used in great extent. Optimisation of the mobile robot can be achieved by the utilization of universal driving wheel.

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