Fatigue Testing Machine Using Matlab

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Abstract- *Fatigue testing is determining the breaking point of a material by subjecting it to a continuous external force. Fatigue testers employ pneumatic pistons which make the setup inexpensive as the forces involved are also not very high. The resultant setup is portable and can be controlled by a central Arduino monitored box.*

Keywords- Arduino Uno, load cell, proximity sensor, Solenoid valve, power supply, relay module, fatigue, stress

I. INTRODUCTION

Fatigue is deterioration of an object after being subjected to repeated stress that eventually causes deformation in the structure and integrity of the object. It is a result of localized hitting in an industrial setting that employs a body subjected to continuous stress. After reaching a certain limit the body is permanently damaged. For this reason, it is crucial to determine this limit. Fatigue testing is the computation of this limit.Many existing fatigue testing methods involve a larger apparatus affixed to a mount. This setup is bulkier and stationary. It is also not easy to modify the testing apparatus.
In order to overcome this limitation, the current setup uses a pneumatic piston that is connected to a compact metal base which can bemoved according to the application. The piston is controlled by a solenoid valve that is in turn latched into on and off states at varying frequencies by a relay. The relay is latched at the set number of cycles as specified by the operator. This latching in turn drives the pneumatic piston that collides with the test object until end of life occurs in the form of either deformation or development of a crack.

An analysis of the readings obtained by subjecting the specimen to stress conditions can be used to perform cumulative damage analysis. Cumulative damage analysis is used for damage analysis by an estimation of mean stresses, and the physical and material fatigue data obtained in the laboratory conditions.

II. DESIGN OBJECTIVES

The aim is to construct a testing machine capable of testing the fatigue life of multiple specimens ranging from glass type composition to fiber type composition. The machine will record the number of cycles necessary for reaching the end life of the specimen.

III. METHODOLOGY

The testing machine has a rotating type cylinder mounted on a metal platform. It is connected to an electromechanically operated solenoid valve. A two-port solenoid valve is used to control the motion of the rotating cylinder. The solenoid valve is actuated using a relay module. The coil of a relay passes a relatively large current typically 30mA for a 12V relay but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay.

The programming and operation of the machine is carried out inside a MATLAB instance by an Arduino support package. The operator specifies the frequency of the machine on the user end. The relay latches according to the frequency and sets the cylinder into motion to strike the specimen. A load cell, SL 100, and an inductive proximity sensor are used for recording the displacement and deformation in the specimen.

The load cell uses the HX711 weight sensor amplifier to measure the weight of the specimen. The amplifier uses a two-wire interface which is attached to the Wheatstone configuration of the load cell. The SL 100 load cell is able to sustain excitation voltages upto 8V, which is provided via an adapter. The mechanical assembly uses an inductive proximity sensor for noting the displacement as the test specimen is subjected to compression and tension cycles.

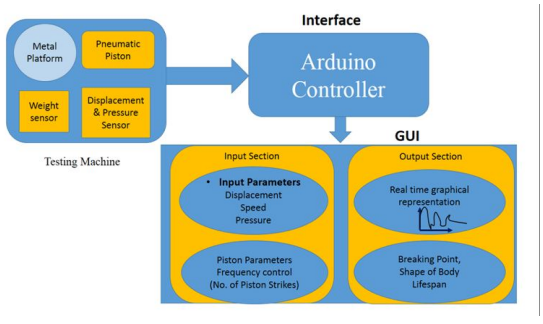

Fig: Block diagram of the system.

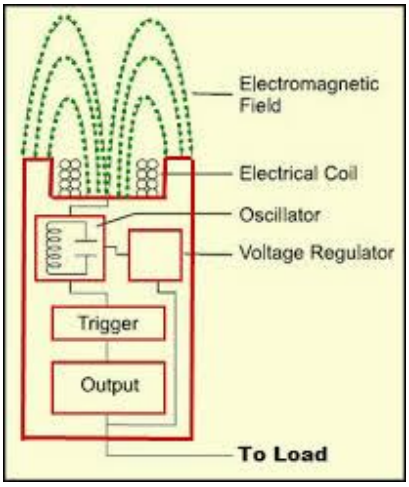

Fig: Proximity sensor working

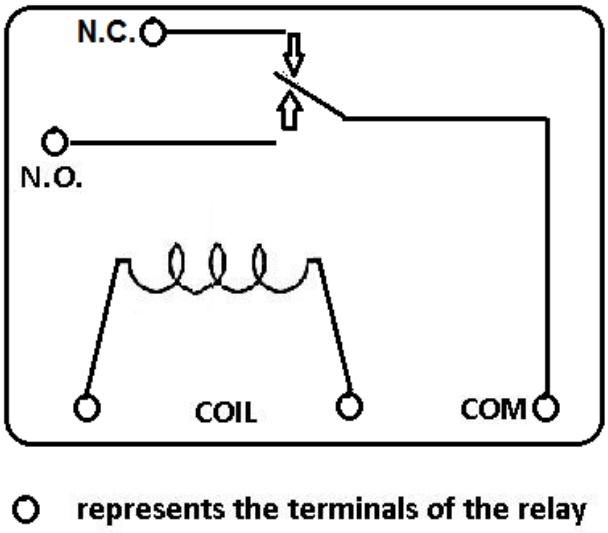

Fig: Relay Circuit SPDT

Arduino

The microcontroller that has been used for this project is from the Arduino series. It uses the ATmega328P processor. It has a combination of digital and analog pins driven by a 16 MHz clock. The programming is done in an environment inside a MATLAB instance by using an Arduino support package.

The board has different communication methods when connected to a computer. ATmega328P provides UART TTL serial communication via Tx and Rx pins of the board.

Voltage signal from Arduino	Transistor Q1	Transistor Q2	Relay
1	ON	OFF	OFF
0	OFF	ON	ON

Fig: Relay circuit operation table

CORE FEATURES:

- Flash memory 32 KB
- SRAM 2 KB
- DC Current per I/O Pin: 20 mA
  DC Current for 3.3V Pin: 50 mA
- Operating frequency: 16 MHz

I/O pins of Arduino:.

Register	Description
Serial	Receive and transmit TTL serial data.
PWM	Provide 8 bit PWM output to the analogWrite() function
Analog and digital	Analog pins are used to measure voltages upto 5 V with 10-bit resolution. Digital pins are similar in function.
SPI	These pins support Serial Peripheral Interface using the SPI library.

ADVANTAGES:

- Economical.
- Can be modified according to the user's required components.
- Works for various types of test objects.

DISADVANTAGES:

- The piston movement is currently along a fixed axis and one way.
- Pneumatic pistons are not useful for higher forces.

APPLICATIONS:

- Industrial product testing and quality assurance.
- Portable stress testing.

IV. CONCLUSION

The machine is suitable for the evaluation of fatigue life in plane bending for the all varieties of composite

materials such as glass fiber and other metallic materials. The fatigue life can be predicted based on the plotting of S-N curves from the data obtained from experimental results. The loading and the unloading of the workpiece is quick and safe. The machine stops automatically when the workpiece breaks into two pieces after complete fracture. The duration of the fatigue testing machine is comparable to the conventional rotating bending machine. The testing is carried out for randomly oriented glass fiber material and the plot of S-N curve is presented**.**

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