<table>
<thead>
<tr>
<th>Figure</th>
<th>Caption</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1.1</td>
<td>A computer controlled system for vibration testing</td>
<td>2</td>
</tr>
<tr>
<td>Figure 1.2</td>
<td>A sinusoid signal period estimation</td>
<td>5</td>
</tr>
<tr>
<td>Figure 1.3</td>
<td>Typical sine sweep waveform</td>
<td>6</td>
</tr>
<tr>
<td>Figure 1.4</td>
<td>Snap of sine sweep waveform as presented by oscilloscope</td>
<td>6</td>
</tr>
<tr>
<td>Figure 1.5</td>
<td>Research outline</td>
<td>8</td>
</tr>
<tr>
<td>Figure 2.1</td>
<td>Frequency varying damp sine waveform</td>
<td>18</td>
</tr>
<tr>
<td>Figure 3.1</td>
<td>Components of a closed loop feedback control system</td>
<td>29</td>
</tr>
<tr>
<td>Figure 3.2</td>
<td>A PID control loop</td>
<td>30</td>
</tr>
<tr>
<td>Figure 3.3</td>
<td>Branches of computational intelligence</td>
<td>41</td>
</tr>
<tr>
<td>Figure 3.4</td>
<td>Basic sets for obtaining an IC system</td>
<td>42</td>
</tr>
<tr>
<td>Figure 4.1</td>
<td>General structure of FLC implementation</td>
<td>58</td>
</tr>
<tr>
<td>Figure 4.2</td>
<td>Various modules of FLC implementation</td>
<td>58</td>
</tr>
<tr>
<td>Figure 4.3</td>
<td>Triangular membership functions</td>
<td>60</td>
</tr>
<tr>
<td>Figure 4.4</td>
<td>I/P membership functions</td>
<td>65</td>
</tr>
<tr>
<td>Figure 4.5</td>
<td>O/P membership functions</td>
<td>65</td>
</tr>
<tr>
<td>Figure 4.6</td>
<td>Control surface of the developed FLC</td>
<td>72</td>
</tr>
<tr>
<td>Figure 5.1</td>
<td>Unity amplitude sine sweep waveform</td>
<td>75</td>
</tr>
<tr>
<td>Figure 5.2</td>
<td>Auto-correlation output of signal shown in Figure 5.1</td>
<td>76</td>
</tr>
<tr>
<td>Figure 5.3</td>
<td>Exponentially decaying sine sweep waveform</td>
<td>76</td>
</tr>
<tr>
<td>Figure 5.4</td>
<td>Exponentially growing sine sweep waveform</td>
<td>76</td>
</tr>
<tr>
<td>Figure 5.5</td>
<td>Constant amplitude sine sweep waveform</td>
<td>77</td>
</tr>
<tr>
<td>Figure 5.6</td>
<td>Multi-tone waveform ((\sin t + \sin 2t))</td>
<td>77</td>
</tr>
<tr>
<td>Figure 5.7</td>
<td>Sine waveform</td>
<td>77</td>
</tr>
<tr>
<td>Figure 5.8</td>
<td>Triangular waveform</td>
<td>78</td>
</tr>
<tr>
<td>Figure 5.9</td>
<td>Saw tooth waveform</td>
<td>78</td>
</tr>
<tr>
<td>Figure 5.10</td>
<td>Square waveform</td>
<td>78</td>
</tr>
<tr>
<td>Figure 5.11</td>
<td>Probability density distribution for time period</td>
<td>80</td>
</tr>
<tr>
<td>Figure 5.12</td>
<td>Probability density distribution for auto-correlation peak</td>
<td>80</td>
</tr>
<tr>
<td>Figure 5.13</td>
<td>Flowchart for the time period determination and trigger generation</td>
<td>82</td>
</tr>
<tr>
<td>Figure 5.14</td>
<td>Block diagram of vibration waveform acquisition and presentation</td>
<td>82</td>
</tr>
<tr>
<td>Figure 5.15</td>
<td>Front panel of the developed VI</td>
<td>83</td>
</tr>
<tr>
<td>Figure 5.16</td>
<td>Auto-correlation output for the acquired sine sweep waveform</td>
<td>83</td>
</tr>
<tr>
<td>Figure 5.17</td>
<td>Experimental block diagram for DSO triggering</td>
<td>83</td>
</tr>
<tr>
<td>Figure 5.18</td>
<td>DSO screen shot showing trigger pulse and stable display</td>
<td>84</td>
</tr>
<tr>
<td>Figure 6.1</td>
<td>Schematic of normalized correlation computations</td>
<td>87</td>
</tr>
<tr>
<td>Figure 6.2</td>
<td>Block diagram for correlation based real time DSO triggering</td>
<td>88</td>
</tr>
<tr>
<td>Figure 6.3</td>
<td>Test signal</td>
<td>88</td>
</tr>
<tr>
<td>Figure 6.4</td>
<td>Correlation output vs. sample delay count for test waveform</td>
<td>89</td>
</tr>
<tr>
<td>Figure 6.5</td>
<td>Constant amplitude sine sweep waveform</td>
<td>90</td>
</tr>
</tbody>
</table>
Figure 6.6 Exponentially decaying sine sweep waveform
Figure 6.7 Exponentially growing sine sweep waveform
Figure 6.8 Multi-tone waveform (sinωt+sin2ωt)
Figure 6.9 Multi-tone waveform with 15% random noise (sinωt+sin2ωt)
Figure 6.10 Sine waveform
Figure 6.11 Triangular waveform
Figure 6.12 Square waveform
Figure 6.13 Probability density distribution of estimated time period
Figure 6.14 Probability density distribution of correlation peak
Figure 6.15 ED output waveform
Figure 6.16 Probability density distribution of estimated time period – ED method
Figure 6.17 Probability density distribution of ED valley
Figure 6.18 PCC output waveform
Figure 6.19 Probability density distribution of estimated time period – PCC method
Figure 6.20 Probability density distribution of PCC peak
Figure 6.21 WHD output waveform
Figure 6.22 Probability density distribution of estimated time period – WHD method
Figure 6.23 Probability density distribution of WHD valley
Figure 6.24 Experimental setup block diagram for DSO triggering
Figure 6.25 DSO screen shot showing trigger pulses and stable display for a sine sweep waveform
Figure 6.26 DSO screen shot showing trigger pulses and stable display for high frequency sine waveform
Figure 7.1 DOD(0, x), -10.0≤x≤10.0 for three values of α = 0.1, 0.5 and 1.5
Figure 7.2 Schematic of the DOD implementation
Figure 7.3 Flowchart for the time period estimation and waveform presentation on VI
Figure 7.4 Flowchart for real time oscilloscope triggering
Figure 7.5 Test signal
Figure 7.6 DOD output vs. time shift index
Figure 7.7 Exponentially decaying sine sweep vibration waveform
Figure 7.8 Exponentially growing sine sweep vibration waveform
Figure 7.9 Constant amplitude sine sweep vibration waveform
Figure 7.10 Multi-tone (sinωt+sin3ωt) vibration waveform
Figure 7.11 Multi-tone (sinωt+sin3ωt) with random noise of 20% of amplitude
Figure 7.12 Multi-tone (sinωt+0.1 sin10ωt) vibration waveform
Figure 7.13 Multi-tone (sinωt+10sin10ωt) vibration waveform
Figure 7.14 Sine vibration waveform
Figure 7.15 Triangular vibration waveform
Figure 7.16 Probability density distribution of the DOD valley
Figure 7.17 Probability density distribution of time period
Figure 7.18 Block diagram of vibration waveform acquisition and presentation
Figure 7.19  Front panel of the developed VI showing two cycles of vibration waveform
Figure 7.20  Block diagram for vibration acquisition and presentation on oscilloscope
Figure 7.21  Snap of the oscilloscope screen for 125ms shaker excitation
Figure 7.22  Probability density distribution of time period – Correlation method
Figure 7.23  Probability density distribution of the correlation peak
Figure 7.24  Probability density distribution of time period – WHD method
Figure 7.25  Probability density distribution of the WHD valley
Figure 7.26  Multi-tone waveform analysis by correlation method
Figure 7.27  Multi-tone waveform analysis by DOD method
Figure 7.28  Multi-tone waveform analysis by WHD method
Figure 8.1  Components of a computer controlled EDVA system
Figure 8.2  Front panel of the LabVIEW simulation program
Figure 8.3  Simulated movement of the armature coil
Figure 8.4  Schematic of the EDVA system
Figure 8.5  Developed prototype EDVA
Figure 8.6  Acceleration waveform amplitude control scheme
Figure 8.7  Triangular membership functions and fuzzy terms
Figure 8.8  Fuzzy PI controller control surface
Figure 8.9  Experimental setup
Figure 8.10  Snap shot of the experimental setup
Figure 8.11  Flowchart for EDVA control
Figure 8.12  Front panel of the developed VI for acceleration magnitude control
Figure 8.13  Measured frequency response of power amplifier
Figure 8.14  Measured open-loop frequency response of EDVA (@2V)
Figure 8.15  Effect of voltage variation on EDVA response (@ 1 kHz)
Figure 8.16  Open loop step response of the EDVA
Figure 8.17  Performance of the estimated model
Figure 8.18  Fuzzy PI and PI controller step response results for bare table at 1 kHz
Figure 8.19  Fuzzy PI and PI controller step response results for bare table at 50Hz
Figure 8.20  Spectrum analysis (FFT) of the FLC controlled shaker output at 1 kHz
Figure 8.21  Fuzzy PI and PI controller step response results for loaded table at 1 kHz
Figure 8.22  Fuzzy PI and PI controller step response results for bare table at 50Hz
Figure 8.23  PI and FLC performances for disturbance rejection
Figure 8.24  Sine sweep response of the FLC for 1 octave/minute
Figure 9.1  Electromechanical model of shaker
Figure 9.2  Electrodynamic shaker (LDS - V408)
Figure 9.3  Internal view of shaker (LDS-V408)  157
Figure 9.4  Time-histories of shaker coil voltage generated by pluck test  159
Figure 9.5  FFT results  159
Figure 9.6  Proposed acceleration waveform amplitude control scheme  161
Figure 9.7  FLC implementation block diagram for acceleration amplitude control  163
Figure 9.8  Flowchart for shaker acceleration amplitude control  163
Figure 9.9  Experimental setup  165
Figure 9.10  Snap of experimental setup  165
Figure 9.11  Front panel of LabVIEW code developed for the host computer  166
Figure 9.12  Measured frequency response of the power amplifier  167
Figure 9.13  Measured frequency response of the shaker with power amplifier  168
Figure 9.14  Effect of voltage variation  168
Figure 9.15  Step response of bare table  169
Figure 9.16  Step response of loaded table  170
Figure 9.17  Step response of bare and loaded table at 10Hz  170
Figure 9.18  FFT results for 2 kHz excitation  171
Figure 9.19  Reference and the measured acceleration waveforms at 10Hz for bare table  171
Figure 9.20  Reference and the measured acceleration waveforms at 10Hz for loaded table  171
Figure 9.21  Reference and the measured acceleration waveforms at 2 kHz for bare table  172
Figure 9.22  Reference and the measured acceleration waveforms at 2 kHz for loaded table  172
Figure 9.23  Frequency profile  173
Figure 9.24  Relative acceleration magnitude profile during swept frequency test at bare table  174
Figure 9.25  Reference and measured acceleration waveforms under rigid load test  174
Figure 9.26  Drive signal  175
Figure 9.27  Measured acceleration magnitude profile during swept frequency test at loaded table  175
Figure 9.28  Relative acceleration magnitude profile during swept frequency test at loaded table  176
Figure 9.29  Relative acceleration magnitude profile during swept frequency test at resonant load  176