Design And Implementation of An Automated Machine Vice Controlled By Microcontroller

Venkatesh Mutthada[1], R. Surya Kiran[2]
[1, 2] Dept of Mechanical Engineering
[1, 2] Sanketika Vidya Parishad Engineering College

Abstract- *This project involves designing and making a pneumatic-operated automatic machine vice. It is used to automatically hold a work-piece during machining and release it once the process is done. The system is controlled by a programmed microcontroller. An IR sensor detects the presence of a work-piece and sends a signal to the microcontroller. The microcontroller then activates the pneumatic system, causing the jaws to hold the work-piece. This setup reduces the need for manual labor, improves accuracy, and saves time.*

Keywords- Pneumatics, DCV, Microcontroller, IR sensor

I. INTRODUCTION

Many manufacturing systems use the power of fluids like water, oil, and air to work. For example, powered clamps open and close using pressurized air or oil, large machines shape metal using hydraulic pressure, and air-powered tools are used to fasten parts. In all these cases, fluid power is used to create strong mechanical force.In small-scale industries, more manpower, time, energy, and maintenance are usually needed. A machine vice is a tool that holds the workpiece during machining. Normally, a worker has to manually hold, load, and unload the workpiece.

As mechatronics engineers, we designed a low-cost automation system using electronic and mechanical components. This system can automatically load, hold, and release the workpiece using timed controls, reducing the need for manual effort.

II. LITERATURE REVIEW

[1] A bench vice is a type of holding device. Machine vices are commonly mounted on grinding machines, drill presses, and milling machines. Abrasive chop saws have a special type of machine vice built into the saw. Some people use machine vices as bench vices because they are small in size and cost-effective.

[2] Dr. S.K. Patel has designed and developed a work-holding vice for drilling and milling operations. This project inspired the idea of using a machine vice not only for drilling but also for other machining processes. In large-scale production of different materials, a lot of time is often wasted on setting up the device and clamping the workpiece. Typically, a trial-and-error method is used until the axis of the hole is aligned with the drill, which consumes time and reduces accuracy. This also increases operator fatigue. A drill jig helps solve this issue by increasing productivity, as it eliminates the need for individual positioning, marking, and frequent checking. One of the key advantages of jigs is that they allow for easy interchangeability of parts.

III. EXISTED SYSTEM

A machine vice is a tool used to firmly hold metal workpieces during tasks like cutting or filing. It can often be rotated for better positioning. An engineer's vice, also known as a metalworking or machinist’s vice, is specifically designed for clamping metal, unlike woodworking vices.

These vices are usually made from cast iron, which is strong, rigid, and affordable (typically 30 ksi gray iron). Some heavy-duty vices are made from stronger materials like 55,000 psi cast steel or 65,000 psi ductile iron. Occasionally, the body may be cast iron, but the channel bar inside is made of steel for added strength.

The jaws of the vice are usually separate and replaceable, often with serrated or diamond-shaped teeth for a better grip. Soft covers made of aluminum, copper, plastic, or wood are used to protect delicate workpieces. The jaw opening is generally equal to or larger than the jaw width.

Engineer’s vices are bolted to the top of a workbench, with the fixed jaw aligned with the front edge. Some models also feature a small anvil at the back. Most vices come with a swivel base for better flexibility. However, cheaper versions, known as "homeowner grade," are often made from low-quality materials like pot metal or weak iron with less than 10 ksi strength. These often have an exposed screw.

The modified version of the machine vice includes advanced features like automatic detection of different

workpiece shapes. It does not use a flywheel to tighten the grip. Instead, it senses the object and automatically holds it in place, creating a precise and efficient working environment. After the machining process is complete, the system also automatically releases the workpiece.

This upgraded system helps eliminate manual effort and increases the speed of production, making it an effective solution for modern manufacturing needs.

Fig.1 Existing machine vice

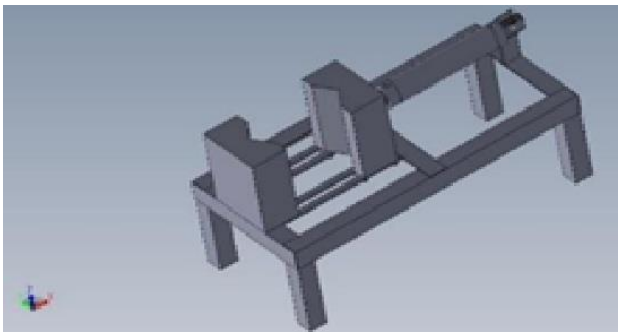

Fig.2 Modified Machine Vice

IV. COMPONENTS

Fig. 3 Compressor

Fig. 4 Pneumatics

Fig. 5 DCV (Direction Control Valve)

Fig. 6 Microcontroller

Fig. 7 Polyurethane Tube

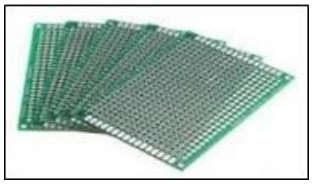

Fig. 8 PCD Band Transformer

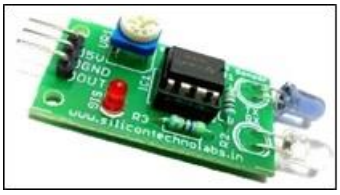

Fig. 9 IR Sensor

Model-IR-RCPL
Voltage-12

V. ASSEMBLY ARRAGEMENTS

The machine vice consists of fixed jaw and the movable jaw. The jaws are made up of mild of thickness of 100mm long and 100mm thickness, the mild steel has the flexibility to hold so strong as well as able to fix the job rigity. There is no bench here for sufficient movement arrest. Since the pneumatics is assembled behind the movable jaw. The pneumatics is connected with the DCV by the polyurethane tube of diameter 20mm. input of the electronic direction control valve is connected with compressor and the output of DCV is connected with the pneumatics. The DCV is controlled with the 8 bit microcontroller. We use the low cost and efficient PIC an 8-bit microcontroller for the invention.

What we made actually is that vice can adapt. We don't research in jigs and fixture for the holding jaws. We made a groove to hold the types of regular and irregular objects.

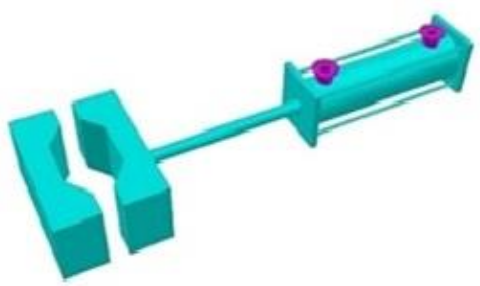

Fig. 20 Machine Assembly

VI. WORKING

The automatic machine vice works using a pneumatic system. It is controlled by a Direction Control Valve (DCV), which operates with a fixed pressure of compressed air. The machine follows a specific sequence of operations, which is controlled by a timer programmed into a PC-based microcontroller.

An IR sensor is used to detect if a workpiece is present. Once a workpiece is detected, the sensor sends a signal to the microcontroller (as shown in Figure 04). A buzzer is also included in the system—it sounds for 2 to 4 seconds to alert that the vice is about to close.

After the buzzer, the microcontroller activates the DCV, and the pneumatic cylinder starts working to hold the workpiece. This system can perform different operations such as holding, screwing, drilling, boring, and surface milling, depending on the requirement. A major advantage of using a microcontroller is that the program can be rewritten, erased, and updated at any time.

Once the operation is complete, the vice opens. The system is designed to move slowly while clamping and retract quickly after the task. The timing of each step can be changed depending on the operation. For demonstration purposes, a default timing is used.

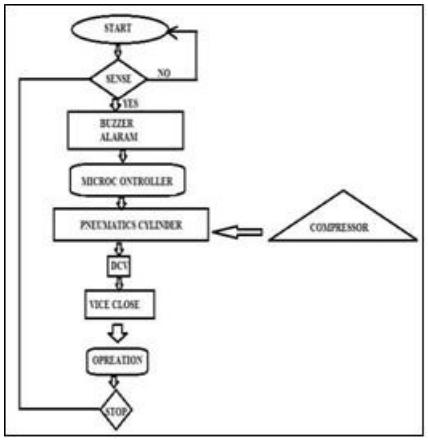

Fig. 11 Working Sequence

VII. ADVANTAGE

1. Reduced Fatigue
2. No Man Power Required
3. It can hold any type of object
4. Increased Productivity
5. Quick operation
6. Extremely high clamping force
7. Design is compact and very simple to operate
8. No need of maintenance

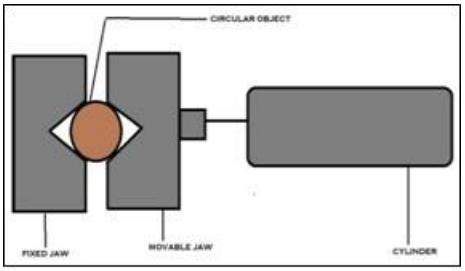

Fig 12 Holding Circular Objects

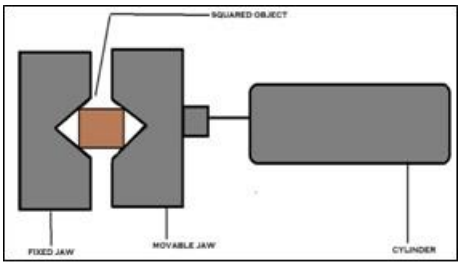

Fig. 13 Holding Square Object

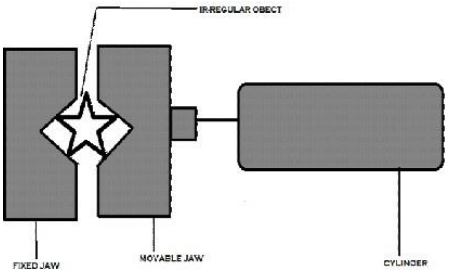

Fig. 13 Holding Irregular Objects

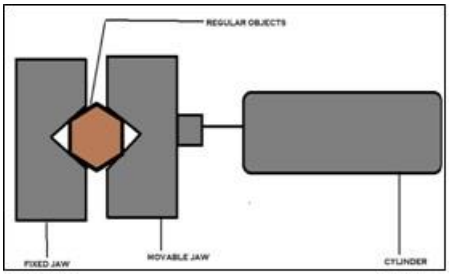

Fig. 14 Holding Regular Objects

VIII. DESIGN ASSEMBLY

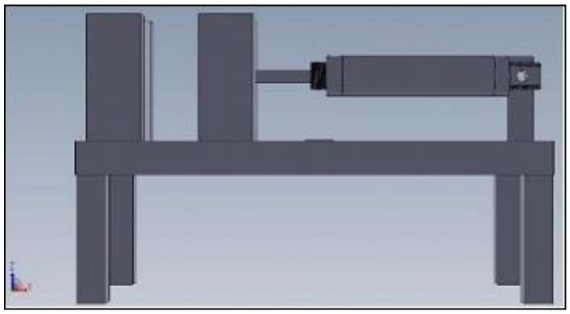

Fig. 15 Front View

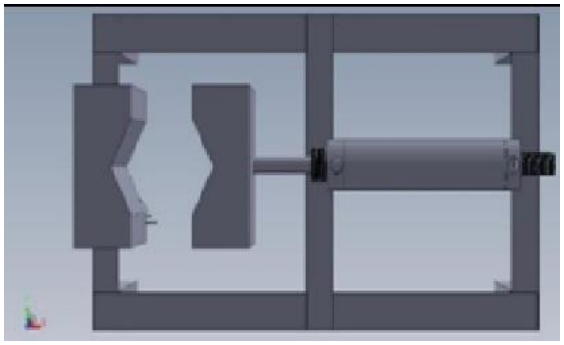

Fig. 16 Top View

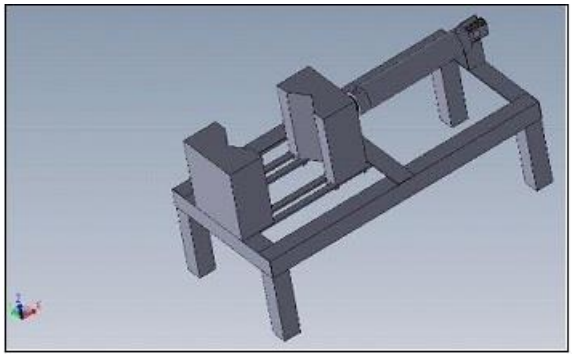

Fig. 17 Isometric View

IX. APPLICATIONS

1. To hold the job rigidly while machining
2. For quick clamping of the object
3. Used in drilling machine

X. PROTOTYPE MODEL

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