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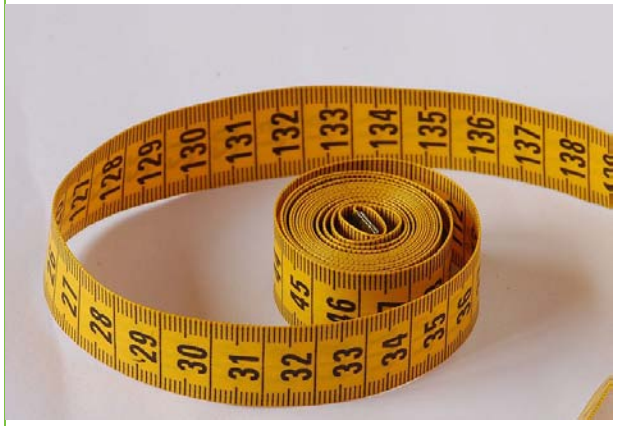
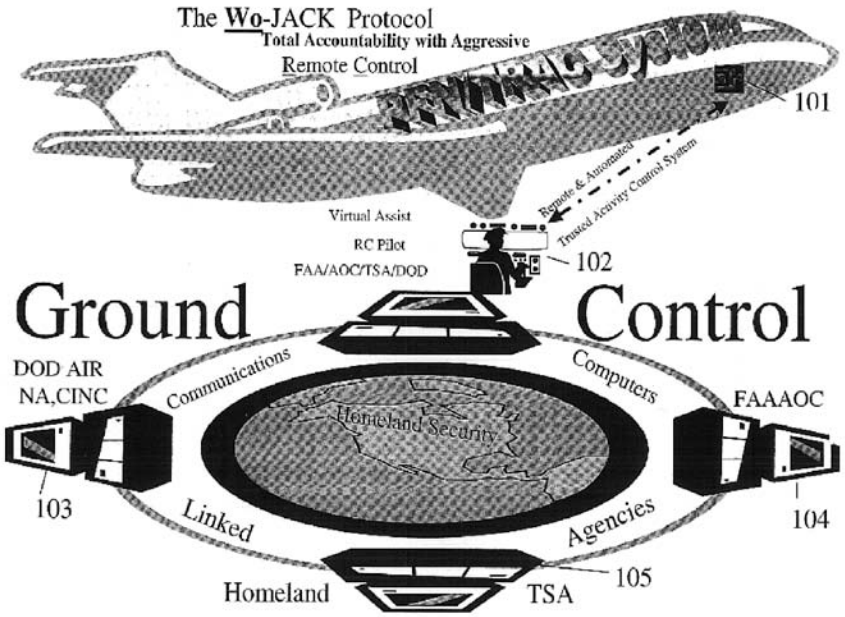
Mechatronics Project Presentation

An Inexpensive Electronic Method for Measuring Takeoff Distances





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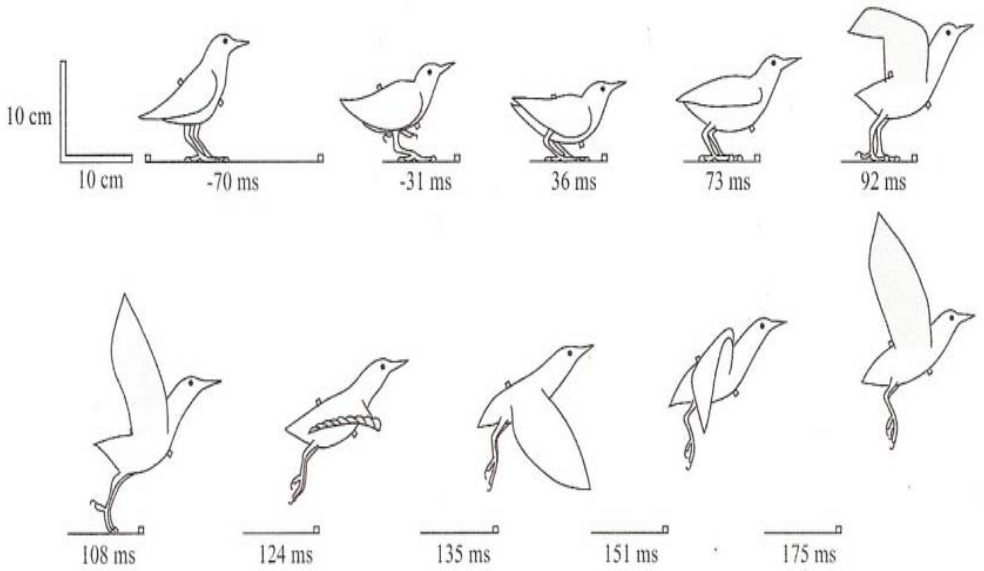
OUTLINE OF PRESENTATION

- INTRODUCTION
- HARDWARE
- EXPERIMENTAL SETUP
- LIVE DEMO
- CONCLUSIONS
- REFERENCES



INTRODUCTION

- The 2010 Society of Automotive Engineers (SAE) Aero Design West competition requires a data acquisition system (DAS) that is capable of measuring the takeoff distance of an aircraft, and display the distance on an LCD screen placed on the fuselage of the aircraft.
- This team has taken upon itself to design such a data acquisition system.
- The goal of this project is:
    - To design a DAS capable of measuring the takeoff distance of the aircraft
    - displaying it on an LCD screen on the plane.
    - The initial design will be a “proof of concept”, tested on a remote control (RC) car.

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PROGRAM IMPLEMENTATION

•Implementation of an accelerometer can be easily modified and adjusted to account for changing system parameters.

•The basic stamp microcontroller (BS2), was used as the main microcontroller component.

•Pbasic,the basic stamp's language, is ill equipped to handle mathematical computations,

•The XBee Pro RF module was chosen to handle the wireless communication tasks in order for a wireless data solution to be implemented.

•The RF device interfaced data logged into the basic stamp's EEPROM and wirelessly transmitted it to an Xbee base station located at a pc within its transmission range.

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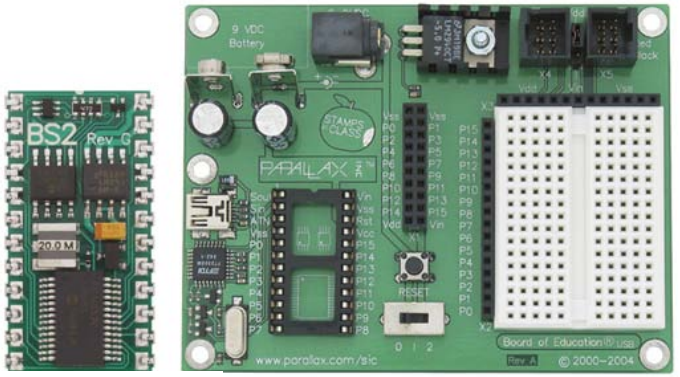
PROGRAM IMPLEMENTATION

Actualization was three fold:

- Data acquisition and storage by the basic stamp
  - Data acquired is stored in the basic stamp's EEPROM
- Data transfer via the Xbee from the basic stamp to Matlab
  - Serial communication directly to the Xbee integrated the basic stamp to Matlab
- Data processing in Matlab
  - Data is filtered via a smoothing program
  - Filtered data is numerically integrated using a discrete Euler method.
- Data transmition for display back to the basic stamp via the Xbee

HARDWARE (BS2)

- The BASIC Stamp 2 serves as the microcontroller on the electronics projects and applications.
- It is used to control data acquisition via input from the sensors and programmed looping criterion
- Programming is performed in PBASIC.

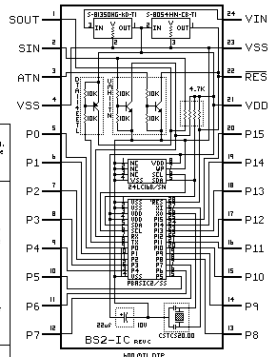


BS2-IC rev. c **Complete BASIC Stamp II circuit in SMT**

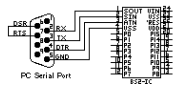
Features

- PBASIC2 Interpreter
- 2048-byte EEPROM
- 20Mhz Resonator
- 5V Regulator
- 4V Brown-Out Reset
- PC Serial Interface
- 16 User I/O Pins
- 8ma Run / 100uA Sleep (no loads, I/O's @ VSS/VDD)

PIN	NAME	FUNCTION	DESCRIPTION
1	SOUT	Serial Out	Temporarily connects to PC's Rx.
2	SIN	Serial In	Temporarily connects to PC's Tx.
3	ATN	Attention	Temporarily connects to PC's DTR.
4	VSS	Ground	Temporarily connects to PC's GND.
			After programming, these pins may be left unconnected.
5	P0	USER I/O 0	User port pins that can be used as inputs or outputs.
6	P1	USER I/O 1	
7	P2	USER I/O 2	In output mode: Pins will source from VDD or sink to VSS. Pins should not be allowed to source more than 20ma or sink more than 25ma each. As groups, P0-P7 and P8-P15 should not be allowed to source more than 40ma or sink more than 50ma each.
8	P3	USER I/O 3	
9	P4	USER I/O 4	
10	P5	USER I/O 5	
11	P6	USER I/O 6	
12	P7	USER I/O 7	
13	P8	USER I/O 8	In input mode: Pins are floating (less than 1ua leakage). The 0/1 logic threshold is approximately 1.4V.
14	P9	USER I/O 9	
15	P10	USER I/O 10	
16	P11	USER I/O 11	
17	P12	USER I/O 12	NOTE: To realize low power during sleep, make sure that no pins are floating, causing erratic power drain. Either drive them to VSS or VDD, or program them as outputs that don't have to source current.
18	P13	USER I/O 13	
19	P14	USER I/O 14	
20	P15	USER I/O 15	
21	VDD	REGULATOR OUT	Output from 5V regulator (VIN powered). Should not be allowed to source more than 50ma, including P0 - P15 loads.
		POWER IN	Power input (VIN not powered). Accepts 4.5V-5.5V. Current consumption is dependent upon run/sleep mode and I/O's.
22	RES	RESET I/O	When low, all I/O's are inputs and program execution is suspended. When high, program executes from start. Goes low when VDD is less than 4V or ATN is greater than 1.4V. Pulled to VDD by a 4.7K resistor. May be monitored as a brown-out/reset indicator. Can be pulled low externally (i.e. button to VSS) to force a reset. Do not drive high.
23	VSS	GROUND	Ground. Located next to VIN for easy battery hookup.
24	VIN	REGULATOR IN	Input to 5V regulator. Accepts 5.5 to 15V. If power is applied directly to VDD, pin may be left unconnected.



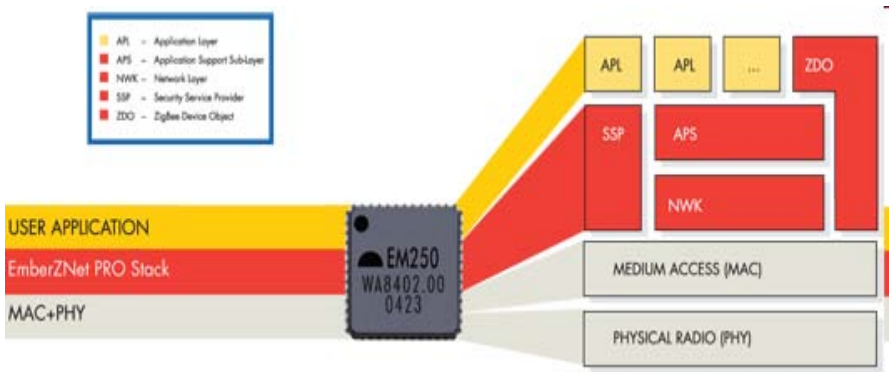
PC - to - BS2-IC connection



Connect DSR and RTS for automatic port detection.

XBee-PRO 802.15.4

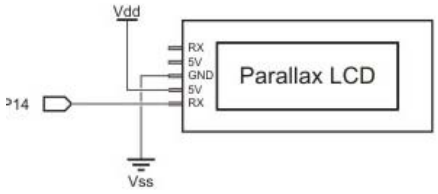
- XBee-PRO 802.15.4 OEM RF modules provid wireless end-point connectivity between the basic stamp and a PC.
- These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking.
- Designed for high-throughput applications requiring low latency and predictable communication timing.

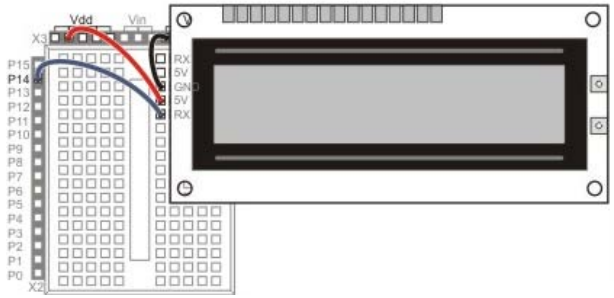


HARDWARE

LCD

- The Parallax Serial LCDs are functional, low-cost LCDs designed to be controlled by the BASIC Stamp microcontroller.
- The LCD displays are two rows by 16 characters.
- In addition, the Serial LCD also provides full control over all of their advanced LCD features, allowing you to move the cursor anywhere on the display with a single instruction and turn the display on and off in any configuration.

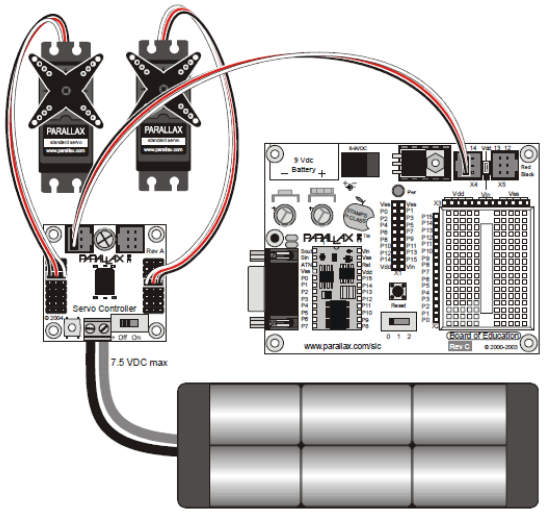




HARDWARE

Futaba S3005 high torque metal gear servomotor

- As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft
- As the coded signal changes, the angular position of the shaft changes

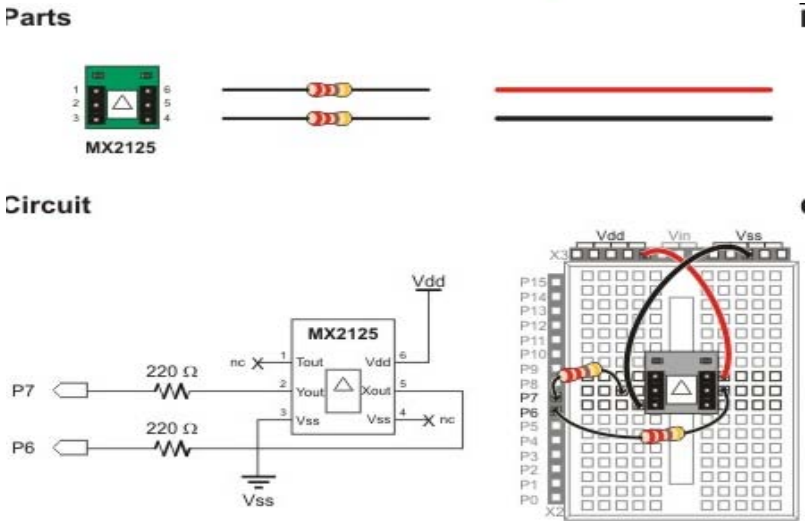


SENSORS USED

ACCELEROMETER

Memsic 2125 Dual-axis Accelerometer

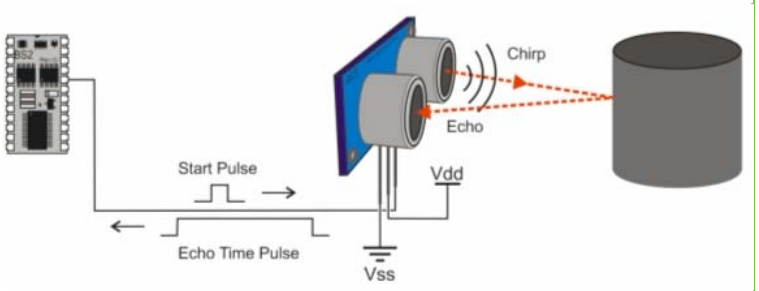
- It has a chamber of gas with a heating element in the center and four temperature sensors around its edge.
- Depending on how you tilt the accelerometer, the hot gas will collect closer to one or maybe two of the temperature sensors.
- Acceleration between [-1,1] g are readable



SENSORS USED

PING SENSOR

- The Ping sensor is used to measure how far away an object is.
- Measurement can range from 3 cm to 3.3 m, detecting an object's distance to within half centimeter.
- The BASIC Stamp's **PULSIN** command measures the time between the high and low changes, and stores it measurement in a variable.



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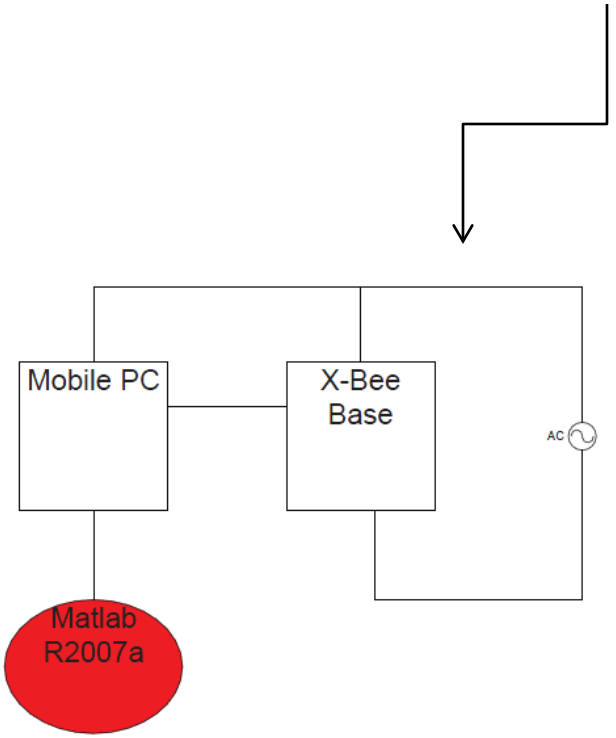
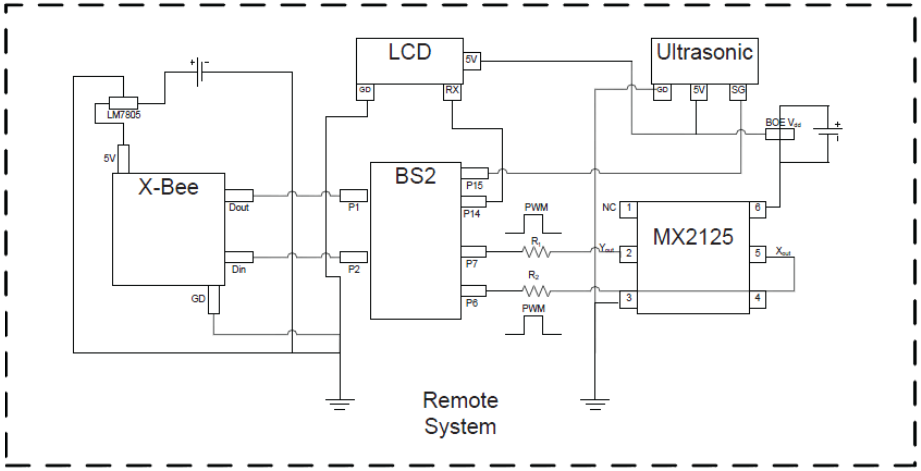
EXPERIMENTAL SET-UP

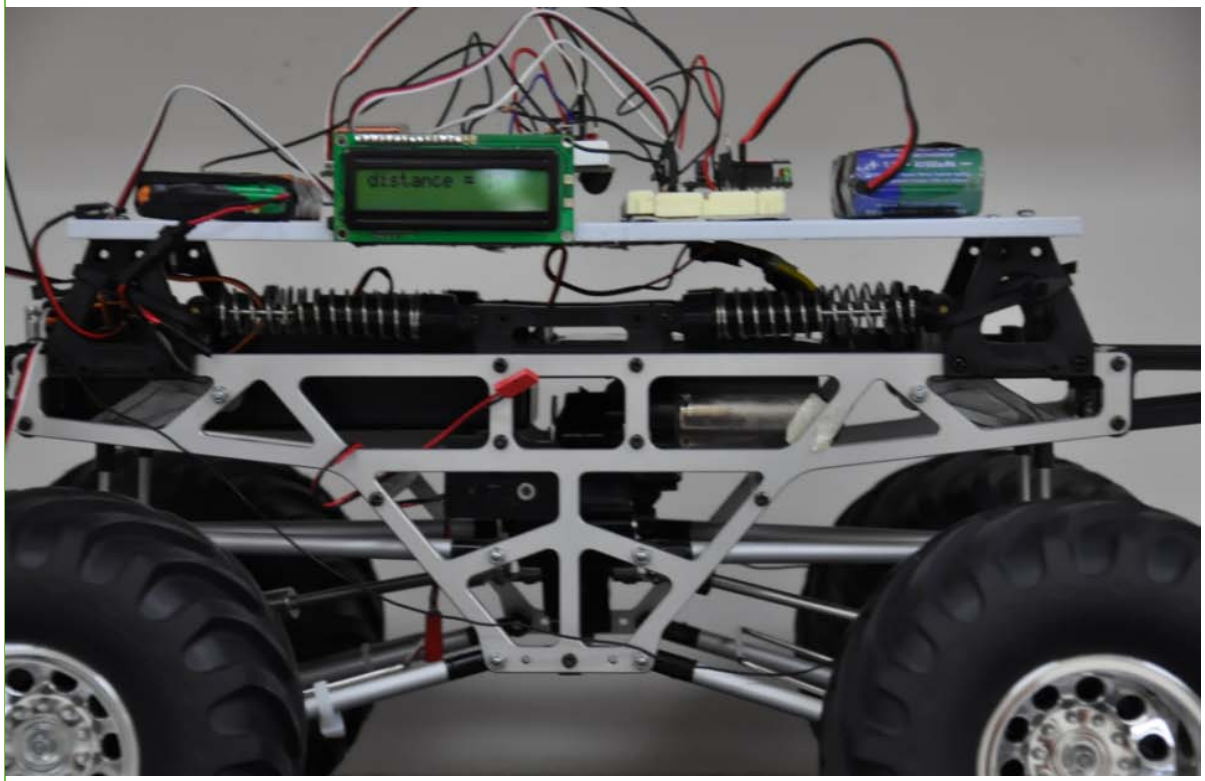




Platform consisted of:

- Brushed DC Motors
- Servomotor for steering
- Receiving Crystal
- Electronics Platform

The Platform



- Tamiya RC truck was used as experimental platform
- Brushed DC Motors
- Suspension was locked

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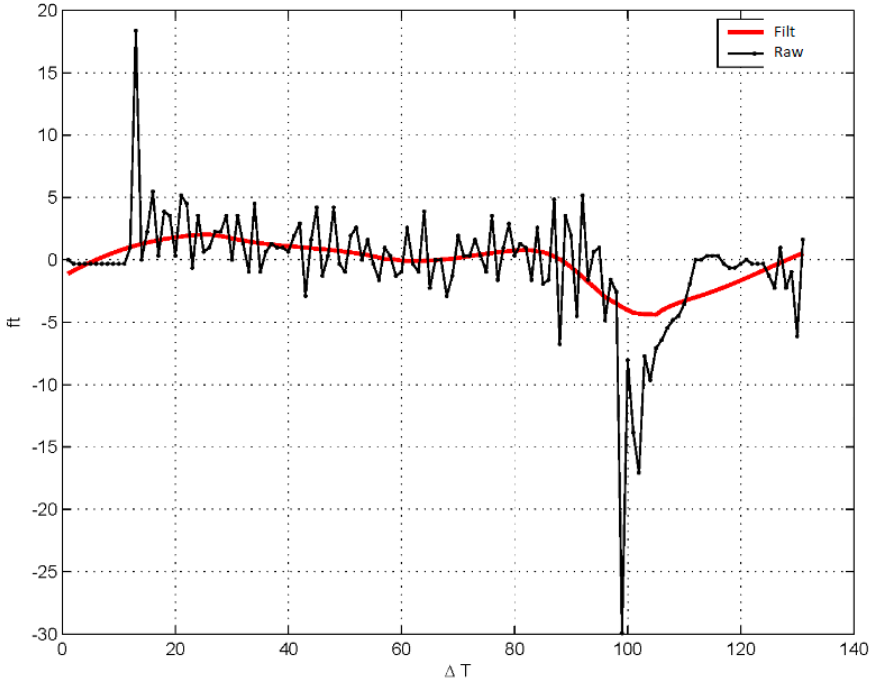
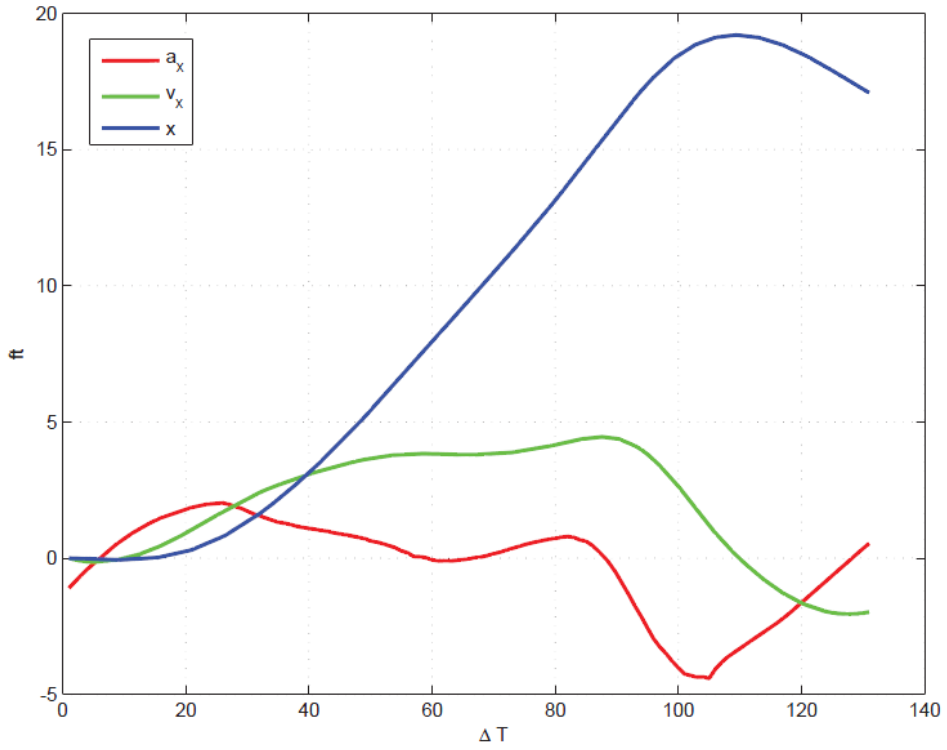
Data Analysis- Filtering



- Data was read in serially as raw data
- In order to obtain palatable data curves, a smoothing algorithm was implemented in Matlab
- The comparison of numerically smoothed to raw data is presented on the left

Data Analysis- Numerical Integration



- Numerical Integration results shown to the left
- RC Car traveled 20 feet
- Numerically integrated to 17 feet
- Error is pronounced at lower speeds and shorter distances
- Lacks consistency

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Bill of Materials

• Parallax Ping sensor	$29.99
• Parallax LCD	$29.99
• BS2 IC	$49.99
• BOE Kit	$79.99
• Futaba S3005	$24.99
• Brushed Electrix DC Motor x2	$49.99 each
• X-Bee Pro starter kit	$179.99
• Tamiya 4 x 4 truck	$400.00
• JR Radio transmitter/crystal	$400.00
• Memsic 2125 accelerometer	$24.99

Total $1319.91

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CONCLUSIONS

- A method for measuring the take off distance was evaluated
- The prototype works but:
  - Lacks consistency due to poor hardware selection (MX2125)
  - Would perform better over longer distances and at higher speeds

Acknowledgements

The authors would like to thank the generous and gracious assistance of Dr. Vikram Kapila and Chandresh Dubey for their advice and guidance throughout the duration of this project and the course. The authors would further like to acknowledge thoughtful discussions with colleagues Parth Kumar, Kwok Yu Mak and, Ryan Caeti.

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- www.parallax.com