Adjustment of Roller in Extrude Process using Stepper Motor

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Abstract— This project is mainly used to reduce the manpower and to increase the accurate dimensions in this process. In a plastic sheet formation the sheet is mainly used for plastic tray for carrying a parts. During plastic formation the plastic sheet can be wasted, from our project we can reduce the wastages of plastic sheet by adjustment of roller. In our project we are doing automatically adjustment of roller in the extrude process.so that the accurate dimensions can be obtained by using the stepper motor with plc programming. And we can use a ranging sensor ie, (vl53lox) it is a Time of flight sensor by using this it can sensed the distance and result in accurate dimensions.

Key words: Stepper Motor, Extrude Process, Roller

I. Introduction

In a company they can manually adjusting the roller by using man power, the distance between the roller are adjust by their assumptions, so that the plastic sheet can be wasted and also it can be reused by grinding process. Due to this wastages their time consumptions is more and the mass production is delayed. Through our implementation this wastages can be reduced by using the stepper motor with plc programming and ranging sensor to result in accurate dimensions. The reusages of plastic sheet through a grinding process can be avoided and there is a need of manpower in slightly in this project.

II. Literature Survey

Stepper motor is a special machine which is defined as brushless DC motor in British standards specifications as it has no brushes with easy open loop control. B.C.Kuo explained the advantages and few disadvantages. Its advantages are excellent response for starting/stopping/reversing, long life and very less maintenance as there are no brushes and winding in the rotor circuit. Its speed is proportional to the input frequency of exciting pulses given to stator winding. It has disadvantages like complexity in design due to double slotting, presence of permanent magnet in rotor for permanent magnet stepper motor and occurrence of resonance, if drive circuit is not properly designed. Stepper motors are used in a wide variety of applications in industry, computer peripherals, business machines, solar array tracking system, motion control and robotics which are included in process control and machine tool applications. Samarajit Ghosh [3], Pillai,S.K[4], G.K.Dubey [5], Vedam Subramanyam [6], Bimal.K.Bose [7], P.S.Bimbra [8], Douglas W.Jones [9] and Gerhard Henneberger [10], explained how stepper motors can be classified according to their rotor design and stator winding type. There are three basic types of stepping motors according to the rotor design, namely Variable Reluctance stepper motors (VR), Permanent Magnet stepper motors (PM) and Permanent Magnet Hybrid (PMH) stepper motors. Permanent magnet motor has more torque capacities than variable reluctance motor but is costlier because of permanent magnet and it has the effect of cogging torque on steady-state torque. Both these types are applicable for large stepping angle which could not be recommended where good dynamic response is required like solar array tracking systems in satellites, robotics etc. Permanent magnet hybrid (PMH) stepper motor which is having the permanent magnet rotor and multiple teeth both on the stator poles and rotor, with excitation in stator poles. Jacek F.Gieras and Mitchell Wing [11] explained that the term hybrid is derived from the fact that the motor is operated under the combined principles of permanent magnet and variable reluctance motors. The positional accuracy of PMH stepper motors is high as its step angle is very small. Because of these reasons, 1.80 step angle PMH stepper motor is considered for design in this research. V.V.Athani [12] explained difficulties in the design of PMH stepper motor like complex airgap geometry which results in complex airgap permeance and also brought out how torque characteristics of PMH stepper motor are significantly affected by the stator & rotor teeth and winding arrangements. A.Sarhan et al [13] and K.R.Rajagopal et al [14] explained difficulties in the design of PMH stepper motor using equivalent circuit model, which is used for solar array tracking system in satellites. 4 Design analysis of PMH stepper motor using equivalent circuit model cannot give accurate results, so finite element method (FEM) is adopted. Cook.R.D et al [15] explained FEM models as a structure of an assemblage of small parts (elements), each element is of simple geometry and therefore is much easier to analyze than the actual structure. Golub et al [16], Saad, Yousef [17], T.A.Stolarski et al [18] explained solution in FEM i.e., how to formulate differential equations, how to frame in matrix form, how small elements are shaped, how to create boundary conditions for these elements and how to create & refine the mesh. Mathew.N.O. Sadiku [19] John R Brauer [20], Nicola Bianchi [21], Brauer.J.R [22], Jacek F.Gieras et al [23] described FEM solution for electromagnetic problems for different permanent magnetic machines. M.K.Jenkins et al [24] stated that hybrid stepper motor has a large number of teeth on the stator and rotor surface and a very small air gap. The authors have also explained how magnetic saturation in the teeth becomes severe while increasing the flux density in the airgap. In addition, both radial and axial fluxes are produced because of axially magnetized permanent magnet and geometric characteristics. Ki-Bong Jang et al [25] described that analysis of PMH stepper motor is more difficult using 2-D modeling. 3-D finite element analysis is one of the solution for nonlinear analysis of axially unsymmetrical hybrid stepper motor under this situation. Ki-Chae Lim and Jung-Pyo Hong [26] explained that finite element method accounts for nonhomogeneity of the solution region. Praveen R.P et al [27] proposed a method to design PMH stepper motor with FEM in 2-D for space craft application with different tooth widths, analysis result is that this design had reduced steady-state torque and increased cogging torque. Design procedure of PMH stepper motor using FEM is analyzed with the concept of tooth layer unit for one tooth pitch by Dou Yiping [28] and Ibrahim Mahariq [29]. Jiaxin Chen 5 et al proposed a design procedure in 2-D Model to get magnetic potential [30], Albanese.R et al [31] and Junqi Huang et al [32]. Current density of exciting coil in the stator and permeability of core materials for stator and rotor are used for FEM analysis using the theory of Brauer.J.R et al [33, 34]. These concepts are incorporated using PDE toolbox of Matlab as explained by Young W et al [35] and user's guide by MathWorks [36]. In the design process tooth width to tooth pitch is maintained as 20 refered to K.R.Rajagopal et al [37]. Karl J. Strnat [38] explained about rare earth permanent magnetic materials properties such as NdFeB and Sm2Co17 which are used in the design of PMH stepper motor to get magnetic potential. Juha Pyrhonen et al [39] explained procedure to calculate permanent magnet current density in terms of flux density and permeability. Using FEM concepts in the design procedure of PMH stepper motor, MMF distribution is analyzed for eight topologies. Aigap permeance is calculated from the concepts explained by K.C.Mukharji [40], John Hindmarsh and Alasdair Renfrew [41], Paul C Krause et al [42], H.D.Chai [43], Cornelia Stuebig and Bernd Ponick [44]. Using MMF values, airgap permeances values for different topologies, steady-state torque is evaluated using concepts of Kuo.B.C, and Chen.Y.I [45]. D.Lin, et al [46], Fengge Zhang et al [47] explained how to reduce cogging torque. Torque ripple of PMH stepper motor is calculated using concepts of high force density of switched reluctance motor explained by U S Deshpande et al [48], inductance profile and steadystate average torque predictions of SRM motor explained by P Materu and K.Krishnan [49], design procedure for low torque-ripple variable-reluctance motor drives explained by D.P.Tormey and D.A.Torrey [50], modeling and control of hybrid stepper motors by K Mizutani et al [51] and instantaneous torque analysis of hybrid stepper motor was dealt by Nobuyuki Matsui [52]. 6 Kieburtz.K.R developed stepper motor dynamic response during single step by means its transfer function [53]. PMH stepper motor transfer function is defined in terms of its phase winding resistance, phase winding self-inductance, phase winding mutual inductance, moment of inertia, damper coefficient and drive speed (10 steps/second). Self-inductance and mutual inductances are calculated using empirical relations provided by H.D.Chai [37]. The effect of inductance on dynamic performance of stepper motor is explained by Leenhouts, A.C [54]. The effect of gap permeance coefficients on dynamic response is explained by Robinsan.D.J et al [55] and Lawvenson.P.J [56]. The dynamic response at high speeds is explained by Pulle.D.W and Hughes.A [57]. Ja.Alvarez-Gallegos [58] and Rich Dirker et al [59] reported the experimental procedure for closed loop control of permanent magnet stepper motor position control without sensors. Jim Cox [60] reported the experimental procedure to measure torque without sensors in a generalized procedure.

III. DESIGN OF EXTRUDE PROCESS

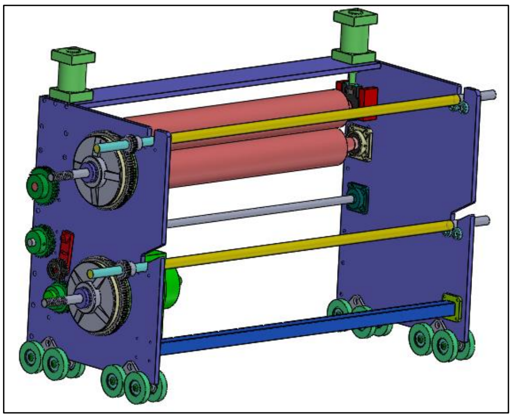

Fig. 1: Extrude process

IV. WORKING

In our project we can fixed the stepper motor above the roller and it will be coupled with the lead screw. The stepper motor can be controlled both clockwise and anticlockwise direction by using with PLC program. If the operation switch on the motor it will slightly rotated on clockwise and the roller can be moved from the upward direction if the required dimension is not in accurate it will be operated on anticlockwise direction and the roller can be moved from the downward direction. The ranging sensors (vl53lox) is fixed in the opposite direction to measure the distance between two rollers. If the roller is in moving upward (or) downward direction the sensor can measure the distance and displayed in digital format. So, we can easily adjust the roller in extrude process, the above sequence of process is carried out until achieving the target.

V. COMPARISON

In our project we can compare the both old extrude process and new extrude process to bring out the advantages of new process.

Old extrude process	New extrude process
– In an old process the roller can be adjusted manually by their assumptions.	– In a new process the roller can be adjusted automatically.
– The plastic sheet can be measured after the formation.	– The measurement can be displayed before the plastic formation.
– The thickness of plastic sheet can be measured by using the screw gauge.	– In this process the sensors can be used to measure the thickness.
– This process need more man power.	– This process need less man power.
– The wastages of plastic sheet is more in this process.	– There is no wastages of plastic sheet in this process.
– The wastages of plastic can be reused through the grinding process.	– The wastages of plastic sheet is eliminated in this process.

VI. ADVANTAGES

- It can save working time.
- It can reduce the recycle process.
- It will be in accurate dimensions.
- It can be used for mass production.
- It can reduce the manpower work.

VII. CONCLUSION

By using the automatic adjustment of roller, we can save the time and result in accurate dimensions, the manpower work is less in this process. It can easily reduce the recycle of plastic sheet formation and used for the mass production. By this process the plastic sheet are in accurate manner through the adjustment of roller by using stepper motor with PLC programming.

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