International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Universal Testing Machine Motion Control System

Sagar S Patel [1], Gayathri K M[2]

[1, 2]School of Engineering, Jain University, Bangalore, India

Abstract: ***Universal testing machine is a kind of basic experimental equipment which can test many mechanical properties of materials such as its stress and strain it is named after the fact that it can perform many standard tensile and compression test on materials, components and structures[1]. All the traditional machine use hydraulic systems which do not have real time control over the loading process for example if the required load to be applied on the specimen is consider 100kg ,then the user only should stop the machine manually and there is no guaranty that the machine stops at 100kg so if the applied load exceeds maximum rated capacity of specimen then the specimen will be damaged. In order to over come this disadvantage of the traditional systems this project aims to achieve real time control over loading process and monitoring the applied load using LabVIEW so that the applied load on the specimen does not exceed the maximum rated capacity. Hence there is a need to improve the control of motion of universal testing machine.***

Keywords: LabVIEW, Stress, Strain, Load Cell

1. Introduction

After manufacturing a sensor the important step is to test the sensor the common method of testing a sensor is to compare with a master sensor .If both the readings from master sensor and specimen sensor is same at all range of operating value then the specimen which is manufactured is said to have good accuracy if there is any variation in the readings of master and specimen is there then the specimen is having some fault

Hence in this project a testing machine which can operate from 0-4 Ton of load is automated which has a master load cell and a space to place a specimen load cell. The data from both the sensors are acquired in real time and plotted in the graph and also in excel sheet for further reference. The majority of early automated testing machines use hydraulic systems which is very costly and which will not give a good accuracy for lower loads and compromising the oil leakage ratio is a complex task so these systems have low testing accuracy ,inconvenience of recording data. The main drawback of the hydraulic systems is the maintenance cost, time, lack of timely data processing and to certain degree limits the use and development of the testing machine.

The existing universal testing machines use hydraulic systems which use hydraulic fluids which are oil based, hydraulic systems can pose a fire hazard when they leak .These leaks can also pose a safety hazard because hydraulic Systems are under high pressure, and fluids can shoot out at a high velocity, potentially harming those nearby the leak.

2. Block Diagram

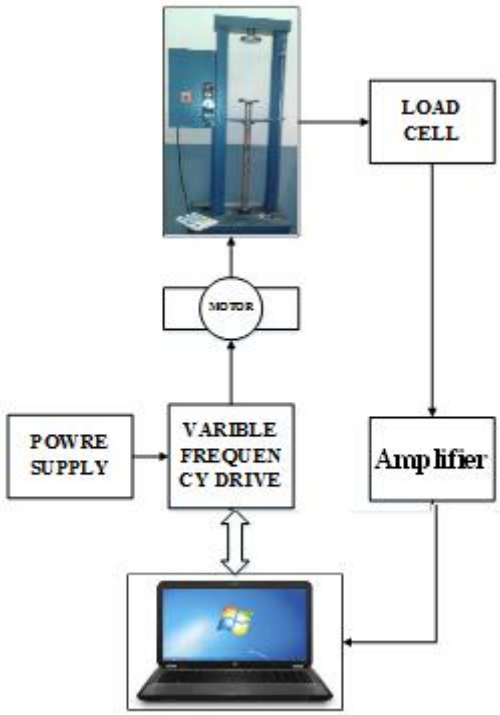

Figure 1: Basic Block Diagram

The rotational movement of induction motor is converted into linear motion by gear box. Upper grip of machine is fixed and the lower grip is connected to the motor through gear box by the movement of lower grip we are going to apply force in between these columns ,this force is applied on the specimen and Load cell which are kept one over the other in-between upper and lower grips will expexience force on them, this force being applied is measured by the Load cell and acquired by data acquisition device through LabVIEW. The control signals like loading rate, start and stop is passed to variable frequency drive through RS458. The measurement and control system is divided into two parts: The data acquisition system by USB6008 and the monitoring system based on the LabVIEW. The measured parameter such as load by the sensor is acquired through data acquisition device and is transferred to computer.

The feedback for control is also sent to the drive through RS485.the Load information is continuously monitored in

LabVIEW and if there is no increment in Load is there the output torque of the Motor should is increased.

3. The Design Of Data Acquisition System And Implementation Of Step Size

The universal testing machine motion control system uses the computer control system which is a combination of software and hardware control system, which has a flexible structure in itself. Compared with the traditional systems which use hydraulic systems we use an electromechanical system which provides a high accuracy for measuring even lower loads as two kg. The measured parameter such as load by the sensor is acquired through data acquisition device and is transferred to computer.

The feedback for control is also sent to the drive through data acquisition device. The rotational movement of induction motor is converted into linear motion by gear box. Upper grip of machine is fixed and the lower grip is connected to the motor through gear box by the movement of lower grip we are going to apply force in between these columns,this force is applied on the specimen and Load cell which are kept one over the other in-between upper and lower grips will experience force on them, this force being applied is measured by the Load cell and acquired by data acquisition device through LabVIEW. The control signals like loading rate, start and stop is passed to variable frequency drive through RS458.

The control signals like loading rate, start and stop is passed to variable frequency drive through RS458.The values of output voltage, output current and D.C bus voltages are continuously acquired through RS-485.The values of these parameters are stored in Holding register of Drive. The start, stop, frequency, forward and reverse commends are passed to Drive by writing to specific Holding registers present in drive. The rotational movement of induction motor is converted into linear motion by gear box. Upper grip of machine is fixed and the lower grip is connected to the motor through gear box by the movement of lower grip we are going to apply force in between these columns, this force is applied on the specimen and Load cell which are kept one over the other in-between upper and lower grips will experience force on them, this force being applied is measured by the Load cell and acquired by data acquisition device through LabVIEW. ASCII code is used with the Board rate of 9600 bits per second.

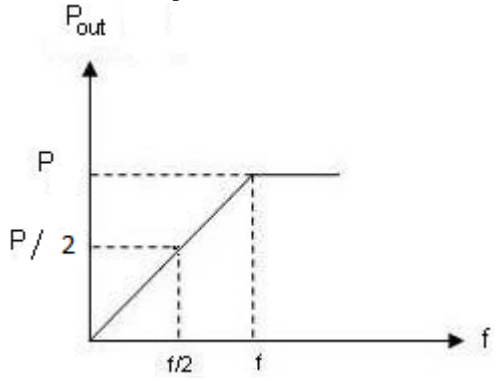

Figure 2: Power and Frequency Relation of VFD drive

The initial frequency of the supply to motor is set to 5Hz .If the Load is not increased by 0.5 Kg in next iteration then the frequency of the supply to motor is increased through RS485 communication in the LabVIEW. The frequency of the supply voltage to motor and power output of motor is Linearly related . At frequency of 50Hz the Motor can output torque which is 180 Watt. The power output by the motor is maintained as minimum as possible to achieve full control over Loading process and to avoid over shooting. Hence when the motor stops due to maximum load applied exceeds the power to the motor the frequency of supply voltage is increased by 0.5.This avoids both over shooting of the Load than the required load .

4. Results

4.1 TEST Result of Stopping Machine When required Load is Reached

The Fig.3. is the test result obtained in LabVIEW .The control Required Load shown in front panel is the Load to be applied in continuous run till 100Kg and to stop further Loading .The front panel contains mainly start, stop, load and unload buttons . The output frequency from variable frequency drive is shown in the indicator. The output current to the motor is compared to the maximum current rating of motor .The motor movement is stopped if the current flow more than the max rated current of motor exceeds.

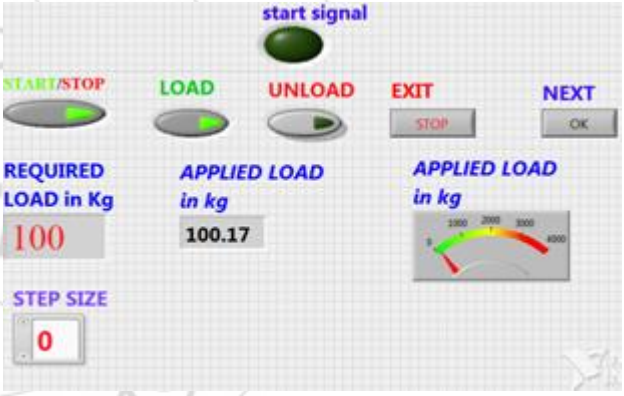

Figure 3: Test Result of Stopping Machine When required Load is Reached

4.2 Test Result of Implementing Step Size

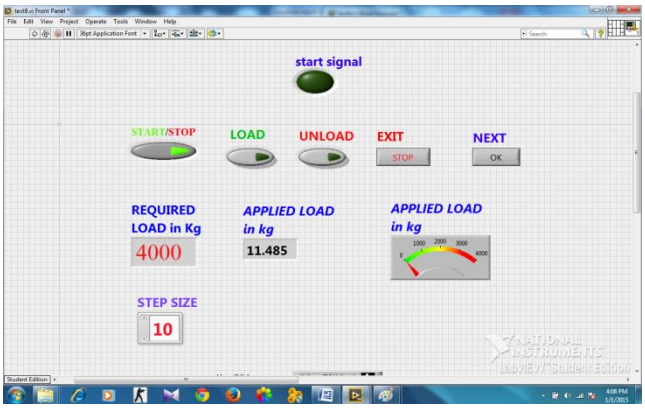

Figure 4: Test Result Of Implementing Step Size

Step size in loading rate is easily achieved since the induction motor with low R.P.M and also gear box which

still reduce the speed is installed. The Fig.4 is the test result of implementing step size .The control Step size which is present in the front panel is used by the user to enter the step size. Consider if a step size of 10Kg is entered here then the Machine will stop for every 10Kg and proceed to next step only when the user press NEXT button in the front panel. This is the main advantage of this project since all the traditional machines use hydraulic machines which cannot be stopped immediately, since we use induction motor and feed back from the load cell to control the loading rate the machine will stop immediately when required load is reached. The Loading rate is kept as low as possible by using the feed back from load cell in LabVIEW.

5.3 TEST Result Master Load cell and Specimen Load cell

The Fig 5.3is the test result of Master Load cell and Specimen Load cell. This option is very useful when the manufacturers of load cell want to test the output of manufactured Load cell against a Master load cell. The Fig 5.3a shows the output of Master load cell and Fig.5.3 b shows the output of Specimen load cell for same Load as masters. The test can be conducted as continuous run from 0 to 4000Kg or by including step size of desired value. The X-axis represents the time where as Y-axis represent the Load being applied on both the Master and specimen Load cell at that time. Easily by seeing the graph Linearity of Load cells can be found out and also conclusion can be drawn weather the Specimen Load cell is giving proper output or not by comparing its graph with Master Load cell graph.

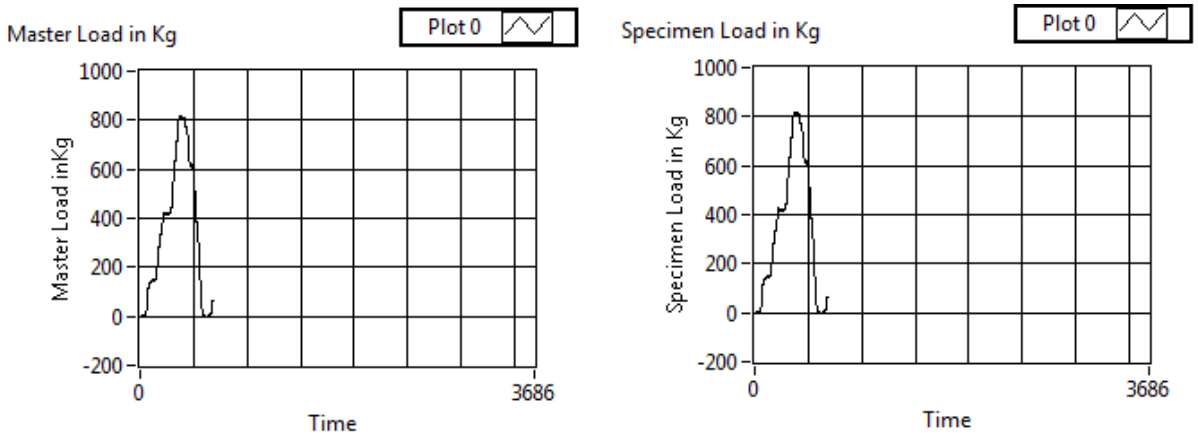

Figure 5: Test Result Master Load cell and Specimen Load cell

4.4 Test Result Master Load cell and Specimen Load cell

D4

	A	B
1	Master	Specimen
2	2.258	1.957
3	0.976	0.764
4	0.994	1.875
5	3.519	3.801
6	9.837	9.354
7	13.211	12.903
8	19.738	18.645
9	27.346	27.964
10	37.209	37.984
11	39.271	38.463
12	43.545	43.238
13	50.444	49.468

Figure 6: Load VS Load Values of Master And Specimen Load Cells in Kg

5. Conclusion

- The universal testing machine motion control system designed by using induction motor will give a good accuracy for lower loads and also meet all requirement of user.
- Since all care is taken about the safety operations the system provides more safety for testing process
- Since the load cells are very sensitive, if there is any load which is greater than the maximum capacity of load cell is applied then the load cell will be damaged so that every precaution is taken not to overload the specimen load cell than the maximum rated capacity. Use an electro mechanical system instead of hydraulic machine to achieve high accuracy with low cost .The project also achieve solving problems in using dial by humans to avoid error between the data shown during the experiment and actual data by real time data storage in Excel sheet and also storage of graphs for further reference.

The proposed system gives a high accurate automation of universal testing machine with low cost compared to earlier systems.

References

[1] Luo. Jun , Xing.Lan-Xing , Zhou.Yan , and Xie. Shao-Rong , "A control system for experimental platform of micro aerial vehicle based on C8051F020", Guangxue Jingmi Gongcheng/Optics and Precision Engineering, , v 15, n 5, p 713-718, May 2007.

[2] Higa. Melanie L. , Tawy. Dalia M. , and Lord. Susan M , "An introduction to LabVIEW exercise for an electronics class" , Proceedings - Frontiers in Education Conference , v 1 , p T1D/13- T1D/16 , 2002.

[3] Hu, Wenqing Yin, Cairong Chen, " Design of the tensile testing machine computer control system based on MCGS" ,2010 International Conference on Challenges in Environmental Science and Computer Engineering.

[4] Zhao Shushang, Liu Bin, Ren Yan,"The Design of Measurement and Control System to WJ-10 Universal

Tension and", 2010 International Conference on Measuring Technology and Mechatronics Automation

[5] Turley. Russ, and Wright. Matthew , "Developing engine test software in LabVIEW", AUTOTESTCON (Proceedings), p 575-579 , 1997 , IEEE Systems Readiness Technology Conference..

[6] Navaee. Shahnam, "Computing and programming with LabVIEW", ASEE Annual Conference Proceedings, p 2211-2225, 2004, ASEE 2004 Annual Conference and Exposition , "Engineering Education Researchs New Heights".

[7] Aw.K.C. , Xie.S.Q. , and Bennett.Hamish , "Development of a abVIEW-based pseudo real-time shaker controller", International Journal of Automation and Control, v 2, n 4, p 526-537, 2008.