ENSC 440/305 - Project Presentation Motion Sensing Remote Controlled Vehicle

Ron KittenBruan Technologies Ltd.

April 17, 2009

Agenda

- Motivation
- Team Members and Roles
- Project Description and Features
- Product Benefits
- System Design – Hardware and Software
- Implementation Schedule and Milestones
- Future Work
- Business Case
- Acknowledgements
- References
- Questions
- Appendix

Motivation

- Video driving games send wrong moral message towards kid on proper driving behavior [1] [2]
- Inexperienced drivers may lead to increase car accident rate [3]
- Reduce risk in deploying rescue team at harsh environments

Team Members and Roles

- Rongen Cheng – Chief Executive Officer (CEO)
  Biomedical Engineering
  - Previous work:
    - Project Management Team at HSBC (Hong Kong) Internet Banking Division (ISS)
    - Research work in Angular Domain Imaging (ADI) under Prof. Glenn Chapman's supervision
  - Project roles:
    - Configure the development environment for microprocessor .
    - Monitor overall project timeline and budget.
    - Improve automation algorithm.
- Austen Chan – Chief Technical Officer (CTO)
  Electronics Engineering
  - Previous work:
    - Electrical Engineer Assistant at Analytic Systems Ltd. Focusing on power electronics development .
  - Project roles:
    - Design and modify hardware electronics system based on software team's input and output requirements.

Team Members and Roles

- Wingkit Lee – Chief Financial Officer (CFO)
  System Engineering
  - Previous work:
    - Junior Software Developer at OGCIO (Hong Kong Government) and as a Mechanical Engineer Assistant at Analytics Systems Ltd.
    - Research work in MIROHOT project under Prof. Shahram Payandeh, specialize in Mechanical Design.
  - Project roles:
    - Design and fabricate special mount for circuitry , improve structural integrality/ rigidity of the vehicle.
- Brian Cheung – Production Director
  System Engineering
  - Previous work:
    - Junior Software Developer at MDA
    - Business Project Support at RIM
  - Project roles:
    - Configure the operating environment for microprocessor.
    - Determine proper I/O method from microprocessor.
    - Improve automation algorithm.

Team Members and Roles

- Bruce Wong – Manufacturing Director
  Engineering Physics
  - Previous work:
    - Research work in the MIROHOT project under Prof. Shahram Payandeh, specialize in robotic fabrication.
  - Project roles:
    - Algorithm and software implementation.

Project Description

- Motion Sensing Remote Controlled (RC) vehicle with Bluetooth Communication Protocol
- Provides:
  - Collision Prevention
  - Collision Detection
  - Natural Mapping Controls
  - Real Time Video Streaming
  - Data Security during transmission
  - Exploration path mapping

Project Feature – Natural Mapping Controls

- Traditional Remote Control Designs require extra training or practice to perform a solid movement.
- Natural Mapping Control Design allows user to perform certain tasks without extra training or practice. [4]

Controller

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Controller

Project Feature – Collision Prevention

- On board Infra-Red (IR) Triangulation-based sensor monitors object in front/behind the vehicle
  - If object is detected, sensor will trigger a signal to controller to stop the vehicle.
  - Collision Prevention distance (60cm) can be set by user under different hardware configuration.

Project Feature

- Real Time Video Streaming
  - On board camera captures front view of the vehicle and transmit to a LCD module on the controller via Bluetooth.
  - This allows the user to understand the environment surrounded in a location where visual information is minimal.
- Data Security
  - Bluetooth Communication Protocol provides one-to-one mapping which avoids signal interference or pickup.
- Self-Exploratory Path Mapping
  - Vehicle will record its operation history which allows user to draw out the map of the vehicle has travelled.

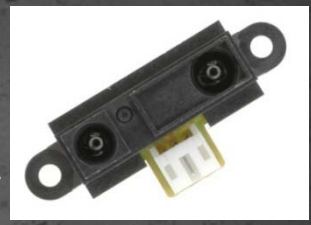
Product Benefits

- Educational Benefits:
  - Educates children how to operates a vehicle via natural mapping control as a normal steering wheel.
  - Collision Prevention and Detection provides a key idea on vehicle operation safety. This may lead to reductions of driving accidents in future.
- Social Benefits:
  - Unmanned vehicle allows searching in harsh or unreachable environment with real time video streaming and collision detection.
  - Natural mapping controls reduce extra training cost and provide easier operating method under urgent condition.
  - Path mapping provides repeatable safe route for future reference

System Design – Hardware

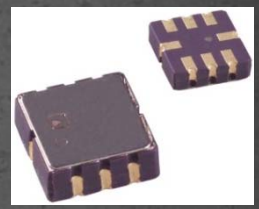
- Gumstix Verdex Pro XM4-bt [5]
  - Marvell® PXA270 with XScale™ Processor
    - Clock speed: 400 MHz
    - Total 120 General Purpose Input Output (GPIO)
  - Memory: 64MB RAM, 16MB EEPROM
  - Infineon PBA31308 Bluetooth module with external antenna
    - Transceiving range up to 100m
  - MicroSD memory slot for extra storage
  - 60, 80, and 24 pins connector for GPIO usage
  - Supply voltage: 5V @ 200mA

System Design – Hardware



- On-board Infra-red (IR) sensors deliver linear response based on object distance – 500mV at 60cm

- Accelerometer changes output voltage based on acceleration

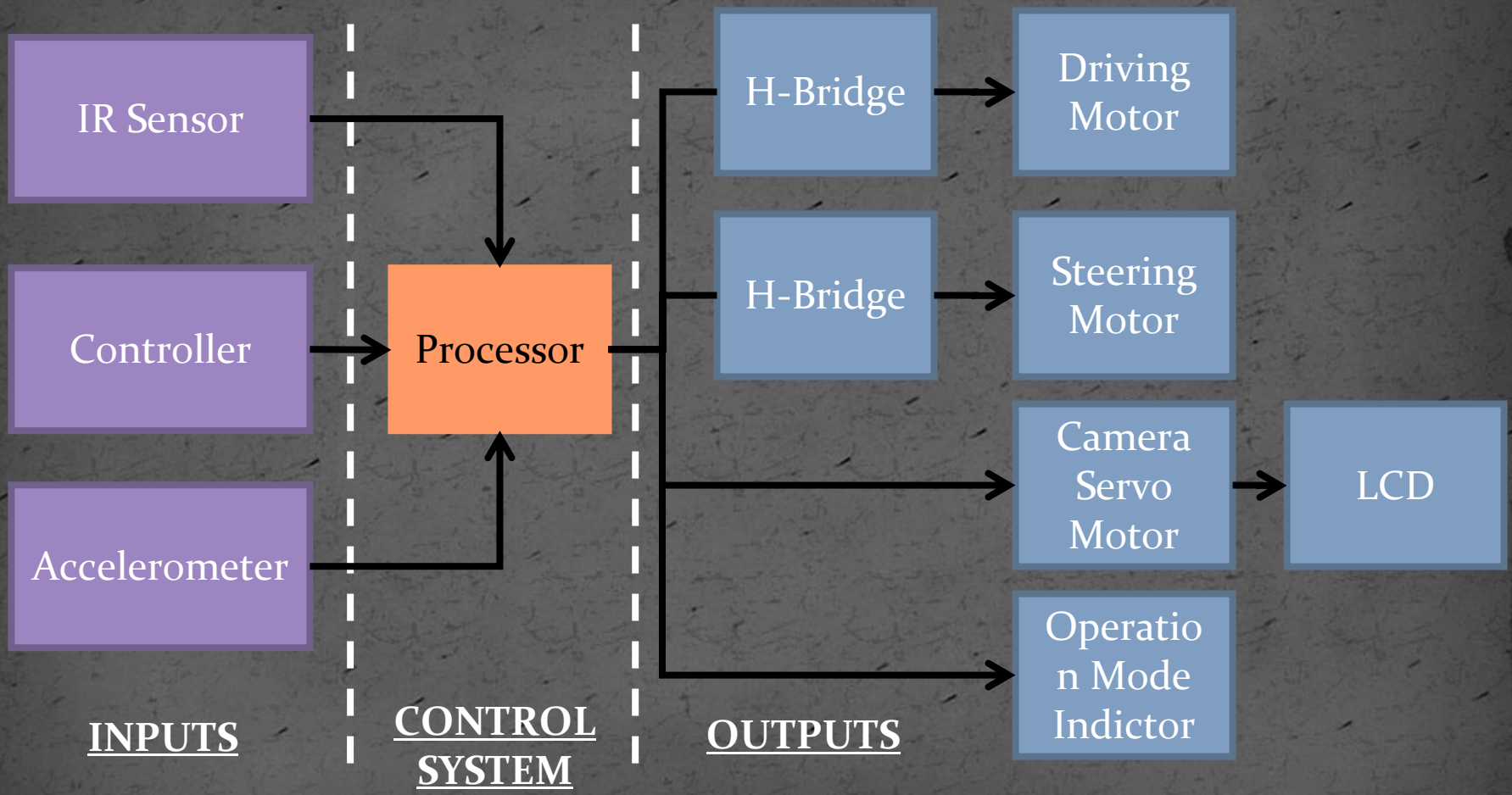


- LCD and webcam transceiver module for real-time video streaming
- PS3 controller provides 3-axis motion sensing, analog output signal at all controllable buttons

System Design – Hardware

- Design mounting platform for MCU, sensors, and hardware circuitry
- Improve backbone structure of the vehicle, i.e. increase rigidity, mobility
- Custom-made handheld platform for controller and LCD display module

Hardware System Flow



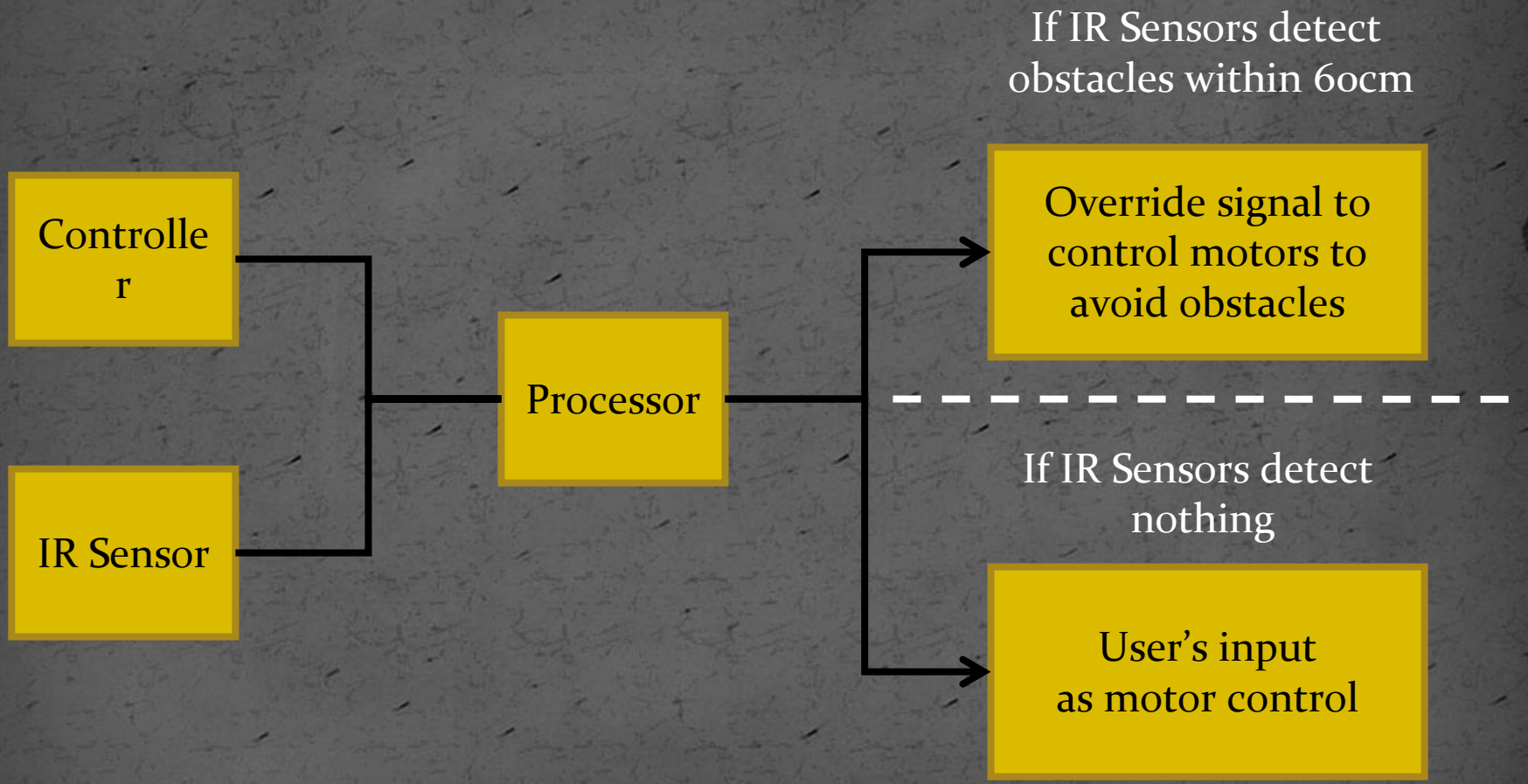
System Design – Software

- Gumstix:
  - Linux kernel – version 2.6.24
  - Bluetooth driver – version 3.24
  - Operates in Open Embedded (OE) environment
    - Cross-compile environment
    - Create Linux Distribution for embedded systems
    - Support large number of hardware architecture and support Linux distribution
  - Decodes PS3 controller signal [5]
    - Buttons
    - Analog signal
    - Motion sensing

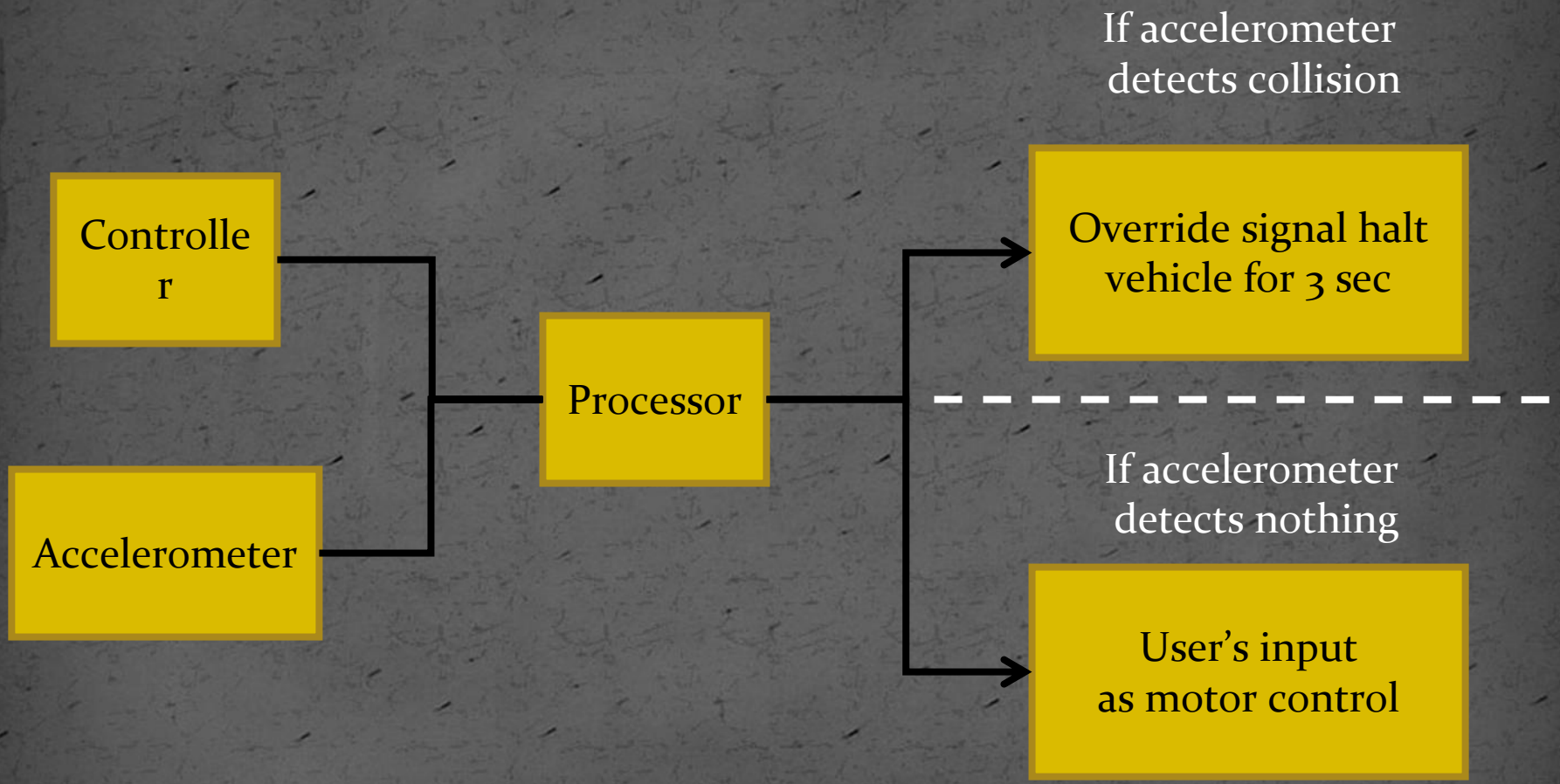
System Design – Software

- Algorithm to calculate true angle representation from controller signal
  - 3 axes (X, Y, Z) to calculate rotation and tilt angle
- Automation
  - Using IR sensors to provide feedbacks of the environment to MCU
  - Multiple and random choices when detect obstacles
- Mapping algorithm
  - Update position and orientation

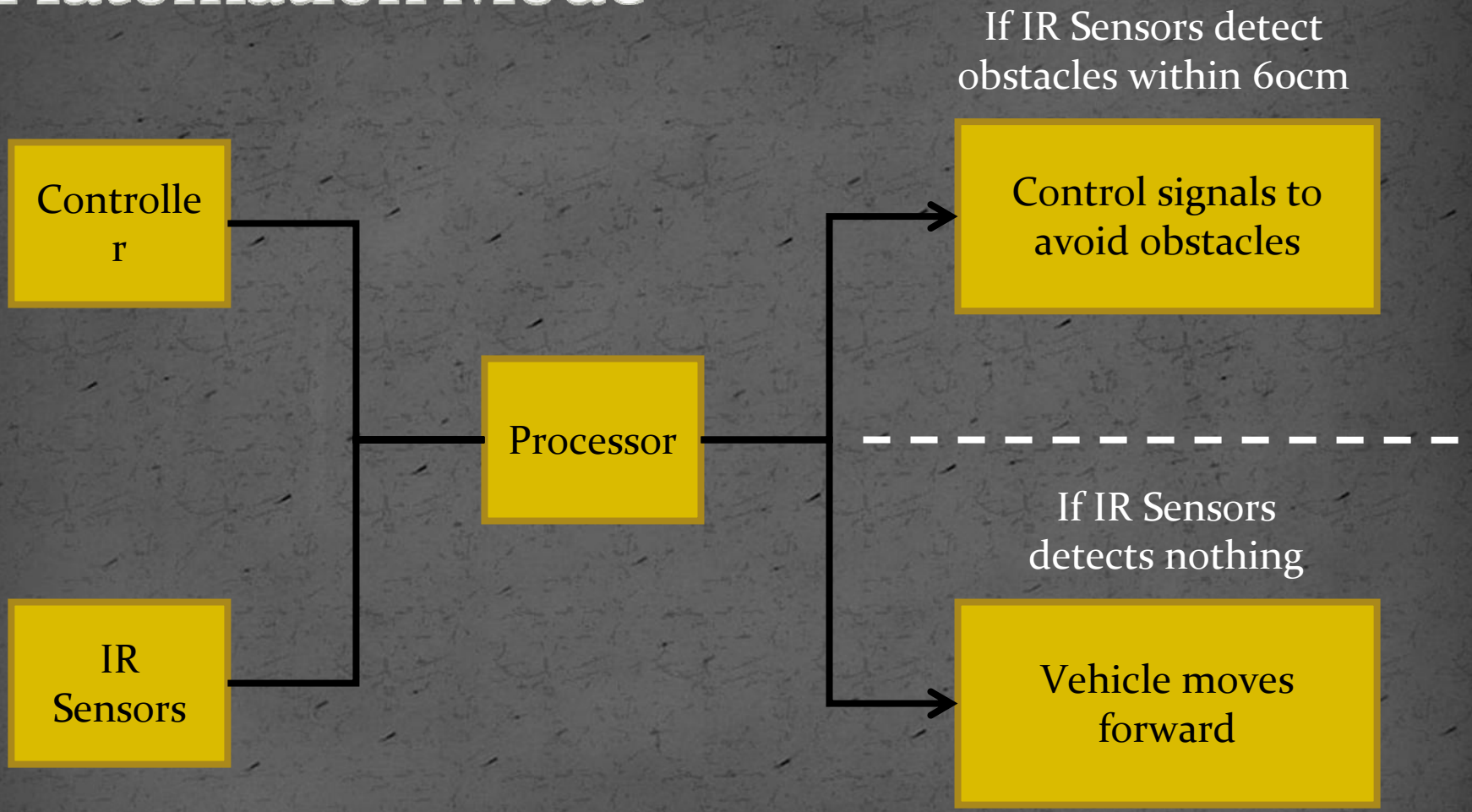
Software System Flow – Collision Prevention



Software System Flow – Collision Detection



Software System Flow – Automation Mode

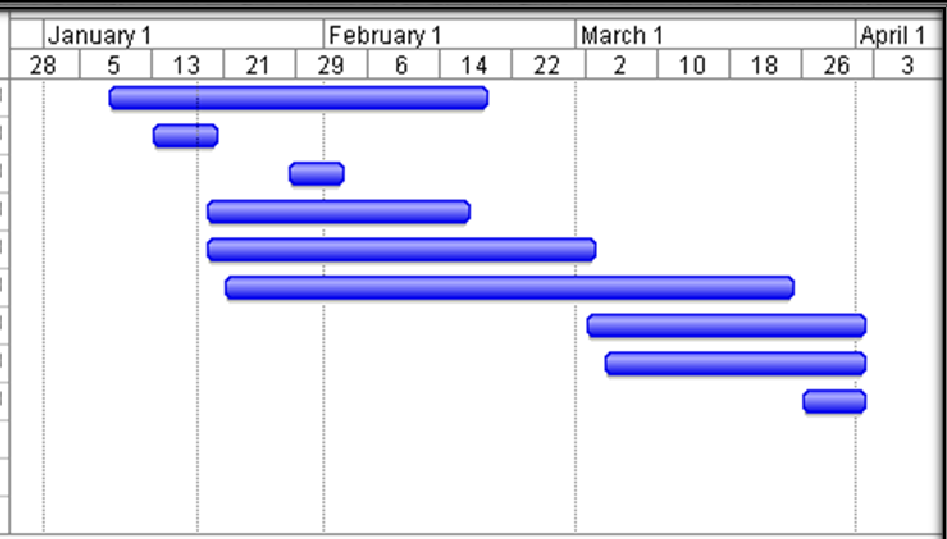


Implementation Schedule

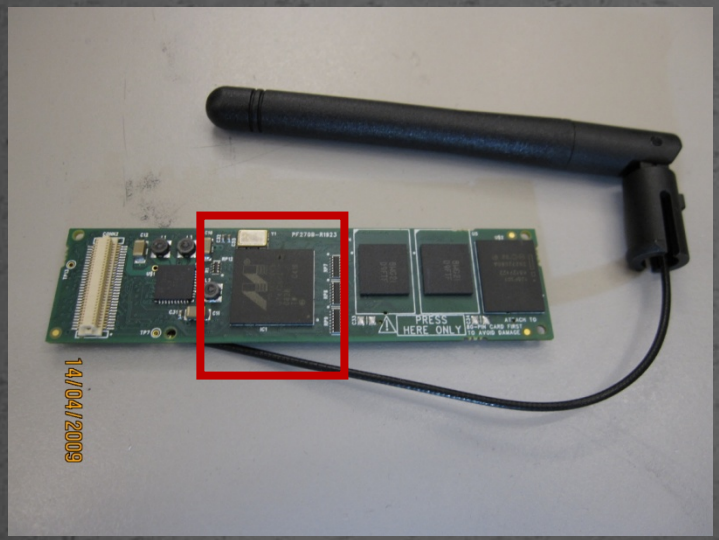
- Week 2
  - Finalized project requirements
- Week 3
  - Designed overall system flow chart
- Week 4
  - IR sensors and accelerometer order received, calibrated sensors response
- Week 5
  - Gumstix received, built development environment for Gumstix, designed first draft of hardware circuitry
- Week 6 – 10
  - Software development, hardware circuitry debug, subsystem testing
- Week 11 – 12
  - Systems integration and obstacles course construction

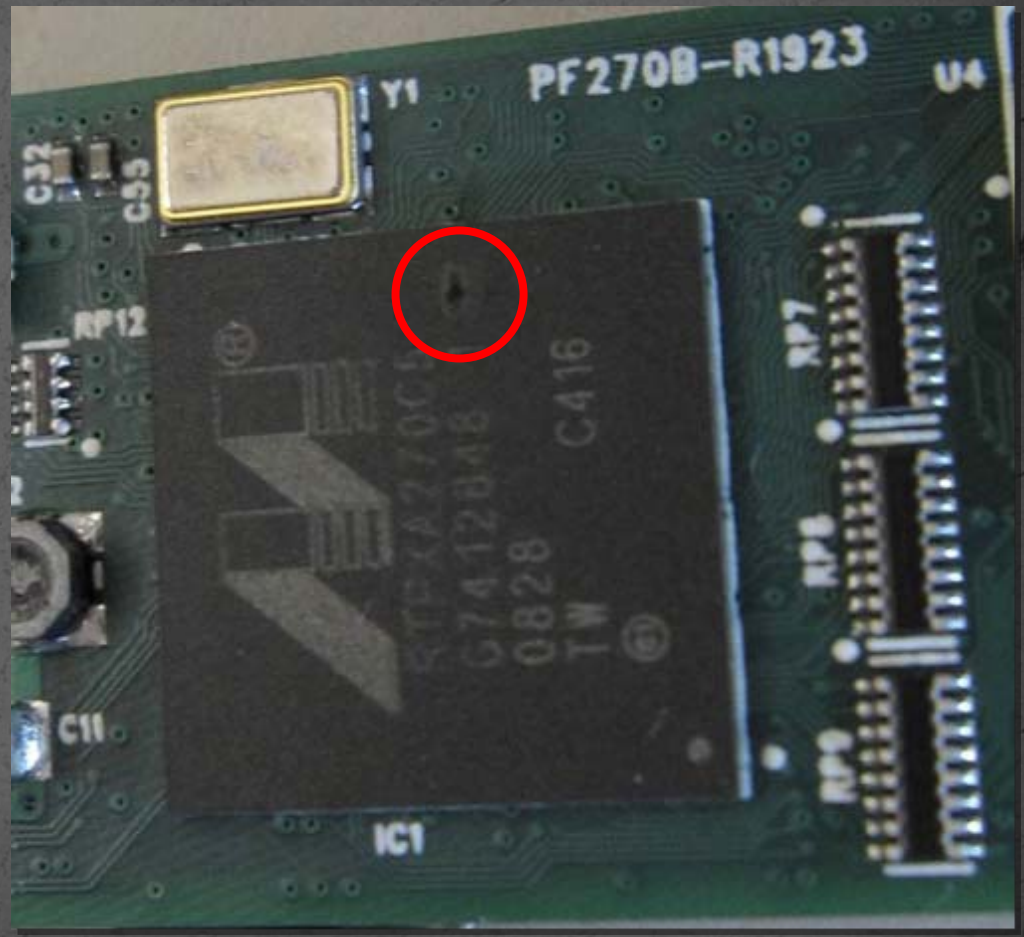
Implementation Schedule – Proposed

Task Name	Start	Finish
Research	Thu 1/8/09	Wed 2/18/09
Proposal/Funding	Tue 1/13/09	Mon 1/19/09
Progress Report	Wed 1/28/09	Mon 2/2/09
Functional Specification	Mon 1/19/09	Mon 2/16/09
Design Specification	Mon 1/19/09	Mon 3/2/09
Software Development	Wed 1/21/09	Tue 3/24/09
Module Test and Assembly	Mon 3/2/09	Wed 4/1/09
Debugging/Prototype Modificatio	Wed 3/4/09	Wed 4/1/09
Presentation, Report and Demo	Thu 3/26/09	Wed 4/1/09



Milestone – March 28, 2009





Futurework

- Replace IR sensors with ultra-sound sensors
  - Increase sensitivity, wider detection angle
- Add GPS module to provide point-to-point self-exploratory
- Replace the 4-wheel based vehicle with caterpillar track
- head-up display on LCD provide information on environmental status, compass, etc.
- Use on-board webcam as image processing which enhance obstacle detection
- Enhance path selection algorithm for automation mode

Business Case

- Target Customers:
  - Search and identify harsh location during emergency situation
    - Help rescue team understand the environment before deploy team members
  - Elementary or junior high school
    - Teach students about proper and safety driving
- Competitors:
  - Autonomous vehicle developed for search and rescue
  - Various remote controlled car toy

Business Case

- Original projected cost:
  - CAD $605
- Financing:
  - Funding from ESSEF and personal savings
- Final total cost:
  - CAD$ 1,000
  - Major contribution from Gumstix replacement

What we have learned?

- Feasibility vs. Achievability
- Team Dynamics
- Budget and schedule
- Project development lifecycle
- Circuitry protection
- Parts replacement cost
- Risk management

Acknowledgements

- Patrick Leung – provided technical help and parts searching
- Steve Whitmore – learned the importance of team dynamic and project documentation
- Jason and Jamie – provided constructive feedback on our project which steered us towards to the successive path
- Pascal (pascal@pabr.org) and Gumstix community – provided all possible help on setup the development environment
- Jeff Rudd (rudd@sfu.ca), Director of Lecture Demonstrations in Physics Department – directed us on improving vehicle's mechanical design
- Our parents – having 5 kids that always missed out dinners and family gatherings
- Our group members – tried to avoid all the possible fighting opportunities

References

[1] - *Virtually Driving: Are the Driving Environments "Real Enough" for Exposure Therapy with Accident Victims? An Explorative Study.* **David Walshe, Elizabeth Lewis, Kathleen O'Sullivan, Sun I. Kim.** 6, s.l. : Mary Ann Liebert, Inc., December 1, 2005, CyberPsychology & Behavior, Vol. 8, pp. 532-537.

[2] - *Virtual Driving and Risk Taking: Do Racing Games Increase Risk-Taking Cognitions,Affect, and Behaviors?* **Fischer, Peter, Kubitzki, Jo¨rg and Frey, Stephanie Guter and Dieter.** 1, s.l. : American Psychological Association, March 2007, Journal of Experimental Psychology: Applied., Vol. 13, pp. 22-31.

[3] - *Effectiveness of graduated driver licensing in reducing motor vehicle crashes* **RobertD. Foss PhD, and KellyR. Evenson PhD**: Elsevier Inc. 12 January 1999, American Journal of Preventive Medicine vol 16, pg 47-56

[4] - **Norman, Donald A.** The Design of Eeryday Things. s.l. : Basic Book, 1998. pp. 75-79.0-465-06710-7.

[5] - gumstix developer site - Gumstix Verdex Pro - Feature Overview [Online] [Cited: April 15, 2009.] http://www.gumstix.net/Hardware/view/Hardware-Specifications/Verdex-Pro-Specifications/112.html

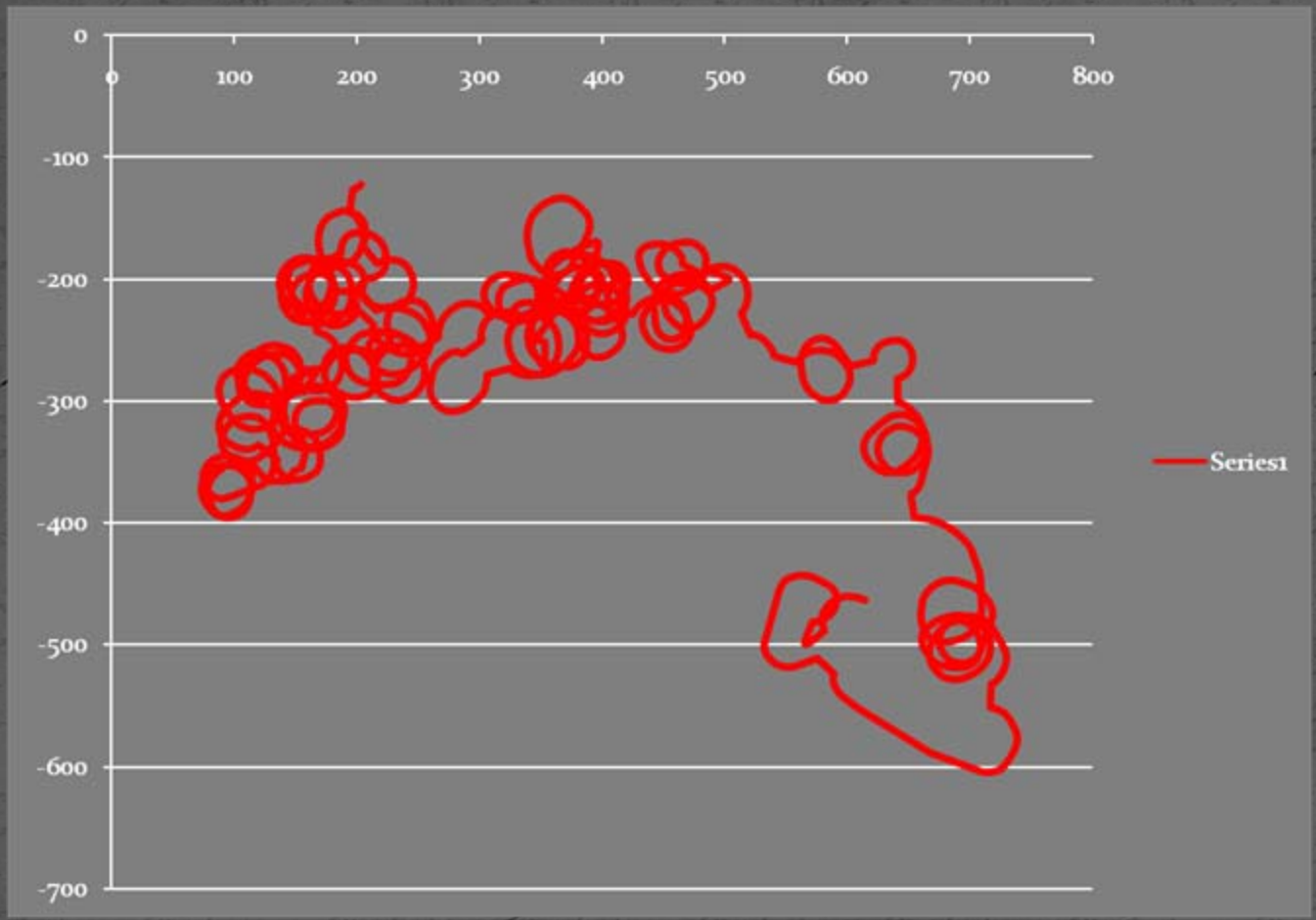
[6] - PlayStation.com - PLAYSTATION®3 - Accessories - DUALSHOCK®3 Wireless Controller:. [Online] Sony Computer Entertainment America Inc., 2008 [Cited: April 15, 2009.] http://www.us.playstation.com/PS3/Accessories/SCPH-98050.

Questions?

Appendix

- Motion Sensing Control
- Automated Mode (8 Sensors)
- Automated Mode (6 Sensors)
- Collision Prevention
- Light Switch

Appendix – Passive Mapping



Appendix

- Real-life application