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# Design of Robotic Sewing Machine System

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***Abstract*: In this paper, a multi-objective design of the sewing machine system is presented. Generally, the sewing machine consists of thread take-up mechanism, needle piercing mechanism, fabric feeding mechanism and bobbin mechanism: But the drawback of using this system is limited thread supply due to bobbin mechanism. This problem is overcome by providing a Gibbs stitching hook, where the bobbin is exempted from this new mechanism. This improves performance by reducing idle time machine by continuous thread supply. Hence, the newly designed system is compact, light-weight and inexpensive. After the whole design, ADAMS, CATIA V5 software is used to simulate the machine and diagnose the synchronization of the mechanism.***

***Keywords: chain stitch, Gibbs hook, Gear train synchronization***

## I. INTRODUCTION

The sewing machine is a kind of high-speed precision machine. The basic function of the sewing machine is to stitch using a thread on cloth and to secure satisfactory quality.

Here, stitch formation consists of following factors [1].

*A.* Needle ba
*B.* Gibbs hook
*C.* Thread take-up lever
*D.* Thread tension

Needle bar makes needle up and down, and upper needle penetrates into the fabric to be sewn. Gibbs hook is pivoted at one end so it operates on the oscillatory motion, instead of rotating in a full circle, which interfaces with the thread below the fabric. Once it has done this, the hook reverses its directions and returns to its original location. The lever of thread take-up is fixed to the body of the arm. The up-down motion bolsters the thread to the needle and screws up the loop created by the shuttle [2].

In this project, we designed a sewing machine which stitches chain type of stitches. The Basic Chain stitch is made by first sending the needle down through the fabric and the needle going to move upside due to the friction between the thread and fabric loop will be formed for stitching. That loop is held by a circular needle and it is underneath the work. The machine at that point advances the texture anticipating the loop on the underside from the last stitch. The following drop of the needle experiences the past loop. The round needle at that point

At high speed, mechanisms of sewing machine like the take-up mechanism[3], the needle piercing mechanism, and the Gibbs hook mechanism must work and cooperate precisely and even one-millimeter error among them may induce machine de-synchronization.

In this design, a slider crank mechanism is used for needle piercing movement, simple gear train of combination spur and face gears are used for transmitting the power and torque to needle and Gibbs movement [4]. The Gibbs hook is attached to gear train via slider crank mechanism which converts rotary motion into oscillatory motion of hook [5].

Design and modeling of the system are done in CATIA V5 software [6]. And for the velocity, acceleration and position analysis of needle mechanism ADAMS software is used [7].

## II. SEWING MACHINE DESIGN

### *A. Sewing machine design*

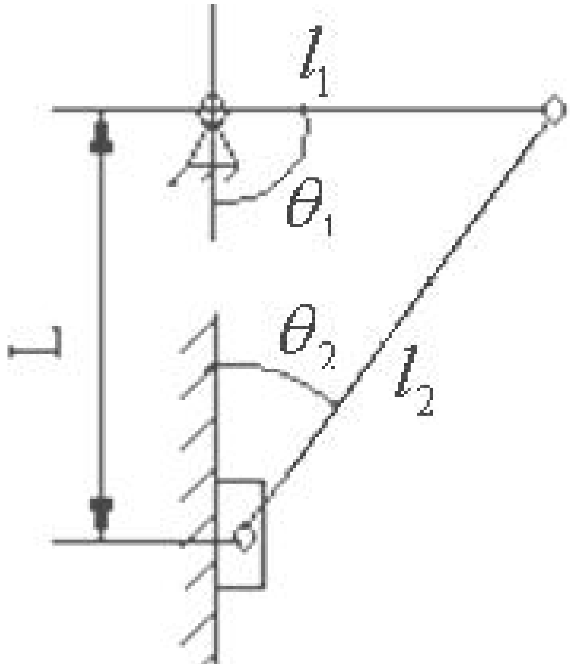
The sewing machine is composed of four mechanisms, and each mechanism can be designed by the different mechanical structure. The needle piercing mechanism can be made by slider crank mechanism or rocker-slider structure. Take up lever mechanism can be composed of the cylindrical cam or four-bar mechanism. Gibbs mechanism can be the type of crank slotted mechanism. In this paper, a sewing machine is designed by slider crank mechanism, a take-up lever mechanism, and Gibbs hook mechanism. Face gear and spline gear meshing mechanism are used for Gibbs hooks drive. This all model is done in CATIA V5 after finishing the model in CATIA model design in ADAMS software, the model is imported partially. By adding the motion and constraint function to the

CATIA model, kinematic simulation and analysis can be processed in it. Figure 1 is the CATIA model of the designed sewing machine. Figure 2 is the kinematic diagram of the sewing machine.

*B. The needle piercing mechanism*

The needle piercing mechanism is used to pierce the fabric. Needle carries the top thread to pass the fabric. Needle piercing mechanism is made of slider crank mechanism (modified). Figure 2 is the kinematic diagram of the mechanism. Figure 4 shows the needle position in three cycles according to our design the position of the slider slotted can be described by the stroke length of the mechanism= 3cm [3].

Fig.1 CATIA Model of Sewing machine



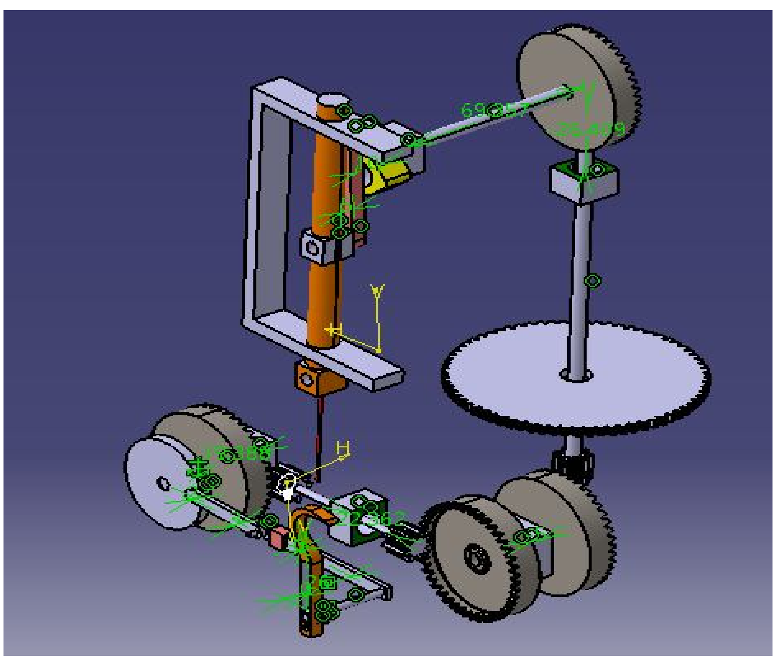



Fig.2 Displacement of needle piercing mechanism [1]

## III.RESULTANT ANALYSIS

### *A. Position analysis*

The position of the needle with respect to crank is plotted using ADAMS software Here 0-360 degrees is the crank rotation and -3 to 3 cm is the needles stroke length.

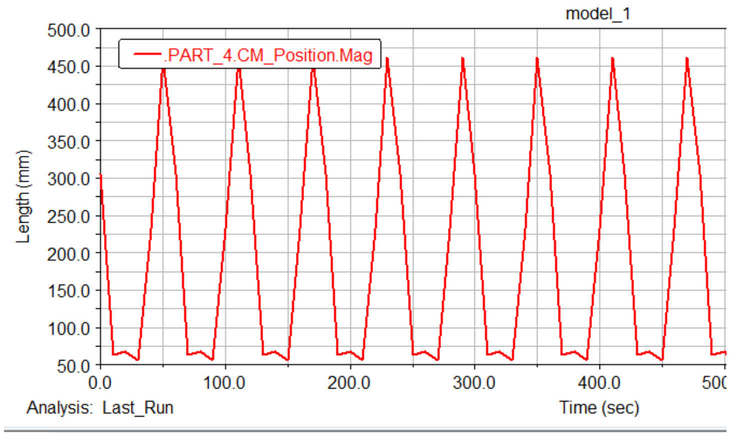



Fig.3 Position analysis

### *B. Velocity analysis*

The velocity of the needle is found out by the instantaneous center of rotation method. Values are plotted manually and also through ADAMS software.

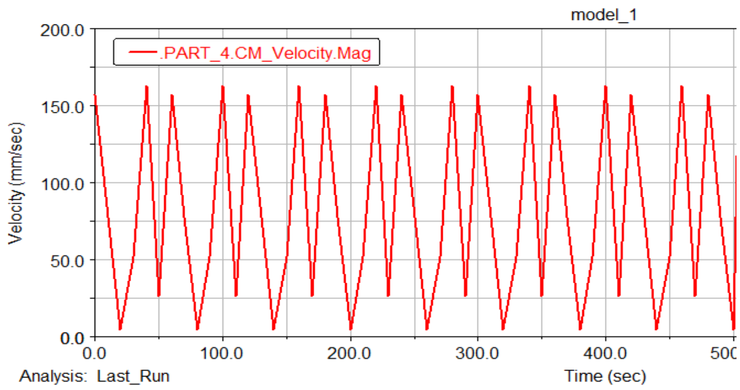



Fig.4 Velocity analysis

### *C. Acceleration analysis*

Acceleration analysis is done manually by using same method instantaneous center of rotation.

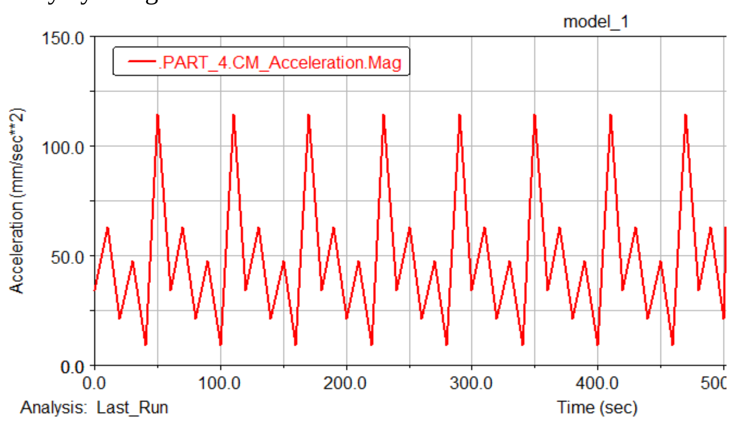



Fig.5 Acceleration analysis

*D. Kinetic Energy analysis*

Considering mass of the rod and needle carrier and using velocity from velocity analysis we can find the Kinetic Energy of the system.

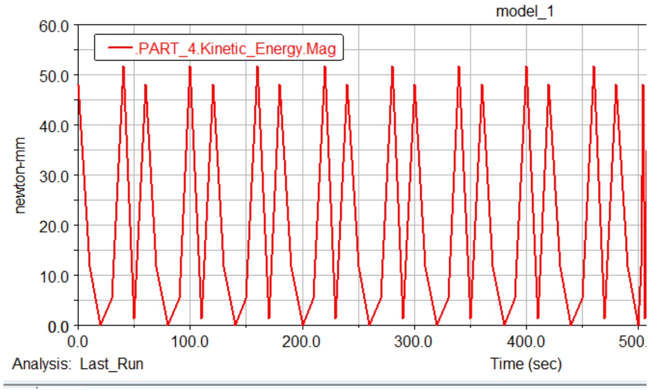



Fig.6 Kinetic Energy analysis

## IV. KINEMATIC ANALYSIS AND OPTIMIZATION

Through the results of design and simulation in section the design satisfies the requirement but except the single crank mechanism design, the cooperation between the crank-slider mechanism and Gibbs hooks mechanism is also important. First speed of the Gibbs hook is same that of the needle piercing mechanism if the yarn that the thread could not go up with the needle because of friction between the fabric and yarn, the yarn ring is formed. The time which the tip of the hooks mechanism goes into the ring formed by piercing needle neither to be slow or fast. From following graphs we can say that needle mechanism and Gibbs hooks mechanism the synchronization will be very good.

When the needle is in the fabric, the fabric feeding mechanism push the cloth in forwarding direction so as to make the second stitch as in this case we don't use feeder mechanism so not required any synchronization between these two mechanisms

The kinematics relationship between these two mechanisms such as needle mechanism and Gibbs hook mechanism is shown in the figure. When the needle is at the highest position, the phase is defined as zero degrees in the system and another mechanism phase is referred to it. The key to success of sewing a seam is the synchronization of the four mechanisms clearly. First, the needle piercing mechanism goes down and then Gibbs hook will come forward. After the take-up lever mechanism has begun to go up, the Gibbs hook begins to rotate. The delay phase between them will exist.

In spite of design and simulation optimization can be done with help of ADAMS software also in the initial design we give crank length as 15mm and connecting rod as 15mm connected to needle holder which in turns gives stroke length as 30mm. and the rotation of Gibbs hooks which should synchronize and timing should be in perfect[7].

## V. CONCLUSION

In mechanical design, we usually do not know whether the design satisfies the requirement. When the design is in reality, the optimized work in this model will be time factor and cost product. If a motion or a system is in design and process, the static and dynamic simulation and analysis software play an important role in design and simulation since all the times. We cannot rely on a prototype for each simulation. In future, we needed to do this automated by using some sensors which the manual interpretation would not be needed. And placing of this compact sewing machine on the robotic arm and make the stitching perfect. Since in the manual stitching, the errors are maximum and the raw material cost to be decreased with minimal rejections. We can use this system.

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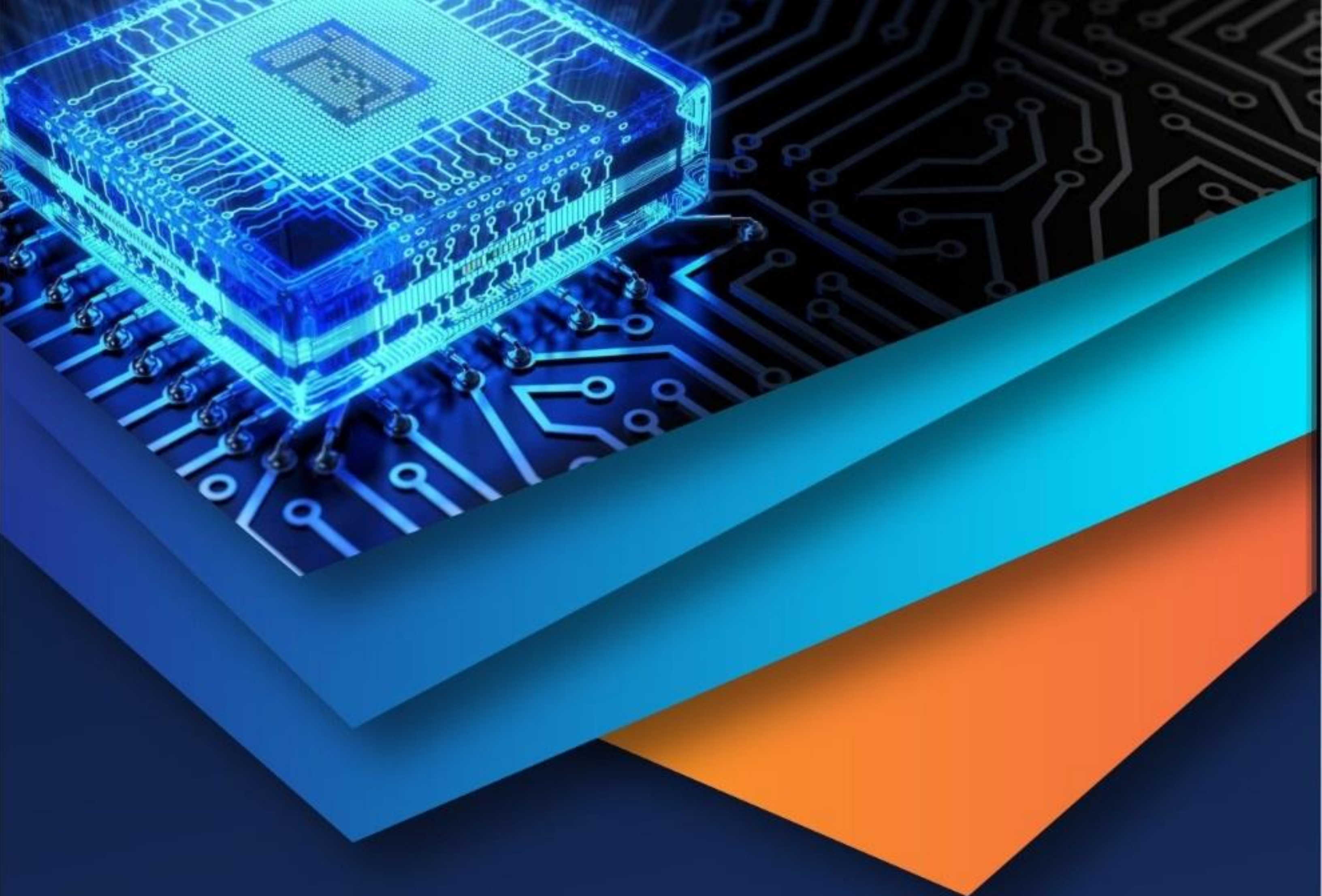


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