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A REVIEW OF GENEVA MECHANISM FOR VARIOUS INDUSTIRAL APPLICATIONS

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ABSTRACT
Geneva drive is a gear mechanism that translates a continuous rotation into an intermittent rotary motion. The rotating drive wheel has a pin that reaches into a slot of the driven wheel and advances it by one step a review of the design and fabrication of the Geneva mechanism. The objective of this review is to design the Geneva mechanism for various applications such as automobile assembly shops, paper cutting machines, Mechanical Watches and Clocks, indexing tables, printing machinery, banknote Counting Machines, Packaging Machines, microcontroller application automated systems to control motion precisely, textile machinery the required intermittent motion for the weaving process, to stop the conveyor in regular intervals in every assembly station, a pin punching machine where the conveyor controlled with the Geneva mechanism due to its automatic work, it saves time, human errors avoided. Used in some 3D printers for controlling the movement of the print head or bed, it enables precise and controlled movements in pick-and-place robotic operations, in devices such as automated drug dispensers and medical imaging equipment, implemented in testing equipment and control systems in aerospace engineering, Smart manufacturing systems integrated into Industry 4.0 technologies. Geneva mechanism relevance and adaptability in various high-precision fields, enhancing efficiency and accuracy in technological and industrial processes.

Keywords:
smart farming, Artificial intelligence, Internet of Things, sensors.

I. Introduction
The Geneva mechanism is one of the earliest intermittent motion mechanisms and when input in continuous rotation, it is probably still the most commonly used. Geneva is available in a variety of sizes. They are cheaper than cams or star wheels and have adequate Performance Characteristics, depending on load factors and other design requirements.
The Geneva mechanism is a commonly used indexing mechanism where an intermittent motion is required. The design and fabricating of a conventional Geneva mechanism is generally simple and inexpensive because there is no specially curved profile on any of the components except straight lines and circular arcs. However, due to the discontinuity of the acceleration at the beginning and ending positions, the shortcoming of using the conventional Geneva mechanism is the large impact when the driving crank engages and disengages with the wheel slot. Classification of Geneva drive mechanism, External Geneva drive mechanism, internal Geneva drive mechanism, spherical Geneva drive mechanism.

II. Literature
This paper provides a review of the Geneve Mechanism. The Experimental tests on the mechanism were performed many times for each selected speed. And appropriate size and thickness of the sheet were used for cutting purposes. Thus, the required intermittent motion is achieved this goal is achieved using the Geneva mechanism in our sheet-cutting machine [1]. The authors conducted experiments and concluded that the contact temperature of the Geneva mechanism is maximum due to a substantial

sliding velocity between the wheels and pin. [2]. The authors studied the profile of the curves for the Geneva mechanism with curved slots designed by the theory of envelope. The mathematical expression in parametric form for the curves and equations of non-undercutting are derived. The criteria for undercutting and double points in the design are also developed. Numerical examples have been performed to demonstrate these effects on the design of the mechanism. Results provided by the authors indicate the importance of parameter selection for the geometry of the slots and their subsequent manufacturing. Also, the results of this work can provide ground rules for optimization work of the mechanism if necessary. It can be noted that this systematic procedure can be of practical value to the design and manufacturing of Geneva mechanisms with curved slots [3]. The authors successfully calculated the angular velocity and acceleration of the Geneva wheel. For the designed Geneva wheel, the roller conveyor the time required by the material to cross the entire belt is calculated accurately. The entire modelling of the project is done with the help of CATIA V5R20 [4]. The authors designed it with the hope that it would be very economical and help full to paper manufacturing industries and wholesale paper stores. The plan satisfies all the significant plan models, as recognized by the group. The paper-cutting Machine will permit the creation of various sizes for use. The advancement of the Paper Cutting Machine has been effectively finished and its objective completely accomplished. A key concern is the cutting of the paper when there is a variance in the voltage it would not make the sharp edge move back and forth over the paper to cut [5]. Researchers fabricated a pin punching machine where the conveyor is controlled with the Geneva mechanism and concluded that to achieve the time reduction in punching operation using the Geneva mechanism and the pneumatic concepts [6]. Researchers developed a model and concluded that the same length of feed at the same interval of time. The length of the feed can be managed by changing the depth of the slots in the Geneva wheel and the path length of the crank can be increased by increasing the radius of the crank and the length of the lever cutter and by changing the number of slots on Geneva wheel. The angular velocity and angular acceleration can be observed for each link by designing the entire model in solid works and then calculating the analysis for each link [7]. The researcher provided the results, Stainless Steel has less deformation when compared to aluminium alloy material, the strain is less in Stainless Steel when compared to aluminium alloy material, and the stress is less in case of the aluminium Alloy. Concluded that Stainless Steel is the best to manufacture the Geneva index plate for conveyors used in medium-sized industries [8]. The authors developed a model and found the feed, which came from the Geneva mechanism carried by the chain drive, is cut by the crank lever mechanism, which is at the end of the chain drive. By using this model, the same length of feed at the same interval of time. The length of the feed can be managed by changing the depth of the slots in the Geneva wheel and the path length of the crank can be increased by increasing the radius of the crank and the length of the lever cutter and by changing the number of slots on the Geneva wheel. The angular velocity and angular acceleration can be observed for each link by designing the entire model in solid works and then calculating the analysis for each link. [9]. Kinematic analysis and computer-aided mechanical engineering design of a four – external slots Geneva stop mechanism designed for use in classroom illustration and teaching of kinematics of intermittent motion has been provided. A finite element-based stress analysis was carried out on the crank and Geneva wheels using a linear elastic isotropic solid mesh model. Static structural analysis carried out by researchers on the two wheels concluded that the material AISI 1060 selected is suitable [10]. Researchers calculated design calculations of conveyor input considering bulk density, size of the lump, belt width, capacity, TPH Lift of the material, Length between centres, belt speed, troughing angle, conveyor Inclination, take Up Travel, Type of Take up – SCREW [11]. Researchers' main consideration was to modify the Geneva mechanism design and mainly add the 4-bar mechanism to improve its vibration in this mechanism when the driven wheel is in contact with the driven wheel while rotating, the plan of a Geneva wheel drive instrument that performs essentially superior to anything traditional wrench drive approach. The plan is based on a 4-bar linkage where the coupler point drives the opened wheel in a recommended irregular design, given the uniform movement of an info wrench. The union of the 4-

bar linkage system utilizes an unpredictable variable methodology for instrument union. By applying suitable imperatives as free decisions in the unique variable conditions, the blend is diminished to the determination of just 3 connection length parameters. With this can concluded that the reduction in jerking of the wheel produces more contact force [12]. The authors reported that the design and development of the feeding mechanism for the sheet metal shearing machine represents a significant advancement in the field of sheet metal working processes. This innovative system addresses critical concerns related to worker safety, efficiency, and cost-effectiveness. By integrating pneumatic components and automation, the system minimizes the need for manual intervention, reducing the risk of worker injuries associated with handling sharp-edged sheet metal. The precise control offered by the pneumatic cylinder ensures consistent and accurate cutting operations, leading to improved quality and productivity [13]. Geneva mechanism has a simple construction and can offer a solution for indexing tables, or any mechanism with intermittent circular motion. Through the years it has proven to be inexpensive and durable. The authors provided a document as a guide to the geometric dimensioning of the mechanism [14]. Researchers conducted experiments on the test rig using the Geneva mechanism to index a table intermittently for bottle washing. the test rig was designed, constructed, assembled, and used to run the experimental study. The graphs plotted for time taken and number of bottles washed at selected speeds were all linear functions while the graphs plotted by varying other parameters such as speed, maximum pin-slot contact force, cycle time, washing time and indexing were represented by third-order polynomial functions of differing coefficients and constants [15]. In the proposed method by the authors, the four-level Hermite polynomials are used and two elements are sufficient to obtain the optimum results. The findings show that there is a decline in the peak acceleration of the Geneva wheel with six curved slots for the optimum results obtained using the proposed indexing motion program by 33.4% and 24.3%, respectively, as compared with the cycloidal and modified sine programs, concluded that the improvement of a decline in the peak acceleration of the Geneva wheel with three, four or five curved slots using the proposed indexing motion program can be better than using the cycloidal and modified sine programs. Moreover, there is a decline in the peak acceleration of the Geneva wheel for the optimum results obtained using the proposed indexing motion program by 14.3% and 16.3%, respectively, as compared with the methods of the variable input speed and the length-adjustable driving link. It would be interesting to compare the performance of the proposed method with other polynomial interpolations 26 for the optimum designs of Geneva mechanisms with curved slots which will be done in future [16]. Researchers conducted experiments on the Geneva drive indexing mechanism that converts the continuous motion of the driver wheel into intermittent rotary motion of the sprocket. According to the film length, the cam wheel diameter was chosen. Cam with pin arrangement integrated with Geneva drive. The input shaft has a driver wheel at one end and a cam drive at the other end. Geneva drive and sprocket are mounted on the output shaft. By cam with Geneva drive arrangement, the continuous motion of the driver wheel converts into intermittent motion of sprocket. Due to sprocket rotation, the film advances frame by frame in front of the lens. Thus the slide show of the film was obtained successfully [17]. Authors tabulated the results of angular displacement and velocity obtained from the miscellaneous geneva mechanism gave a slight difference, whereas in the case of angular acceleration, this miscellaneous produced high impact (depending on the number of slots and initial input angular velocity) when the centreline of the slot was below or above the line tangent to the direction of the pin's motion [18]. Researchers studied and concluded the case study with non-linear equations such as Geneva and the Four-bar mechanism ICA method is one of the significant methods for dynamic optimization [19]. The authors concluded that as the drive mechanism of the Geneva mechanism, the elliptic crank can replace the elliptic gear mechanism in some range. For the given groove number, different Geneva mechanisms with different kinematic coefficients can be combined. Of course, the kinematic coefficients τ must be less than τm for the outer Geneva mechanism and larger than τm for the inner Geneva mechanism [20]. The test rig uses the Geneva mechanism to index a table intermittently for bottle washing. The test rig was designed, constructed, assembled, and used to run

the experimental study. As the drive speed of the Geneva mechanism increases, the cycle time, washing time and indexing time decrease while the maximum pin-slot contact force and washing efficiency increase. The washing efficiency of the test rig from 5 rpm to 19 rpm increased from 81.57% to 96.89%. It is concluded that at 19rpm, the designed bottle washing machine had a washing time of 2.434 seconds and a maximum efficiency of 96.89% [21]. The authors experimented, with the test rig using the Geneva mechanism to index a table intermittently for bottle washing. The test rig was designed, constructed, assembled, and used to run the experimental study. The test runs were performed five times for each selected speed. The cycle time obtained for selected speeds was between 10.639 seconds and 38.060 seconds, the washing time was between 2.434 seconds and 7.844 seconds and the indexing time was between 0.078 seconds and 1.772 seconds [22]. Authors studied, putting pipette tips in racks is a repetitive and boring task that is done several times a day by lab technicians. By using the mechanism designed in this research, lab technicians will be able to put pipette tips in racks automatically, and very fast. The designed mechanism has one degree of freedom and consists of a feeder, a fixed guide, a moving guide, a separator, and a Geneva mechanism. Also, the motion of the mechanism is simulated in Solid Works software. As the presented device is a mechanism and not a robot, it has the advantages of high simplicity and low final cost and it doesn't require complicated control boards, expensive cameras and image processing algorithms which makes it affordable for most laboratories [23]. Authors experimented and compared, by comparing the manual operation of packing and the automatic operation of packing bottles concluded that the new automatic system would reduce the cost of labour and increase production [24]. Researchers studied the modelling and finite element analysis (FEA) of a Geneva mechanism with four slots, The modelling of this mechanism is simple and has a good potential for different applications [25]. Observations and experiments were performed for the small-scale industry, the design and fabrication of paper-cutting machines using the Geneva mechanism is useful in mass production. The traditional paper cutting machine has demerits like being large in size, high cost, need skilled labours, high self-weight etc. This demerit can be overcome by using a machine with a Geneva wheel as it is compact and has less manufacturing cost. This mechanism reduces the paper cutting time, reduces the wastage of raw material and simultaneously increases the productivity with accuracy [26]. A general algorithm for the kinematic synthesis of Geneva mechanisms has been formulated for assigned displacement programs to avoid the typical shock-loading problems of conventional Geneva mechanisms. Significant numerical examples show the effects of the design parameters on the geometry of the resulting profiles. In particular, the number of driving cranks; number of slots; imposed displacement program; and pin radius of the driving crank for the Geneva mechanism, have been considered [27]. The variation of the angular velocity and angular acceleration of the driven Geneva wheel is close to the actual situation [28]. The mathematical expression in parametric form for the curves and equations of non-undercutting are derived. The criteria for undercutting and double points in the design are also developed. Numerical examples have been performed to demonstrate these effects on the design of the mechanism. The results of this work indicate the importance of parameter selection for the geometry of the slots and their subsequent manufacturing. Also, the results of this work can provide ground rules for optimization work of the mechanism if necessary. It can be noted that this systematic procedure can be of practical value to the design and manufacturing of Geneva mechanisms with curved slots [29]. The kinematic and static analysis of conventional Geneva mechanisms has been formulated and realized in an algorithm implemented in Mat-lab, to run suitable numerical examples [30]. The project carried out by the authors is very useful in the field of small-scale industries. It is also useful for the workers to carry out several operations in a single machine. Compared to the individual machining operations this combination of various operations into a single machine, ultimately reduces the overall budget [31]. Punching on paper and G. I. Sheet with more prescribed than a conventional punching machine. A conventional punching machine takes more time for Job setting, Marking, and Punching operations. Labour costs are also higher. With this Geneva wheel-based auto roll punching machine the time taken for all this process can be reduced production time also reduced and production rate

will be high. No extra skill is required to operate this system. Operation is very smooth and, in this system, we can get more output by applying less effort [32]. The authors reported saving a lot of time and effort by automating the processes. Any type of operation can be performed along with the conveyor movement using this machine design just by changing the operating tool at the slider end Performable Operations: Notching, Punching, Drilling, Blanking, and Lancing [33]. Researchers analyzed the application of the series combined mechanism of outer geneva and elliptic gear could reduce the entering and quitting angular acceleration of geneva, reduce the flexible impact and improve the dynamic performance of geneva mechanism by selecting appropriate starting phase angel and eccentricity of the elliptic gear, which was applicable in the actual production [34]. The authors presented a method for improving the kinematic characteristic of the Geneva mechanism. Instead of designing another mechanism with better kinematic characteristics, the input velocity of the mechanism is assumed variable. Genetic algorithm strategies have been used for this purpose. [35]. Acknowledging the practically significant drawbacks of the traditional Geneva mechanism, an efficient alternative variety of the mechanism was presented and optimized. Using a fixed groove cam to control the radius of action of the driving pin, the discontinuity of the wheel acceleration was avoided and its maximum velocity and acceleration were reduced [36]. A plantain chips slicing machine was designed, fabricated, and tested and reported that efficiency is 73.8% [37]. In this work, the proposed method reveals that there is no need to alter the existing structure. The remaining work is likely to focus on improving the dynamic performance of the mechanism, e.g. by minimizing the residual vibration [38]. Researchers used the cycloid crank mechanism as the driving mechanism of the Geneva mechanism. In a certain slot number situation, the Geneva mechanism with different kinematic coefficients can be integrated. If proper parameters in the combination can get the Geneva mechanism which has instantaneous dwell or constant velocity at middle position [39]. A kinematic model of the indexing mechanism has been derived utilizing the homogeneous coordinate transformation method and conjugate surface theory. In addition, analytical expressions have been derived for the slot profile with and without an offset feature, respectively. It has been shown analytically that the use of an appropriate offset angle eliminates the singular points and double points on the slot profiles, and therefore improves the control of the indexing wheel [40].

III. Conclusion

The following conclusions are drawn from the review of the Geneva mechanism, researchers in one of their works concluded that the main objective of the Geneva mechanism is to reduce the timing for sheet cutting and to neglect the time to mark the sheet, this goal is achieved using the Geneva mechanism in our sheet cutting machine. Researchers suggested that systematic procedure can be of practical value to the design and manufacturing of Geneva mechanisms with curved slots. A few authors calculated the angular velocity and acceleration of the Geneva wheel and designed the Geneva wheel and roller conveyor for the time required by the material to cross the entire belt accurately. Applications to achieve the time reduction in punching operation using the Geneva mechanism. The authors designed and observed the angular velocity and angular acceleration for each link by designing the entire model in solid works and then calculated the analysis for each link with the use of different materials. Few researchers did Kinematic analysis and computer-aided mechanical engineering design of a four – external slots Geneva stop mechanism designed for use in classroom illustration and teaching of kinematics of intermittent motion has been provided. Authors in one of their works concluded that the main consideration was made to modify the Geneva mechanism design and mainly add the 4-bar mechanism to improve its vibration in this mechanism when the driven wheel is in contact with the driven wheel while rotating. Researchers provided innovative systems addressing critical concerns related to worker safety, efficiency, and cost-effectiveness. By integrating pneumatic components and automation. Geneva's mechanism has proven to be inexpensive. Geneva and Four-bar mechanism ICA method is one of the significant methods for dynamic optimization. For the small-scale industry, the design and fabrication of paper-cutting machines using the Geneva mechanism is

useful in mass production. Researchers reported that the traditional paper-cutting machine has demerits like being large, high cost, needing skilled labor, high self-weight etc., by using a machine with a Geneva wheel as it is compact and has less manufacturing cost.

References

[1] Rohit Sharma, Kashmir Singh Ghatorha, "Automatic sheet cutting machine: Design and Fabrication using Geneva mechanism", Think India journal, School of Mechanical Engineering Lovely Professional University, Phagwara, Punjab, India. ISSN NO: 0971-1260, Vol-22, Issue-37, PP NO: 3-5, December -2019.

[2] Getachew A. Ambayea, Hirpa G. Lemub, Mesay A. Tolchac. "Contact temperature analysis of the classical Geneva mechanism through numerical methods" International Research Journal of Engineering and Technology (IJERT), https://doi.org/10.1016/j.matpr.2022.01.420 PP NO: 6-8, Norway, 10-February-2022.

[3] Jyh-Jone Lee, Bin-Heng Jan "Design of Geneva mechanisms with curved slots for non-undercutting manufacturing" Mechanism and Machine Theory Department of Mechanical Engineering, National Taiwan University https://doi:10.1016/j.mechmachtheory.2008.09.003, PP NO: 9-11, Tiwan.

[4] M. V. Ingalkar, Mr. A. R. Sonekar, Mr. Y. D. Bansod. "Design, Cad Modeling & Fabrication of Geneva Operated Roller Conveyor" International Journal of Engineering Trends and Technology (IJETT) – ISSN NO: 2231-5381, Volume-46, Number -2, PP NO: 12-14, India, April 2017.

[5] Ranjith S. Kumar, Nitish Kaushik, Sangeeth M. Kumar. "Development of a paper shearing machine using Geneva mechanism", Journal of Emerging Technologies and Innovative Research (JETIR), https://doi.org/10.1063/5.0108095 14 October 2022, PP NO: 15-17, India.

[6] Gowtham Gunasekaran, "Geneva Conveyor Technology with Pneumatic Pin Punch", International Journal of Research in Engineering, Science and Management, Volume 4, Issue 5, May 2021, ISSN 2581-5792, PP NO: 18-21, India.

[7] Ajay S. Parmar, Amar Singh, Avinash Singh, Avneesh Pandey, Kunal Singh, Maneesh Upadhyay, "Intermittent Paper Cutting Mechanism by Giving Feed through Geneva Wheel" International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 05, ISSN: 2395 -0056, PP NO: 22-25, India May -2017.

[8] Narayana, Kalyani Radha, "Modeling, analysis and fabrication of Geneva index plate", Journal of Emerging Technologies and Innovative Research (JETIR), (ISSN-2349-5162) Volume 5, Issue 9, PP NO: 25-27, India September 2018.

[9] Mohit S. Kalamkar, Mihir B. Choudhry, Aditya B. Jogi, Aniket K. Bawankar, Abhishek D. Raghorte, Avinash R. Bhusari, Gaurav Thakre, "Review on Design and Fabrication of Paper Cutting Machine by Using Geneva Mechanism", International journal of innovative research in technology, ISSN: 2349-6002, Volume 5 Issue 10, PP NO: 28-29, India.

[10] Olurotimi Akintunde Dahunsi, Anthony Yinka Oyerinde, Ojo Phillip Bodunde, Olugbenga Sunday Olunloyo, "Kinematic Analysis and Design of a Geneva Stop Mechanism Teaching Aid for Intermittent Motion", Journal of Machinery Manufacturing and Automation (IJIRSET), Vol. 6 Issn. 1, PP NO: 30-32, Nigeria 2017.

[11] Konakalla naga srianantth, vaitla rakesh, pothamsetty kasi visweswararao, "design and selecting the proper conveyor belt", international journal of advanced engineering technology, ISSN 0976-3945, Volume 4, issue 2, PP NO: 33-35, India April – June 2013.

[12] A. Chandra Shekhar, Shaik Himam Saheb, S. Shahab, "Analysis of Geneva mechanism using dwell symmetrical coupler curve mechanism", Elsevier journals, https://doi.org/10.1016/j.matpr.2020.05.025. PP NO: 36-38, India June 2020.

[13] V N Santapen, V W Khond, A B Kota, "Recent development in feeding mechanism of sheet metal shearing machine for productivity improvement", Journal of Physics: Conference Series (IOP Publishing), http://doi:10.1088/1742-6596/2763/1/012027 PP NO:39-40, India 13/08/2024.

[14] Eduardo Martinez Escobedo "Geneva Mechanism Geometric Resolution" Journal of Physics Conference Series, IOP Publishing, http://doi:10.1088/1742-6596/1391/1/012003, PP NO: 41-42, Spain 2019.
[15] Amechi Joseph Ujam, Gerald Ejeogo, Emmanuel Ufomba, "Experimental Analysis of Geneva Mechanism for Bottle Washing", International Institute for Science, Technology and Education (IISTE), ISSN 2222-1727, Vol.7, No.1, PP NO: 43-46, NIGERIA 2016.
[16] WY Lin, YH Tsai and KM Hsiao "A new indexing motion program for optimum designs of Geneva mechanisms with curved slots" Journal of Mechanical Engineering Science (IISTE) June 16, http://DOI:10.1177/0954406216656021, PP NO: 47-49, Taiwan 2016.
[17] V. Mallikarjuna, and B. James Prasad Rao, "Design & analysis of Geneva drive using Catia", International journal of research in aeronautical and mechanical engineering, ISSN: 2321-3051, Vol.4, Issue 5, https://doi.org/10.30684/etj.34.9A.11, PP NO: 50-52, India May 2016.
[18] Dr. Nabil N. Swadi, "Kinematics Characteristics of The Internal & External Geneva Mechanism Under The Effect of Multi Design Parameters", engineering and technology journals, (ASME) Vol.34, Part (A), No.9, https://doi.org/10.30684/etj.34.9A.11, PP NO:53-54, Iraq.
[19] Arash Mohammadzadeh Gonabadi, Mohammad Nouri Damghani, "Multi-Objective Optimization of Kinematic Characteristics of Geneva Mechanism Using High-Tech Optimization Methods", mechanics, material science and engineering journals, ISSN 2412-5954, March 2017, http://DOI:10.2412/mmse.26.65.331, PP NO: 55-57, Iran 2016.
[20] Han Jiguang Yu Kang, "Analysis and Synthesis of Geneva Mechanism with Elliptic Crank", International Journal of Hybrid Information Technology, Vol.8, http://dx.doi.org/10.14257/ijhit.2015.8.8.26, PP NO: 58-59, China 2015.
[21] Ujam, A. J, Ejeogo, G and Onyeneho, K. C, "Development and Application of Geneva Mechanism for Bottle Washing", American Journal of Engineering Research, Volume-4, Issue-11, e-ISSN: 2320-0847, p-ISSN: 2320-0936, PP NO:60-62, Nigeria 2015.
[22] Jun Zhanga, Shuli Suna, Hoang Anh Tuanb, "Optimization Design and Analysis of Rotary Indexing Mechanism of Tool Magazine in Machining Centre ", Jordan Journal of Mechanical and Industrial Engineering, Volume 14, Number 1, ISSN 1995-6665, March 2020, PP NO: 63-66, China.
[23] Mohammad Ghanatian , Sajjad Taghvaei , Seyyed Arash Haghpanah, "Design of a mechanism for sorting and filling of pipette tips into racks", Institute of electrical and electronics engineers, (IEEE), http://DOI:10.1109/KBEI.2019.8735053, PP NO: 67-70, Iran 2019.
[24] Vinod M. Bansode, Abhilash A. Giram, Omkar K. Kamble, Vinod A. Gite, "Design and Analysis of Automated Packaging Machine for Industrial Applications", ISSN: 2456-5660, Volume 06, Special Issue 01, PP NO: 71-73, Pune, India August 2021.
[25] Georgeta HARAGA, Elena IONIŢĂ, Ana-Maria AVRAMESCU, "Analysis and modeling of geneva mechanism", journal of industrial design and engineering graphics, special issue ICEGD volume 10, special, PP NO: 74-76, China June 2015.
[26] Shubham P. Bhalerao, Gayatri N. Bari, "Geneva Mechanism Operated Paper Cutting Machine", International Journal of Advance Research and Innovative Ideas in education., Vol-6 Issue-2, 2020 IJARIIE-ISSN(O)-2395-4396, PP NO:77-79, India,
[27] Giorgio Figliolini and Pierluigi Rea, "Effects of the design parameters on the synthesis of Geneva Mechanisms", http://DOI:10.1177/0954406212466194, PP NO: 80-81, Spain 26 July 2012.
[28] Jishun Song, Yongshi Song, "The Geneva Mechanism Motion Simulation and Research to Improve the design Method", International Institute for Science, Technology and Education, ISSN: 1662-8985, Vols. 774-776, PP NO: 82-84, China 2013-09-04.
[29] Jyh-Jone Lee, Bin-Heng Jan, "Design of Geneva mechanisms with curved slots for non-Undercutting machining.", International Research Journal of Engineering and Technology, ISSN: 1662-7482, Vols. 479-480, PP NO: 85-86, Taiwan 2013-12-06.

[30] Giorgio Figliolini a, Pierluigi Rea a, Jorge Angeles, "The pure-rolling cam-equivalent of the Geneva mechanism.", International Research Journal of Engineering and Technology, http://doi:10.1016/j.mechmachtheory.2006.01.002, P NO: 87-89, Canada 2 January 2006,
[31] M. Dilip Kumar, K. Sai Rohith, E. Anand kumar, G. Ramesh, "Fabrication of Auto Roll Punching Machine", International Journal of Engineering Research & Technology, ISSN: 2278-0181, Vol. 6 Issue 04, PP NO: 90-91, India April-2017.
[32] R. Syam Sudhakar Rao, A. Hari Tej, C. Siva Sai, A. Rupesh Kumar, A.Narayana Reddy, B. Sai Krishna, "Design Of Geneva Wheel Based Auto-Roll Punching Machine", International Research Journal of Engineering and Technology, e-ISSN: 2395 -0056, p-ISSN: 2395-0072, Volume: 04 Issue: 03, PP NO:92-94, India Mar -2017.
[33] Ansari Mohammed Mazhar Mohammed Rashid, Khan Arshad Irfanullah, Khan Karim Jumma, "Automatic Notching & Drilling Machine", International Journal of Engineering Research & Technology, ISSN: 2278-0181, Vol. 9 Issue 06, PP NO: 95-97, India June-2020.
[34] Shen Shaohua, Cai Jifei, "Kinematic Analysis on Series Combined Mechanism of Elliptic Gear and Outer Geneva", Applied Mechanics and Material, Vol. 312, http://doi:10.4028/www.scientific.net/AMM.312.42, PP NO: 98-100, Europe 2013.
[35] M. Heidari, M. Zahiri, and H. Zohoor, "Optimization of Kinematic Characteristic of Geneva Mechanism by Genetic Algorithm", World Academy of Science, Engineering and Technology, School of Mechanical Engineering, University of Tehran, PP NO: 101-103, I.R. Iran.
[36] M Heidari, A A Atai, and M Shariat Panahi, "An improved Geneva mechanism for optimal kinematic performance.", Journal of mechanical Engineering Science, Vol 216, 17, PP NO: 104-106, Tiawan April 2002.
[37] Okafor, B.E., Okafor, V.C, "Design of a Plantain Chips Slicing Machine", International Journal of Engineering and Technology, Volume 3 No. 10, ISSN: 2049-3444, PP NO: 107-109, Nigeria October, 2013.
[38] J-J Lee and C-C Cho, "Improving kinematic and structural performance of Geneva mechanisms Using the optical control method", Institution of mechanical engineers, Journal Mechanical Engineering Science, Vol 216, PP NO: 110-111, 17, Taiwan April 2002.
[39] Han Jiguang, "Synthesis of Combined Geneva Mechanism with Cycloid Crank", International Institute for Science, Technology and Education, http://DOI10.1109/ICDMA.2011.293, PP NO: 112-113, China 2011.
[40] Jung-Fa Hsieh1, Fu-Shou Wang, "Design of Geneva Mechanism with Curved Slots", International Research Journal of Engineering and Technology, ISSN NO: 1662-7482, Vols. 479-480, PP NO: 114-115, Taiwan 2013-12-06.