SOFTWARE FOR AUTOMATIC CONTROL OF HYDRAULIC PRESS

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Abstract

In this study, a software is written to control via and transfer to computer of all functions (stop/start of main engine, up and down of the ram, start and stop the process based on a computer described reference stroke and power values) which will transfer required test parameters (power/stroke diagram) and will control the hardware circuits on a computer of a manually controlled forging press.

There were four buttons on the forging press used in this study. Two of them were controlling the start and stop the main engine, and the other to were controlling the up and down movement of the ram. For making the system as computer controlled, another two-position switch has been added to the control panel and therefore, computer controlling choice became available.

For picking up the pressure power applied by the forging pres, a sensor which transfers pressure to current added to hydraulic pump exit. This current information exchanged to resistance and relayed to the analogue input of the I/O card of computer. Hence, the resistance value can be read by software and the pressure information applied by the forging press obtained. To pick up the information about the positioning of the ram, an encoder was mounted which will transmit signals according to the movement of the ram, so, a movement information relative to pulses from encoder transmitted to the software as an input via I/O card. To control the star / triangle circuit and to open or close the solenoid valves which control the movement of the ram a relay control card has been designed. Therefore, by using the objects taken place on the main menu of the software that control the relay card, the forging press functions controlled.

***Keywords**: Hydraulic Press, Software, Hardware, Stroke Control*

Introduction

Usually, there are two buttons on manual forging press' that stops and starts the hydraulic engine. To use the forging press, first the main engine started. Then, by using the buttons controlling up and down movement of the ram, the position of the ram is arranged proper to the experiment material. Pressure value of the hydraulic press given to the piston which moves the ram is read over a manometer.

During the experiment, the related button is pressed; this carries the risks of part breakings or detaches some parts from the material. Additionally, to draw a stroke-power diagram, measuring the experiment parameters indirectly creates some difficulties. In this study, the control of all processes transferred to computer. Moreover, by means of software, the maximum values of stroke – power limited and the experiment performed securely. Another advantage of this study is, to register in a different file of all experiment parameters for each experiment and automatically drawing of the stroke-power diagrams by computer [1] [2].

Material and Method

In this study, a manual forging press capable to apply a pressure of 150 tones, modified to be controlled by software. The software that is controlling all the functions of the forging press was written in Visual Basic Programming Language. [3] The main form of the software is shown on the figure 1. The software, The software was run on a Pentium 150Mhz, 64 Mbyte RAM and operation system Windows 98.

In this forging press, there is an electrically operated and 300 bars pressure providing oil pump. The up and down movement of the ram controlled by 2 each of button operated 220 V 50 Hz solenoid valves. Therefore there are four buttons on this modernized forging press which two of the buttons start and stop while the other two control the ram movement. With this study by mounting a two-positioned switch on the control panel new functions added to the forging press.

When the switch positioned to "manual" it is possible to control the forging press with the buttons. When it is positioned to "Automatic" all controls transferred to computer. Additionally to provide the connection of the forging press with the computer, two each of 9 pinned computer connector mounted to the control panel. Connector one, makes possible to communicate with the relay control card and the circuits controlling start / stop and up & down movements. On the other hand, Connector two, transmits the pressure information received from pressure-resistance transducer and position information received from rotation encoder to the I/O card of the computer. Since the interface of the pressure cylinder is constant and the pressure and power relative to each other, it is possible to measure the pressure at the pump exit to measure the power of the forging

press [4]. For processing this measured pressure value, a pressure-current transformation is used which is capable to transform 0-400 bars to 4-20 mA.

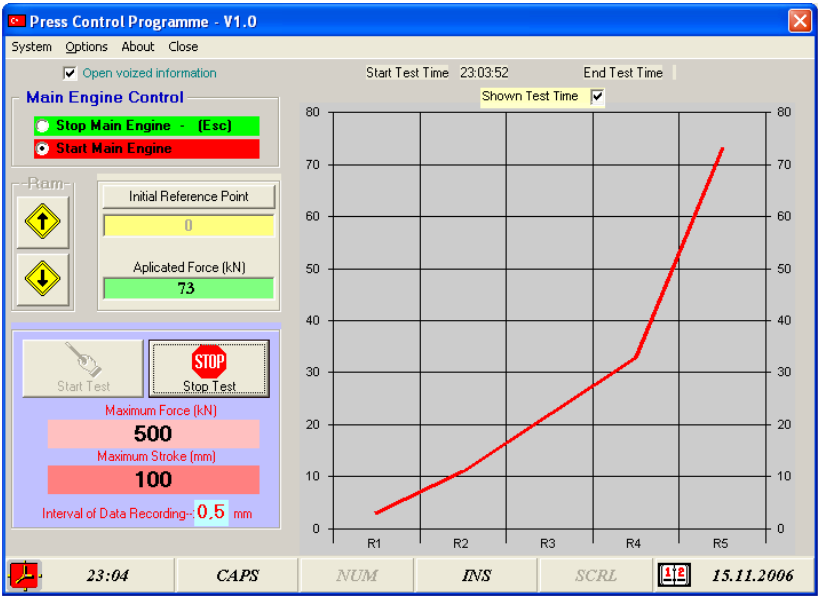

Figure 1. Main form of the Software

In this sensor the pressure between 0-400 bars is transformed to 4-20 mA. To transmit this pressure / power information to the computer, an AIO-3310 I/O card is plugged to PCI slot of the computer as shown figure 2. To transmit the 4-20 mA exit signal produced by the transducer to analogue input, it is transformed to 0-10 Volt. Therefore, pressure information as read by the computer using this card's address, with timer component and with the assistance of a software rooting shown below.

```
Private Sub TimerKuvetOku_Timer()
Dim Status3: Dim Temp3 As Single
Dim buf3 As Integer
 Status3 = aio3310_smart_AtoD(2, 7, 2, Temp3)
If Status3 <> 0 Then
MsgBox "Aio3310 Error Card! (Error no:" + Str(Status) + ")"
'aio3310_close
 End
End If
 buf3 = Temp3 * 100:  TxtYuk.Text = Int((buf3 / 100 - 2.54) * 20.08032 * 9.81)
End Sub
```

The amount of movement of the ram is read through rotation encoder. In a reel system, the diameter was set as 2 pulses would be obtained at the encoder exit for each 1 mm movement of the ram. There pulse information is transmitted to encoder reading card which is plugs to ISA slot of the computer as shown at figure 4, and then, this data is transferred to a two-dimentional serial with the assistance of the routine given down below of the software

```
Private Sub TxtStrokReferansi_Change()
If CmdDeneyStart.Enabled = False Then
   If Val(TxtStrokReferansi) >= Strok_Kontrol_Deger Then
     'aio3310_set_point 2, 0, 6, 0 'aşağı valfını kapat
      XY(Data_adedi, 1) = TxtStrokReferansi 'enoderi oku ve aktar
      XY(Data_adedi, 2) = Val(TxtYuk.Text) 'kuvveti oku ve aktar
      Data_adedi = Data_adedi + 1
      CmdDeneyStop_Click
      MsgBox "Verilen Maksimum STROK Dikkate Alınarak Deney
Tamamlanmıştır...",
      vbInformation, "Deney Sonu..."
   End If
 End If
End Sub
```

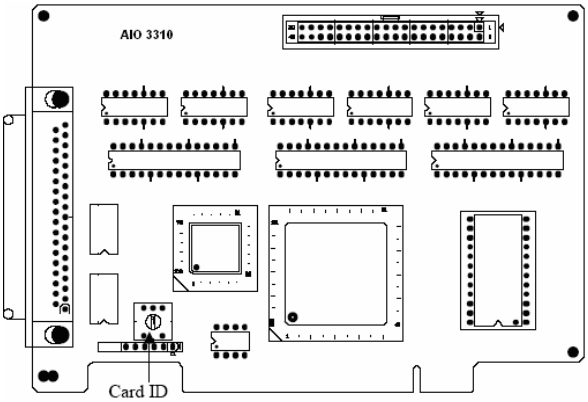

Figure 2. AIO-3310 Analog/Digital I/O card.

Encoder and card linked to each other as shown at figure 6 [5]. Hence the position information is relayed to the software via this card.

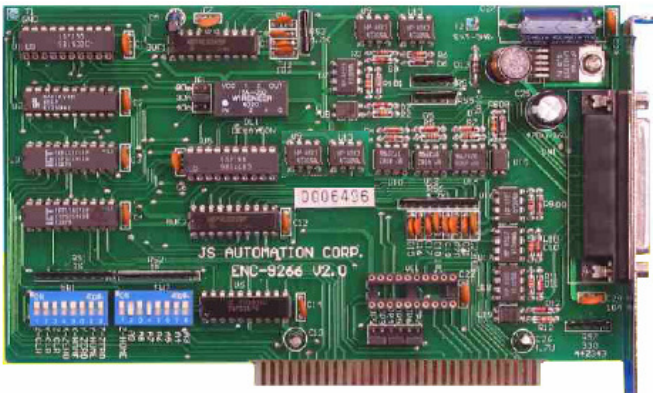

Figure 3. View of the card which is reading encoder values

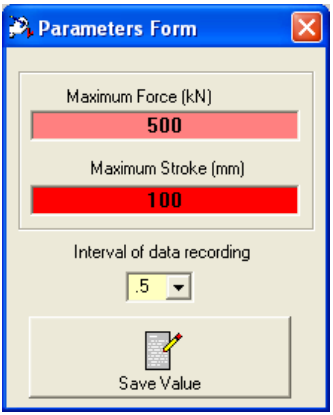

Figure 4. View of the Parameter form

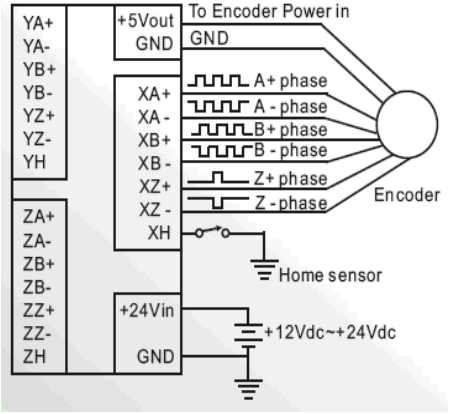

Figure 5. Principal Schema of Encoder Link

When the software is run, a form that is shown at figure one is displayed. “Manuel-Auto” switch which is on the control panel is positioned as auto and by clicking “start main engine” button at the main from, the main engine is taken to ready position at a star link then after 4 seconds started by shifting to triangle link.

To stop the forging press, “Stop Main Engine” button is clicked or “Esc” is pressed on the keyboard. For the test sample placement, up and down arrows on the keyboard pressed and ram is positioned.

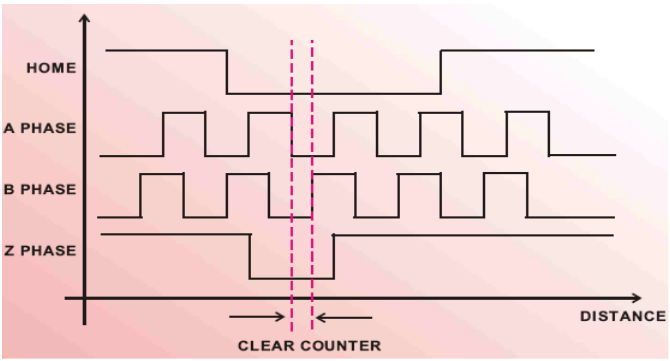

Figure 6. Ossilogram of Encoder Outputs

Table 1 Encoder Reading Card Addresses

I/O address	R/W	Status
I/O BASE ADDRESS+0	READ	Read OL
	WRITE	Write PR
I/O BASE ADDRESS+1	READ	Read SR
	WRITE	(Write to control registers) MCR (DATA MUST BE 00XXXXXX) ICR (DATA MUST BE 0100XXXX) OCR (DATA MUST BE 10XXXXXX) QR (DATA MUST BE 111111XX)

On the form shown at Figure 1 at by clicking “Options” menu then “Calibration data”, another form which is shown at figure 4 is displayed. With this form, maximum power, maximum stroke and the recording intervals are given and by clicking “Save Value” we return back to the main form. To start the experiment, click “Start Test” button, then wait for the automatically finishing up. With the starting of test, the movement of the ram by moments and the pressure applied to the sample is displayed and recorded to disk area to be used for the graphics. Ossilogram of Encoder Outputs is shown at figure 7 and Encoder Reading Card Addresses is shown at Table 1.

When the measure is reached to any value given in figure 4, in other words, the pressure power exceeds the given value or when the sample is pressed more than the given value, the test is stopped automatically and the test data is plotted to the graphic taken place on the form 1. To manually stop the test, press “Stop Test” button. Immediately after stopping the test

the data s recorded to disc and from there, by means of the routine given down below plotted to the graph.

```
Public Sub VerileriOku()
Dim D_adi As String
Dim D_adi2 As String
Dim Deney_Tarihi
Dim X As Single
Dim Y As Single
Dim i As Integer
   ' Dosyyı aç
D_adi = App.Path
If Right$(D_adi, 1) <> "\" Then
D_adi = D_adi & "\"
D_adi = D_adi & "Veriler.dat"
D_adi2 = App.Path
If Right$(D_adi2, 1) <> "\" Then
D_adi2 = D_adi2 & "\"
D_adi2 = D_adi2 & "KayAdedi.dat"
Open D_adi For Input As #1
Open D_adi2 For Input As #2
Input #2, Data_adedi, Deney_Tarihi
Close #2
ReDim XY(1 To Data_adedi, 1 To 2)
' dosyadan oku ve diziye aktar
 FrmAna.MSChart1.chartType = 3
  FrmAna.MSChart1.ColumnCount = 1
FrmAna.MSChart1.RowCount = Data_adedi
FrmAna.MSChart1.TitleText = Deney_Tarihi
For i = 1 To Data_adedi
   Input #1, X, Y
   XY(i, 1) = X
   XY(i, 2) = Y
   FrmAna.MSChart1.Row = i
   FrmAna.MSChart1.RowLabel = X
   FrmAna.MSChart1.data = Y
Next i
Close #1
End Sub
```

By double clicking the graphic taken place on the form given at Figure 1, it is displayed full screen to see the details. By using the form opened (look at Figure 8) this graphic is copied to clipboard or saved as Excel format

Figure 7. The view of computer controlled forging press

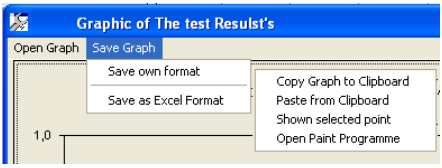

Figure 8. The form graphically displays the results.

Conclusion

One of the problems encountered in the experiments was the pulses produced by encoder could not be read clearly by the computer. For the solution, by using the operating system of the computer, a real time precedence given to the software controlling the hardware (That is, fro task manager, a real time precedence assigned to the related application). Additionally, since the electricity installation of the forging press was not earthed well, there were static disturbances which affect the software negatively. For this, a well earthling was performed, an L-C filter added on and the static disturbances reduced to minimum by data cable monitoring.

Since the precision of the analogue I/O card is 6mV, the analogue value difference at the pressure transducer should be 0,5 kN to make readable of the forging press' pressure value for the software. That means, between 0-1500kN intervals, the operative precision is at least 50 kg. Since the transducer used in this experiment designed for 0 – 400 bar interval, for more precise experiments, it should be replaced with different pressure transducers.

With this study applied on an existing hydraulic forging press, all functions are controlled by buttons, controlled by a computer precisely. Additionally, the power and stroke values during the experiment transferred to computer environment. Another important property given to the forging press is, safety limits. When the power or the stroke limit values reached, the forging press is stopped automatically.

Reference

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