Development of a System for Automatic Seat parts Selection in Assembly Line

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***Abstract*: This paper deals with the development of an automated system which is used as one of the work place in production line for manufacturing automotive seat parts sub assemblies. There are two modules in this project. The first module is selection of a seat part model from various models; the other is assembly system for motion which is connected to previous stages of production line. The project involves Automation.**

Keywords— Seat parts, Fixtures, Proximity sensors, Programmable logic Controllers.

I. INTRODUCTION

Automation helps to save man power, to achieve accuracy repeatability and to reduce time consumption in manufacturing units. Seating systems are one of the major concerns in automobiles. Seat plays a important role for automobiles for its comfort and for the users to make the drive properly.

An automotive seat is of two types; bucket seat and bench type seat. A bench seat is along the seat length and the other seat is designed for single person. The Basic parts of automotive seat are:

1. Seat Slider
2. Recliner
3. Height Adjuster
4. Head rest
5. Seat Latch for Locking
6. Cushions
7. Back rest

Fig 1 : Basic Seat Structure

A. Introduction to Seat Adjuster

A seat adjuster is a part which is to the bottom of the seat. It is attached to car chassis. Adjusters are responsible for track motion of seats. They are provided with locking mechanism to fix the seat from sliding after adjustment. Seat Adjuster has three parts as in figure (2) as:

1. Seat frame
2. Top Block
3. Bottom train

Automotive seat adjusters are very crucial for human safety, ergonomics and performance of the vehicle. Early methods in automotive industries follow manual approach in assembly lines. A product once designed is examined and then mechanical fixtures and jigs according to its profile is made and installed into various substations of product assembly line. This is a long term process and there are drawbacks like time for manufacturing in mass production, issues relating productivity, quality and more man power requirement. In order to overcome these issues the assembly lines are thus equipped with automation system.

The manufacturing line consists of various work places. This project deals with the design and development of completely automated work spot in the manufacturing assembly for automotive seat adjuster sub assembly .To manufacture a adjuster sub assembly the various processes included are Lever Assembly, Model checking, Ball rollers assembly, Force calculation and motion Checking, Final inspection.

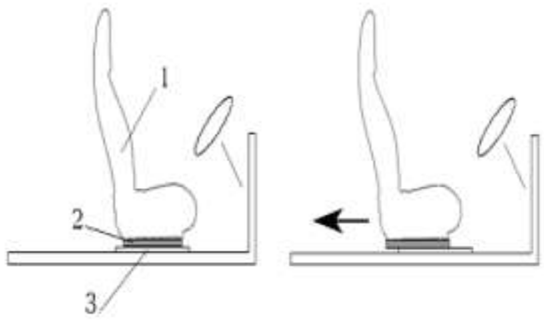


Fig 2: Seat Adjuster sideways motion

Fig 3: Seat Adjuster Isometric view

II. PROBLEM DEFINITION AND OBJECTIVE

A. Problem Statement:

To design and develop a system for

- Selection of seat adjuster model from various adjuster models
- Ball roller assembly in the selected adjuster model.

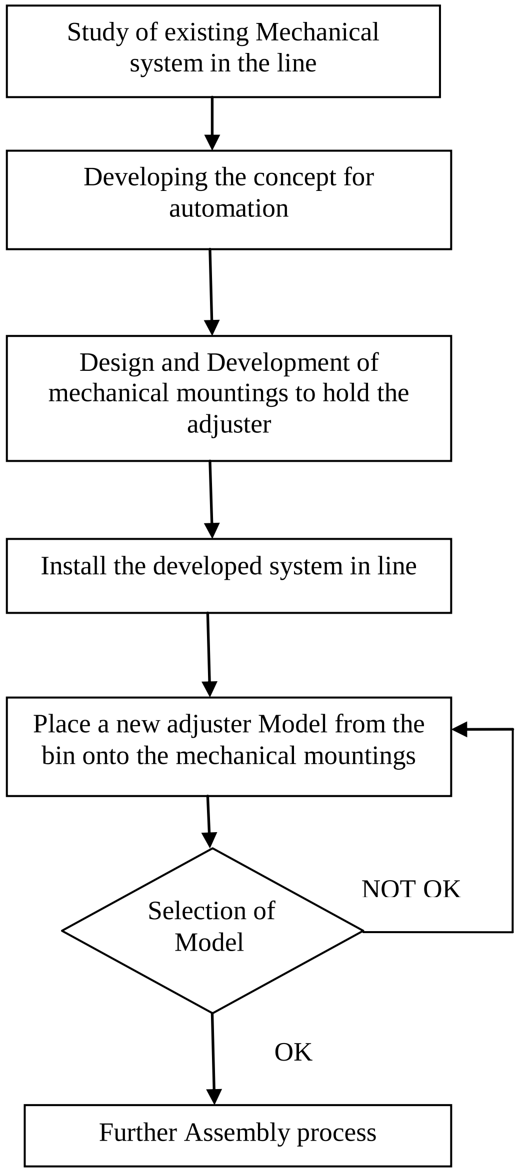
B. Need

The available mechanical system for manufacturing Seat adjuster involves time factor and operator involvement. So there is chance of adjuster components being swapped at further stages of assembly line. It is very important stage to decide the type of adjuster to undergo further assembling.

C. Objectives

The objective of the project is to increase productivity, reduce manpower by introducing an automated system for selecting the components of seat adjustment mechanism.

III. METHODOLGY



IV. AUTOMATION IN SEAT ADJUSTERPRODUCTION

Automated production lines are used to make the manufacturing cell with multiple operations. The production line itself consists of work spots within the factory/industry, which are connected by a series of workstations that refine parts from one station to another in a sequence. These consist of distributed workstations connected by a sequential system.

In automated assembly line the un-processed parts come to the production line and undergo a series of automated processing at various workstations with base parts moved from each workstation and processed/assembled as final product. This project involves Product level Automation.

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Using Proximity inductive Sensors, Reed switches Programmable logic controllers (PLC), pneumatic Actuators, and Display we need to provide the appropriate model suitable for assembling in the production line.

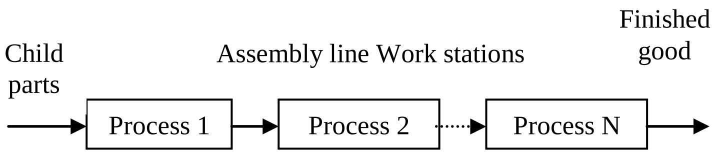

Fig 4: Basic Assembly Automation process

A. *Stages in Seat Adjuster Assembly*

1. Lever Assembly
   To move the seat a lever extension is provided at the bottom to the slider in a car. In this stage a lever is assembled to apply to and fro motion and for locking.

2. Model Checking Station
   In this stage various adjuster models come for assembly are collected and the exact channel is made to select proper model suitable for further assembling.

3. Ball roller assembly between top and bottom blocks
   At this point of assembly ball rollers are placed automatically so as to allow easy to and fro motion in seat when installed in the car

4. Force Calculation and motion checking
   The force with which a human can handle the seat pull operation is calculated in this stage and if any failure models come then it is adjusted to follow the slide with minimum force.
5. Final inspection
   Re-work for above stages is done before the product going to packaging stage.

B. *Conceptual Sensor Matrix for Model Selection*

Sensors that are very convenient to sense the Seat adjuster model according to industry environment are proximity sensors and reed switches as the product itself is a metal. For four different types of sliders there are four different sub categories in each. So there are 16 different models to be differentiated. Sensors are represented as S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12 and S13 for sensing Slider's Pin locator, Floor Mounting bracket, Side Mounting bracket, top block, bottom train, Flange, Cushion Mountings, finished products and the combination is illustrated from figure (5).

Sensors	Position in Car	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Type 1	Co-driver Left	OFF	ON	OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	ON	OFF
	Driver left	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON	ON	OFF
	Driver Right	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	ON	OFF	ON	OFF
	Co-driver Right	OFF	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF
Type 2	Co-driver Left	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	ON	OFF
	Driver left	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON	ON	ON
	Driver Right	OFF	OFF	ON	OFF	ON	OFF	ON	OFF	OFF	ON	OFF	ON	OFF
	Co-driver Right	OFF	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	ON	ON
Type 3	Co-driver Left	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	ON	OFF
	Driver left	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	ON	OFF	OFF
	Driver Right	ON	OFF	OFF	ON	ON	OFF	ON	OFF	OFF	ON	OFF	ON	OFF
	Co-driver Right	ON	OFF	OFF	ON	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF
Type 4	Co-driver Left	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	ON	OFF
	Driver left	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	ON	ON	OFF
	Driver Right	OFF	OFF	OFF	ON	ON	OFF	ON	OFF	OFF	ON	OFF	ON	OFF
	Co-driver Right	OFF	OFF	OFF	ON	ON	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF

Fig 5: Sensor ON/OFF matrix for corresponding adjuster model

TABLE 1: CONCEPT OF SELECTION OF AN ADJUSTER MODEL

Type	Driver Right hand side Seat Slider	Driver Left hand side Seat Slider	Co-driver Right hand side Seat Slider	Co-driver Left hand side Seat Slider
Type 1	Model 1	Model 2	Model 3	Model 4
Type 2	Model 5	Model 6	Model 7	Model 8
Type 3	Model 9	Model 10	Model 11	Model 12
Type 4	Model 13	Model 14	Model 15	Model 16

C. Assembly Line Considerations

In automated assembly lines the child parts are brought to the first work station to start the process. Once the part enters the line the time factor plays a key role in production and productivity. Each work station is allotted some time bound depending on type of operation to be performed. After the product finishes its assembly in first station it is transferred to the next station and then this continues until last stage of the line. So a detailed mathematical model is explained below to solve the production line issues for successful production and profits to industry. Depending on these the industries can either switch their operations so as to meet production standards and manufacturing strength. So, the ideal cycle time of the assembly line is given as

$$T_i = \text{Max}\{T_{pt}\} + T_{tt} \tag{1}$$

Where T_{pt} is the processing time for a work station, T_{tt} is the transferring time i.e.., time to shift parts from one station to another. The average production cycle time is as in (2)

$$T_{av} = T_i + NT_{LS} \tag{2}$$

Here, N is the frequency of line stop

The efficiency of the assembly line is the reliable capacity of the line time to time and is defined as ideal production cycle time to average production time as in (3)

$$E = \frac{T_i}{T_{av}} \tag{3}$$

V. RESULTS AND DISCUSSION

In order to save time and increase productivity of automotive seat sliders, a semi automated workstation is introduced in manufacturing production line which requires only a single operator. The seat sliders are mounted on the chassis of the vehicle, so it should be rigid enough to withstand breakage and bends. For particular vehicle particular design is made based on human safety and ergonomics. In manufacturing unit every design is completed using its child parts.

A system is developed using the proximity inductive sensors (metal detectors), programmable logic controller, and pneumatic cylinders to automatically detect the slider model to be given for assembling. The output is displayed using indication lamps which indicate the presence of particular model depending on sensor input. The jigs, fixtures and gauges are designed so as to hold the slider from its base plate as such in the automobile. The fixture designed is universal for 16 seat slider models and sensor mountings are common for all sliders models arriving at the workstation.

VI. CONCLUSION

The concept Model selection system is successfully developed and is processed for installation. The project is thus aimed to fulfill the loss acquired from traditional methods with semi automated assembly lines. The automotive seat slider is one of the parts of the seat. The human intervention is minimized in production phase of slider sub assembly at each station, and detected models are sent through proper channel provided in further stages of the line.

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