ANTI-VIBRATION TRANSPORT INCUBATOR



- INTRODUCTION
- PREVIOUS RESEARCH
- AVTI PROJECT OBJECTIVE
- PROJECT DESCRIPTION
- SOFTWARE DESCRIPTION
- SOFTWARE DIAGNOSTICS
- PROJECT SCHEDULE
- COST ANALYSIS



1 of 9 expectant mothers do not carry to full term.

More than $\frac{1}{2}$ a million in the US are born prematurely

Early prenatal care: increases life expectancy by 90%

"Outborn" neonates, require emergent transfer to a NICU (Newborn Intensive Care Unit) center.

Regulations <u>**DO NOT**</u> exist for the control of <u>**VIBRATION**</u> exposure experienced by premature infants during their transport.



Although previous research has attempted to reduce the vibration experienced by the neonate, no significant breakthroughs have occurred.

WHEEL TESTING



Tested 3 different wheel types::

•Soft Rubber

•Hard Rubber

•Moldon Rubber

RESULT: •Soft rubber wheels absorbed the most vibration •Reduced noise **MATTRESS TESTING**



Used 4 different mattress scenarios: •No Mattress

•Foam Mattress

•Gel Mattress

•Gel Mattress & Foam Mattress

RESULT: None of the mattress combinations attenuated the vibrations

FLOOR TESTING



Compared the hospital floor with norarubber .

RESULT: Reduced noise levels by 20 dB

The purpose of the Anti-Vibration Transport Incubator project aims to measure and reduce the amount of vibration levels neonates experience when being transported within an incubator.







Objectives:

- 1. Develop a method to measure and reduce vibrations experienced through incubator transportation.
- 2. Data will be compiled and analyzed through DAQ system.
- 3. Incorporate necessary changes to the incubator to minimize the vibrations and aid in a smoother transport.

Project planning involves setting goals, establishing schedules, and estimating budgets to obtain the desired results.



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AVTI Implementation Blueprint



System 1: Mechanical Dampening



These type of dampers are the only anti-vibration method found on present-day incubators. During compression the coil spring stores energy. The cylinder gradually dissapates this energy until stability is restored.

System 2: Datalogger





The A/D converter uses the continuously varying analog signals from the accelerometer's movement and displays it in a waveform chart into the computer.



System 3: Dynamic Shock Absorption (Z Axis)



Servo	JR DS8711
Manufacture	'JR
Applications	Heli/Airplanes/Sailplanes
Туре	Digital Ultra High Torque
Torque 4.8V	347 oz/in (24.8 kg/cm)
Torque 6.0V	403 oz/in (28.8 kg/cm)
Speed 4.8V	0.19 sec/60 degrees
Speed 6.0V	0.15 sec/60 degrees
Dimensions	41mm x 37mm x 20mm
Weight	67g
Bearings	Dual Ball Bearing
Gear Type	Metal



Electrical

(specifications are for operation at V_{dd} = 5.0 V and T = 25°C unless stated otherwise)

Paran	neters	Units	Min	Typical	Max
Supply Voltage (V _{dd})	Operating	V	2.5	5.0	5.25
Current Consumption	Operating	mA	0.90	1.20	1.50
Current Consumption Standby	Standby	μA	-	-	5
Input Voltage for Logic	Low ¹	V	-	-	0.2 * V _{dd}
Input Voltage for Logic	: High ¹	V	0.8 * V _{dd}	-	-
Analog Output Resista	ance(R _{out})	kΩ	24	32	40



System 3: Dynamic Shock Absorption (X & Y Axis)

Servo	JR DS9411MG
Manufacturer	JR
Applications	Heli/Airplanes
Туре	Digital High Speed/Low Profile
Torque 4.8V	82 oz/in (5.8 kg/cm)
Torque 6.0V	95 oz/in (6.78 kg/cm)
Speed 4.8V	0.15 sec/60 degrees
Speed 6.0V	0.12 sec/60 degrees
Dimensions	40mm x 25mm x 20mm
Weight	40g
Bearings	Dual Ball Bearing
Gear Type	Metal





GyroFutaba GY240ManufacturerFutabaTypeAVCS Vector ControlData SettingOnboard PotsData Display-CompatibilityFutaba, JR, HitecGain ControlOnboardVoltage4-6VDimensions27mm x 27mm x 20mmWeight25g



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AVTI Software Flow Chart



- Convert ANALOG signal from the acccelerometer into DIGITAL signal for calculations
- PWM signals control the servos
- PWM signals are generated using Timer 0 and Timer 1 interrupts
- Servos are moved proportionally to the acceleration

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Pulse Width Modulation signal to Servo Motor



3 wires: Red (+5V)/ Black (GND)/ White (Signal)

The position signal is a single variable-width pulse that can vary from 1ms to 2ms.

The width of the pulse controls the position of the servomotor shaft.

Results from Test Run



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Gantt Chart

56 \checkmark 57 \checkmark 58 \checkmark 59 \checkmark 60 \checkmark 61 \checkmark 62 \checkmark 63 \checkmark 64 \checkmark 65 \checkmark 66 \checkmark 67 \checkmark 68 \checkmark 70 \checkmark 71 \checkmark 72 \checkmark 73 \checkmark 74 \checkmark 75 \checkmark 76 \checkmark 77 \checkmark 78 \checkmark 80 \checkmark 81 \checkmark 82 \checkmark 83 \checkmark 84 \checkmark 86 \checkmark	Week 16: Feb 26 to Mar 4 Team meeting NI LabVIEW Developer Training Team meeting NI LabVIEW Developer Training Week 17: Mar 5 to Mar 11 Obtain Cart and Springs Cart Construction LabVIEW development Met Mr. Walding Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEW Met Travis	3 days 1 day 1 day 1 day 26 days 6 days 1 day 5 days 1 day 1 day 1 day 5 days 2 days 2 days	Mon 3/2/09 Mon 3/2/09 Tue 3/3/09 Wed 3/4/09 Fri 3/6/09 Fri 3/6/09 Sat 3/7/09 Sat 3/7/09 Sat 3/7/09 Won 3/9/09 Wed 3/11/09 Mon 3/16/09	Wed 3/4/09 53 Mon 3/2/09 53 Tue 3/3/09 53 Wed 3/4/09 54 Wed 3/11/09 53 Wed 3/11/09 54 Wed 3/11/09 54 Wed 3/11/09 54 Wed 3/11/09 54 Word 3/11/09 54 Mon 3/9/09 64	5 7 8 9 2SS	Team 9 FAlicia,llancy Team 9 Alicia	
57 \checkmark 58 \checkmark 59 \checkmark 60 \checkmark E 61 \checkmark 62 \checkmark E 63 \checkmark E 64 \checkmark E 65 \checkmark E 66 \checkmark E 66 \checkmark E 67 \checkmark E 68 \checkmark E 69 \checkmark E 70 \checkmark E 70 \checkmark E 71 \checkmark E 72 \checkmark E 73 \checkmark E 74 \checkmark E 74 \checkmark E 77 \checkmark E 77 \checkmark E 77 \checkmark E 78 \checkmark E 79 \checkmark E 79 \checkmark E 70 \checkmark E 71 \checkmark E 72 \checkmark E 73 \checkmark E 74 \checkmark E 74 \checkmark E 75 \checkmark E 77 \checkmark E 77 \checkmark E 78 \checkmark E 78 \checkmark E 79 \checkmark E 80 \checkmark E 81 \checkmark E 83 \checkmark E 84 \checkmark E 86 \checkmark E 86 \checkmark E 87 $E77$ E	Team meeting NI LabVIEW Developer Training Team meeting Phase two: Implementation Week 17: Mar 5 to Mar 11 Obtain Cart and Springs Cart Construction LabVIEW development Met Mr. Walding Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEW Met Travis	1 day 1 day 26 days 6 days 1 day 5 days 3 days 1 day 1 day 5 days 5 days	Mon 3/2/09 Tue 3/3/09 Wed 3/4/09 Fri 3/6/09 Fri 3/6/09 Sat 3/7/09 Sat 3/7/09 Sat 3/7/09 Won 3/9/09 Wed 3/11/09 Mon 3/16/09	Mon 3/2/09 53 Tue 3/3/09 57 Wed 3/4/09 50 Wed 3/11/09 57 Fri 3/6/09 53 Wed 3/11/09 57 Wed 3/11/09 67 Mon 3/9/09 63	5 7 8 9 2SS	Team 9 FAlicia,Ilancy Team 9 Alicia	
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59 ✓ 60 ✓ 61 ✓ 62 ✓ 63 ✓ 64 ✓ 65 ✓ 66 ✓ 67 ✓ 68 ✓ 69 ✓ 70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Team meeting Phase two: Implementation Week 17: Mar 5 to Mar 11 Obtain Cart and Springs Cart Construction Lab/IEV/ development Met Mr. Walding Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish Lab/IEV/ Met Travis Wet Travis	1 day 26 days 6 days 1 day 5 days 1 day 1 day 1 day 5 days 5 days 5 days	Wed 3/4/09 Fri 3/6/09 Fri 3/6/09 Fri 3/6/09 Sat 3/7/09 Sat 3/7/09 Mon 3/9/09 Wed 3/11/09 Mon 3/16/09	Wed 3/4/09 58 Wed 4/8/09 58 Wed 3/11/09 58 Wed 3/11/09 58 Wed 3/11/09 62 Mon 3/9/09 62 Mon 3/9/09 64	8 9 2SS	Alicia	
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61 ✓ 62 ✓ 63 ✓ 64 ✓ 65 ✓ 66 ✓ 67 ✓ 68 ✓ 69 ✓ 70 ✓ 71 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Week 17: Mar 5 to Mar 11 Obtain Cart and Springs Cart Construction LabVIEV/ development Met Mr. Walding Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEV/ Met Travis Wet Travis	6 days 1 day 5 days 3 days 1 day 1 day 5 days 5 days	Fri 3/6/09 Fri 3/6/09 Sat 3/7/09 Sat 3/7/09 Mon 3/9/09 Wed 3/11/09 Mon 3/16/09	Wed 3/11/09 59 Fri 3/6/09 59 Wed 3/11/09 62 Mon 3/9/09 62 Mon 3/9/09 64	9 2SS	Alicia	
62 ✓ 63 ✓ 64 ✓ 65 ✓ 66 ✓ 67 ✓ 68 ✓ 69 ✓ 70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Obtain Cart and Springs Cart Construction LabVIEW development Met Mr. Walding Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEW Met Travis Wet 10: Mar 19 to Mar 25	1 day 5 days 3 days 1 day 1 day 5 days 5 days	Fri 3/6/09 Sat 3/7/09 Sat 3/7/09 Mon 3/9/09 Wed 3/11/09 Mon 3/16/09	Fri 3/6/09 59 VVed 3/11/09 62 Mon 3/9/09 64 Mon 3/9/09 64	9 2SS	Alicia Alicia	
63 ✓ 64 ✓ 65 ✓ 66 ✓ 67 ✓ 68 ✓ 69 ✓ 70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Cart Construction LabVIEW development Met Mr. Walding Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEW Met Travis Wet 11: Mar 19 to Mar 25	5 days 3 days 1 day 1 day 5 days 5 days	Sat 3/7/09 Sat 3/7/09 Mon 3/9/09 Wed 3/11/09 Mon 3/16/09	Wed 3/11/09 63 Mon 3/9/09 63 Mon 3/9/09 64	2SS	🛏 Alicia	
64 ✓ 65 ✓ 66 ✓ 67 ✓ 68 ✓ 69 ✓ 70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	LabVIEW development Met Mr. Walding Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEW Met Travis Week 19: Mar 10 to Mar 25	3 days 1 day 1 day 5 days 5 days	Sat 3/7/09 Mon 3/9/09 Wed 3/11/09 Mon 3/16/09	Mon 3/9/09 63 Mon 3/9/09 64	200		
65 ✓ 66 ✓ 67 ✓ 68 ✓ 69 ✓ 70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Met Mr. Walding Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEW Met Travis Wet 11: Mar 19 to Mar 25	1 day 1 day 5 days 5 days	Mon 3/9/09 Wed 3/11/09 Mon 3/16/09	Mon 3/9/09 64	355	Alicia, Nancy	
66 ✓ 67 ✓ 68 ✓ 69 ✓ 70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Proposal presentation practice Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEW Met Travis Wet 11: Mar 19 to Mar 25	1 day 5 days 5 days	Wed 3/11/09 Mon 3/16/09		4SS	Ly Team 9	
67 ✓ 68 ✓ 69 ✓ 70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓ 87 ✓	Week 18: Mar 12 to Mar 18 Work on proposal report Finish LabVIEW Met Travis E Week 19: Mar 19 to Mar 25	5 days 5 days	Mon 3/16/09	Wed 3/11/09 65	5	Alicia,llancy	
68 ✓ 69 ✓ 70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Work on proposal report Finish LabVIEW Met Travis	5 days		Fri 3/20/09			
69 √ 70 √ 71 √ 72 √ 73 √ 74 √ 75 √ 76 √ 77 √ 78 √ 79 √ 80 √ 81 √ 83 √ 84 √ 85 √ 86 √	Finish LabVIEW Met Travis	O starter	Mon 3/16/09	Fri 3/20/09 66	6	Alicia,Nancy	
70 ✓ 71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Met Travis	3 days	Mon 3/16/09	Wed 3/18/09 68	8SS	Alicia, Nancy	
71 ✓ 72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Week 19: Mar 19 to Mar 25	1 day	Fri 3/20/09	Fri 3/20/09 69	9	Alicia, Nancy	
72 ✓ 73 ✓ 74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	- 1100n 13. Mai 13 to Mai 23	3 days	Sun 3/22/09	Wed 3/25/09			
73 √ 74 √ 75 √ 76 √ 77 √ 78 √ 79 √ 80 √ 81 √ 82 √ 83 √ 84 √ 85 √ 86 √	Work on proposal report	2 days	Sun 3/22/09	Mon 3/23/09 70	0	Alicia, Nancy	
74 ✓ 75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Test accelerometer with LabVIEW	1 day	Wed 3/25/09	Wed 3/25/09 72	2	Alicia,Nancy	
75 ✓ 76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Week 20: Mar 26 to Apr 1	7 days	Sat 3/28/09	Fri 4/3/09		••••	
76 ✓ 77 ✓ 78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Work on accelerometer	1 day	Sat 3/28/09	Sat 3/28/09 73	3	Team 9	
77 √ 78 √ 79 √ 80 √ 81 √ 82 √ 83 √ 84 √ 85 √ 86 √	Meeting with John Artis	1 day	Sat 3/28/09	Sat 3/28/09 75	5SS	Team 9	
78 ✓ 79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Research gyro and RC servo	7 days	Sat 3/28/09	Fri 4/3/09 76	6SS	Team 9	
79 ✓ 80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Finished testing the accelerometer and LabVI	1 day	Tue 3/31/09	Tue 3/31/09 77	7SS	Team 9	
80 ✓ 81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Meet to discuss mechanical setup for the tray	1 day	Wed 4/1/09	Wed 4/1/09 78	8	Team 9	
81 ✓ 82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	⊡ Week 21: Apr 2 to Apr 8	7 days	Thu 4/2/09	Wed 4/8/09			
82 ✓ 83 ✓ 84 ✓ 85 ✓ 86 ✓	Test accelerometer and LabVIEW	2 days	Thu 4/2/09	Fri 4/3/09 79	9	Team 9	
83 ✓ 84 ✓ 85 ✓ 86 ✓	Met John Artis	1 day	Thu 4/2/09	Thu 4/2/09 81	1SS	Team 9	
84 🗸 85 🗸 86 🗸	Met John Artis	1 day	Sat 4/4/09	Sat 4/4/09 83	2SS	Team 9	
85 🗸 86 🗸	Research parts and upper tray design	3 days	Sat 4/4/09	Tue 4/7/09 83	3		
86 🗸	Design upper tray control	3 days	Sun 4/5/09	Tue 4/7/09 84	4SS	Team 9	
97	Buy parts	1 day	Wed 4/8/09	Wed 4/8/09 85	5	Team 9	
07	Phase three: Testing	24 days	Thu 4/9/09	Thu 5/7/09			
88 🗸	🖃 Week 22: Apr 9 to Apr 15	3 days	Thu 4/9/09	Sun 4/12/09			
89 🗸	Obtain components	1 day	Thu 4/9/09	Thu 4/9/09 86	6	Team 9	
90 🗸	Construct prototype	1 day	Sat 4/11/09	Sat 4/11/09 89	9	Team 9	
91 🗸	Research component specs	1 day	Sun 4/12/09	Sun 4/12/09 90	0	Team 9	
92 🗸	Week 24: Apr 16 to Apr 22	6 days	Thu 4/16/09	Wed 4/22/09			
93 🗸	Meeting with John Artis	1 dav	Thu 4/16/09	Thu 4/16/09 91	1	Team 9	
94 🗸	Work on Cart	3 days	Sat 4/18/09	Mon 4/20/09 93	3	Aligia	
95 🗸	Research software	2 days	Tue 4/21/09	Wed 4/22/09 94	4	Hancy	
96		10 days	Thu 4/23/09	Sat 5/2/09			
97	□ Week 25: Apr 23 to Apr 29	5 days	Thu 4/23/09	Mon 4/27/09 9	5	Team 9	
98	Week 25: Apr 23 to Apr 29 Collect vibration samples						

24 31 7 14 21 .

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Parts Cost	
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Parts Cost	Quantity	Source	Expected Cost	Actual Cost
Microcontroller Atmel MiniMax 51C	1	EPO	\$50	\$50
Connector (accelerometer)	2	EPO	\$5	\$5
Ribbon (accelerometer)	1	EPO	\$5	\$5
Cart	1	Houston Corvette	\$140	Donated
Cart Wheels	4	ТСН	\$60	Donated
Laptop	1	AVTI Group	\$800	Borrowed
Plastic Container (Incubator Tray)	2	The Container Store	\$40	\$40
Kionix Accelerometers	2	Kionix	\$70	Donated
Futaba GY240 Gyro	2	RC Hobby	\$240	\$240
JR DS 8711 Servo Motor	1	RC Hobby	\$140	\$140
JR DS 9411MG Servo Motor	2	RC Hobby	\$180	\$180
Zues 6V Battery	1	EPO	\$10	\$10
12V Battery	1	EPO	\$15	\$15
Gas Shock Cylinders	4	Advanced Auto Parts	\$60	\$60
Plexi Glass Sheets	2	The Container Store	\$12	\$12
Assortment of Servo arms and hardw	/are	RC Hobby	\$40	\$40
Spring Coils	4	Advanced Auto Parts	\$20	\$20
		Total	\$1,887	\$817

\$817

Cost Analysis



AVTI Total	Project Cost	
Parts		\$817
Equipment		\$0
Labor		\$25,200
	Total Cost	\$26,017

Labor Cost

Project Phase	Weeks	Hours per Week	o. Team Member	Vage Per Membe	Total Cost	
Preparation	5	20	3	\$20	\$6,000	
Research						
Acquire Parts, Equipment, ect						
Implementation	8	20	3	\$20	\$9,600	
Built incubator prototype						
Data Acquisition with LabViev	v software					
Integrate anti-vibration system	m					
Develop program for anti-vibr	ation system					
Testing	8	20	3	\$20	\$9,600	
Test incubator prototype				Total	\$25,200	





