Converting Plain English Loom into Automatic Rapier Loom

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***Abstract* - This paper gives the details of weaving machines and power loom industry. Basically under the projectwork the Plain English loom is modified intoautomatic loom using suitable mechatronics based proximity sensors and the shuttlemechanism is replaced by rapier mechanism. The synthesis and velocity analysis of rapiermechanism is done and velocity and acceleration of various links are found out. Thefactors affecting the production rate and productivity are discussed.**

***IndexTerms* - Loom, Rapier Mechanism, Shuttle Mechanism, Production Ratio, Weft feeder**

I. INTRODUCTION

The power loom sector occupies a pivotal position in the Indian textile industry. Though current growth of this sector has been restricted by technological obsolescence, fragmented structure, low productivity and low-end quality products, infuture Technology would play a lead role in this sector and will improve quality and productivity levels. Innovations would also be happening in this sector, as many developed countries would be innovating new generation machineries that are likely to have low manual interface and power cost. Indian textile industry should also turn into high technology mode to collect the benefits of scale operations and quality. The existing power looms are semi-automatic hence these require an essential need of operator. Most of times due to carelessness of operator the quality andproductivity of woven fabrics are affected. And also due to use of shuttle mechanism of existing looms the machine has to stop after few minutes and it cannot continue theweaving operation until operator does not start it. Also the shuttle mechanism producesnoise and causes hearing damage of workers. Sometimes the shuttle comes out of itsguided passage and causes severe accidental conditions. Often due to running out ofguided passage the threads coming from beam are broken and joining of beam withbroken threads is a time consuming task. Ultimately above mentioned causes affect thehuman safety and efficiency of machine. Hence there is need of such a weavingmachine which can provide safety to workers and enhance productivity.

II. LITERATURE REVIEW

Anirban Guha[1]In several developing countries, numerous small scale textile units, the main source of livelihood for millions, weave cloth on outmoded shuttle looms. With little or no access to capital, this sector continues to rely on outmoded and refurbished fly shuttle looms. Apart from poor productivity much of this sector is plagued by noise generated by these looms. Futile attempts have been made to introduce shuttleless looms in this sector but available designs are expensive. In this paper we discuss the kinematic synthesis of a crank driven shuttleless rapier loom which is being examined as an alternative solution to the shuttle loom.

A. N. M. Masudur Rahman [2] The study was carried out to find out the effects of various parameters on efficiency in rapier looms. To do so, the efficiency is analyzed by various parameters such as weaver's skills, loom speed, weave structure, pick density, loom allocation per weaver, size take up %, tension on warp etc. The main objective of this study is to increase the efficiency and through that increase the productivity and profitability. Unlike in winding, warping and sizing where the emphasis is on the quality of preparation, in the loom shed, control of fabric quality as well as of productivity assumes significant importance.

Umang S. Modi [3] Shuttle Loom is widely used in Indian Power loom industry due to its versatility to weave nearly all kind of fabrics. The only problem with this machine is that the speed is low compared to the other weaving machines. It can be enhanced by improving the speed of shuttle loom .This needs to increase the speed of picking mechanism which plays the main role in weaving of fabric. Detailed study was done on the working of the picking mechanism of present loom. Experiments have been carried out to study the motion of a shuttle in the present machine. Kinematic and Dynamic analysis are done for the present loom. Cam profile has been generated and Kinematic and Dynamic Analysis are carried out for the designed cam. A prototype is manufactured and from the practical experiment it has been observed that the accuracy, speed and force of picking mechanism have been increased.

III. PROBLEM STATEMENT

To convert or modify semi-automatic loom into automatic loom using suitable mechatronics based proximity sensor to regulate the weaving operation till the breakageof thread carried by rapier mechanism instead of shuttle. To replace shuttle mechanismof existing loom by rapier mechanism of modern automatic loom to enhanceproductivity of woven fabric by maintaining the overall cost of power loom. The project is carried out to meet following objectives.

- Modification of existing Plain English loom into automatic loom by suitablecombination of mechanisms of "existing and modern automatic looms".
- Velocity Synthesis and analysis of rapier mechanism
- Increasing productivity
- Improvement in quality of woven fabric by controlling quality influencingfactors
- Reducing overall cost of machine i.e. loom

IV. METHODOLOGY:

Weaving: The basic weaving operation involves a warp this consists of a set of evenlyspaced parallel warp yarns into which individual transverse weft yarns are sequentiallyinserted, so as to obtain a suitably interlaced structure which is called a 'woven fabric'.The woven structure is determined by the order or pattern in which individual warpyarns are made to interlace with the weft yarns. Before each weft yarn is inserted, theindividual warp yarns are raised or lowered as determined by the required fabricstructure.

Motions in Looms: The raising or lowering of the warp yarns, known as 'shedding', forms adiamond-shaped opening across the warp called the 'shed', through which the weftyarn is inserted.Each weft yarn inserted is pushed or 'beaten-up' against the previously insertedweft by means of a movable reed, which consists of a uniformly spaced set of plates orwires. By repeating these operations cyclically, a woven fabric with a distinct uniform structure is formed.
Shedding: It is the process of dividing the longitudinal threads called 'warp' into twosheets.
Picking: It is the process of insertion of transverse thread called 'weft' into the spacecreated by the division of warp sheets.
Beating: It is the process of pulling the inserted wefts one after the other to form cloth.
There is no change in these principles whether it is Handloom, Power loom, Automatic loom or Shuttle less loom technology.

Shuttle Weaving: A component called shuttle is used for picking of threads into shed created by warp. Weaving machines have been developed to enable the industrialproduction of woven fabrics in large volumes at high weaving speeds. This requiresthe preparation of warp and weft yarns of suitable quality, and various preparatoryoperations (winding, warping, sizing, drawing-in the warp yarns through the droppers,of the harness and the reed).Above illustrated operations are essential to ensure that high-quality fabric canbe produced with minimum interruptions to production. After carrying out thenecessary preparation, the warp and weft threads are transferred to the weavingmachines in the production unit. They are then interlaced to form a woven fabric havinga particular density, width and type of interlacing, so as to be able to achieve particularphysical characteristics (such as air permeability, abrasion resistance, tensile strength,crease retention, draping, etc.) as required for the fabric's intended application.

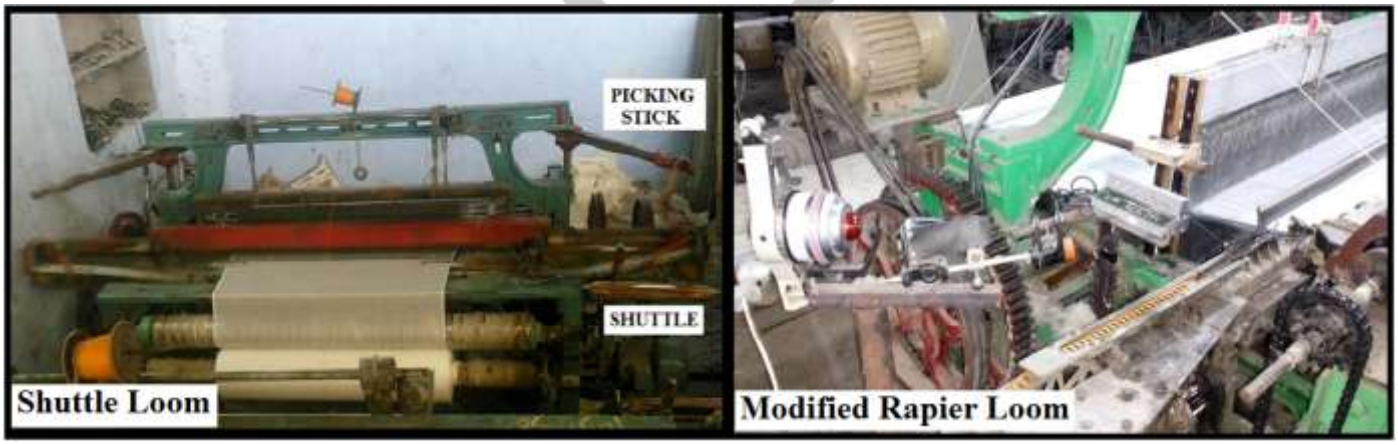

Figure 1: Weaving by Shuttle Loom and Modified Rapier Loom

Shuttleless Weaving: Shuttleless Weaving Machines are generally of wider widths enabling the simultaneous weaving of two or more widths up to 400/420 centimeters in case of Air Jet and Rapier and up to 540 centimetersin case of Gripper. The weft insertion rates achieved are 1560, 1480, 2850 and 2565 meters per minutefor Gripper, Rapier, Air Jet and Water Jet

Weavingmachines respectively. Shuttleless Weaving Machines are suitably designed to match the requirements of high insertion rates, shedding, and beating and other auxiliary motions. Let-off and take-up mechanisms and weft monitoring are invariably controlled through microprocessors. The machines are equipped with features like automatic pick finding & repairing and weft accumulators.

Modifications and Replacements: The picking and beating mechanisms of Plain English loom are replaced by respective mechanisms of China rapier loom. After making successful replacements the production ratio of both Plain English loom and modified rapier loom are compared for result.

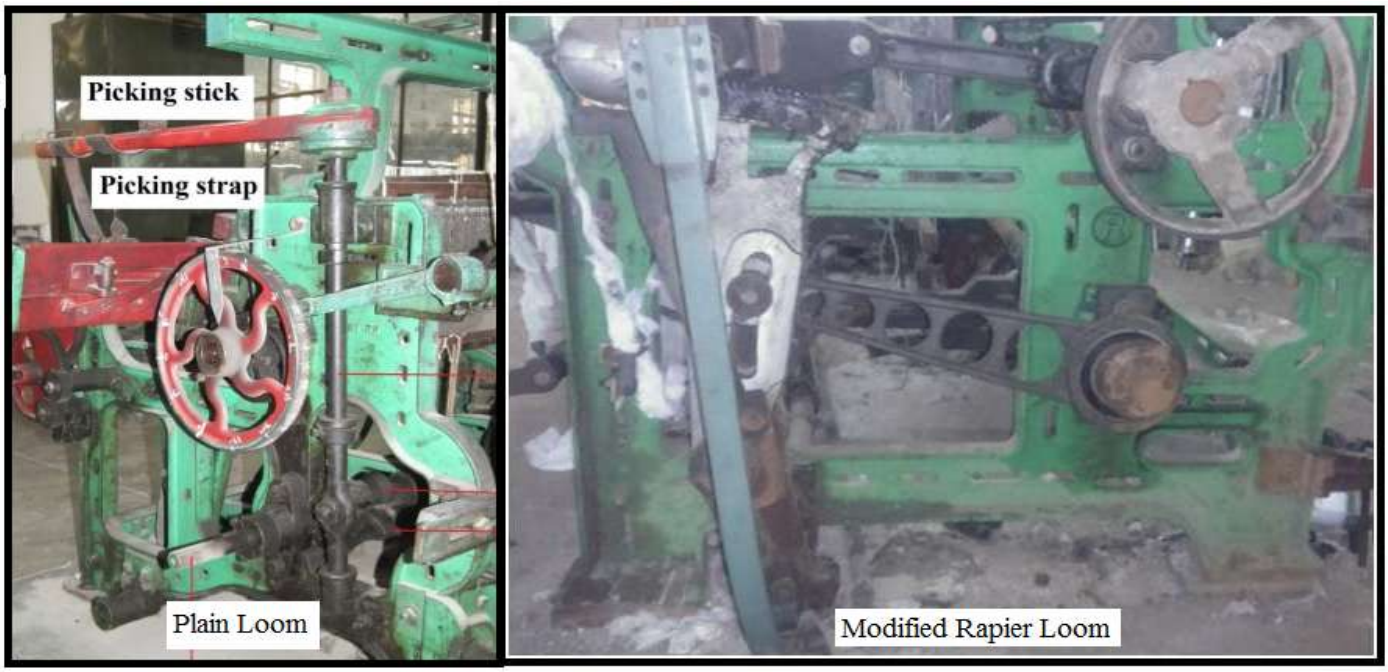

Figure 2: Beating and Picking Mechanisms

V. EXPERIMENTAL CALCULATION OF PRODUCTION RATIO

Warp: It is the yarn coming from beam perpendicular to rapier motion.
Weft: It is the yarn filled by rapier parallel to its motion and perpendicular to lengthof warp.
Picking: It is the process of insertion of transverse thread called 'weft' into the space createdby the division of warp sheets. One complete filling of weft into warp sheet is referred asone pick.

- The Quality of manufactured fabric cloth is expressed in terms of gram/meter. Alsonumber of picks per inch of warp yarn decides quality. More the picks per inchgood will be quality and less the picks per inch poor will be quality. The pick perinch of warp varies between 26 and 68.
- For 40 pick product the rapier or shuttle should fill 40 wefts in 1 inch advancementof warp. The calculations of production ratio are don for same quality (72gram/meter and 40 pick) of cloth fabrication on rapier and shuttle loom.

Observation Table:

a) Neglecting stoppage of machine due to breaking of thread, electricity cut-off and labor carelessness:

Table 1:

Parameters / Type of Loom	Modified Rapier loom	Shuttle loom
Quality (gramper meter)	72	72
Pick per inch	40	40
Average time for 10 pick (sec)	3.535	4.215
Length of advancement for 40 pick, L (inch)	1	1
Time for 40 pick, T(sec)	3.535 x 4 = 14.14	4.215 x 4 = 16.86
Rate of production, R.P (inch/sec)	R.P = L/T =1/14.14 =0.07072	R.P = L/T =1/16.86 =0.05931

b) Considering stoppage of machine due to breaking of thread, electricity cut-off and labor carelessness:

Table 2:

Parameters / Type of Loom	Modified Rapier loom	Shuttle loom
Production , (meter/hour)	6.8	4.9

Sample Calculation:

The production ratio (neglecting stoppage of machine due to breaking of thread, electricity cut-off and labor carelessness)is given by,

$$(P.R)_N = \frac{\text{Rate of production of rapier loom}}{\text{Rate of production of shuttle loom}}$$

$$(P.R)_N = \frac{0.07072}{0.05931} = 1.192$$

The production ratio (considering stoppage of machine due to breaking of thread, electricity cut-off and labor carelessness) is given by,

$$(P.R)_C = \frac{\text{Production in meter per hour by rapier loom}}{\text{Production in meter per hour by shuttle loom}}$$

$$(P.R)_C = \frac{6.8}{4.9} = 1.3878$$

Result:

$(P.R)_N = 1.192$
$(P.R)_C = 1.3878$

VI. CONCLUSION

From above result it is clear that the rate of production obtained by modified rapier loom is more than that of production rate obtained by shuttle loom.The necessary study and observations have been made to convert conventional shuttle loom i.e. Plain English loom into Rapier loom. The mechanism of picking i.e. rapier mechanism is synthesized and analyzed for velocity and acceleration. The shuttle mechanism is replaced by rapier mechanism. The assembly and testing of the entire project is done successfully. The production obtained by rapier loom is found 20% more than conventional shuttle loom.

REFERENCES

[1] Guha, Anirban and C.Amarnath.
"Synthesis of Bar Linkage Mechanisms to Guide and DriveRapiers."13thWorld.

[2] Rahman, ANM Masudur, and Md Ruhul Amin.
"Efficiency Analysis Ln Rapier Loom." (2001).

[3] Modi, Umang S., and B. A. Modi.
"Design and Analysis of Picking Cam for High Speed Shuttle Loom."

[4] Szabó, Lóránt, and László Szabó.
"Weft insertion through open profile reed in air jet looms." Annals of the Faculty of Engineering Hunedoara 10.2 (2012)211.

[5] Talukdar, Marinal Kanti, P. K. Sriramulu, and Dinkar Bapurao Ajgaonkar. Weaving: Machines, Mechanisms, Management. Mahajan Publishers, 1998.

[6] Lord, Peter R., and Mansour H. Mohamed. Weaving: Conversion of yarn to fabric. Elsevier, 1982.

[7] Hanson, William J. "Noise reduction in the fly shuttle loom." The Journal of the Acoustical Society of America 55.S1 (1974): S37-S37.