MSc Embedded Systems Group Project: Task Statement

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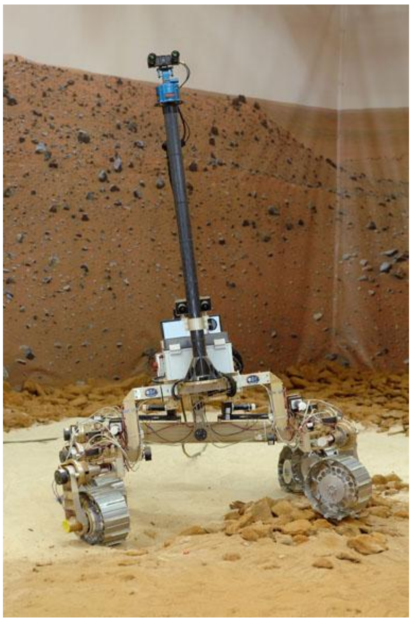
Hazardous Areas Explorer Autonomous Guided Vehicle

Introduction

A wide variety of autonomous guided vehicles (AGVs) are being developed and put to use, to undertake tasks in remote or hazardous locations. These vehicles are made up of a complex system of networked intelligent sub-systems.

In this assignment you are required to work as a team to develop the control system for a prototype explorer AGV, configured to perform a given task.



http://www.astrium.eads.net/en/

The Explorer AGV Preliminary Design

The chassis of the vehicle, including choice and configuration of motors and steering is given. Also given is the power supply. The chassis will have four independently steerable wheels, each driven by its own DC motor, with a servo for steering (see Figures in Appendix 2).

Team Working

The full team (i.e. all those taking the module) will be divided into sub-teams, each one of three or four persons. Each sub-team will be given an AGV sub-system to develop. While the sub-team takes lead responsibility for its individual task, all sub-teams will need to work very closely with each other. In order to produce the finished prototype you will need to integrate all sub-systems together, negotiate physical placement of various payloads, and agree test schedules.

Fabrication of AGV Sub-Systems

The intelligence of each sub-system is provided by one or more mbed microcontrollers, all interconnected by a single data communication bus. For most sub-systems you will need to build a circuit, including an mbed, and interconnect it to power supply, communications bus, sensors and actuators. Local power regulation may be needed, although the mbed does have its own on-board regulator. The mbed mounts easily onto a "bread-board" prototyping unit, which allows other components to be mounted. This should be transferred to a prototyping pcb (printed circuit board) for the final system. It is also possible to design and make a custom pcb, though time may not allow this. You will need to negotiate with other team members on how and where to mount your sub-system on the main chassis, along with any transducers you are using.

Trial Task: Project Demonstration

The AGV will be placed in an area of uneven light, in a space approx 10m x 10m. The ground surface will be comparatively even, but there will be distributed obstacles. These will be approximately square in cross-section, have minimum height of 200mm approximately, and width around 200mm. There will be a space of at least 1m between obstacles. If light is perceived to be uniform, or it is dark, the AGV should remain still. When a light differential is detected, the AGV must navigate to the place where the light is brightest, and then open its solar panel. There is limited time pressure in completing this task, but all obstacles must be avoided.

References

Toulson R and Wilmshurst T. *Fast and Effective Embedded System Design: Applying the ARM mbed*. Elsevier. July 2012. ISBN: 978-0-08-097768-3

The mbed web site. http://mbed.org/

Siegwart, R. and Nourbaksh, I. (2004). *Introduction to Autonomous Mobile Robots.* MIT Press, Cambridge, MA. ISBN 0-262-19502-X.

Appendix 1: Proposed Sub-Systems

Notes:

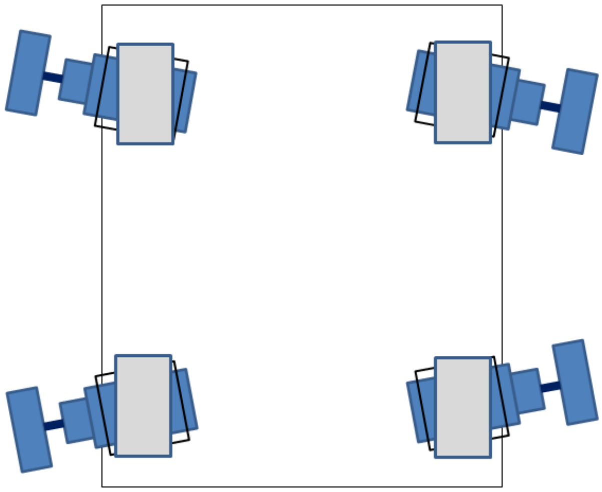
There is some flexibility in defining the exact function of these sub-systems, and in adjusting the boundaries between them.

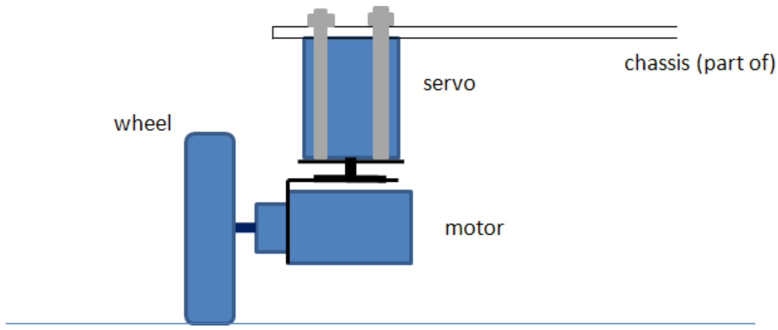
Every sub-system should have a diagnostic mode which demonstrates in some way its functionality independent of the overall system. Test mode should normally be selected by a 2-way switch, with a red LED clearly indicating that test mode is in operation.

Sub-system	**Technical Notes**	**Implementation Notes**
Chassis, motors, wheels (given)	Chassis is approx 400x300mm, with distributed attachment holes for mounting of sub-systems. A 4-wheel system is implemented, in which each wheel can be independently driven and steered.	-
Power supply (given)	A 12V rechargeable lead-acid battery will be mounted on the chassis; it supplies power to all sub-systems. A regulated 5V supply will be taken from this, and will be available for all sub-systems. The mbed can accept this as power input, and regulate internally. Further local regulation will be required for any other supply voltages.	-
Data comms. Bus (protocol agreed by full team)	Links all sub-systems, with agreed protocol and message codes.	Needs to be agreed at early stage by full team.
Central controller and Locomotion	Receives data from all peripheral systems, and provides drive signals to motor sub-assembly. Each needs PWM drive to motor, and PWM drive to steering servo.	Sub-team will need to consider geometry implications of steering mechanism.
Obstacle sensing	Identifies presence of obstacles ahead of AGV, and communicates with central controller.	A possible sensor geometry, using ultrasound sensors, is shown in App. 2.
Light Sensing	Identifies direction of light source, and communicates with central controller.	
Diagnostics	Displays AGV status (Liquid crystal alphanumeric display). Allows test signals to be injected.	Central controller echoes all incoming messages to diagnostics?
Deployable solar panel	At a signal from the central control deploys solar panels; retracts same at other signal. Panel must have area less than 20000mm^2 when closed, and greater than 40000mm^2 when open.	For purposes of this exercise panels need not be actual solar panels, just sheets of card or similar.

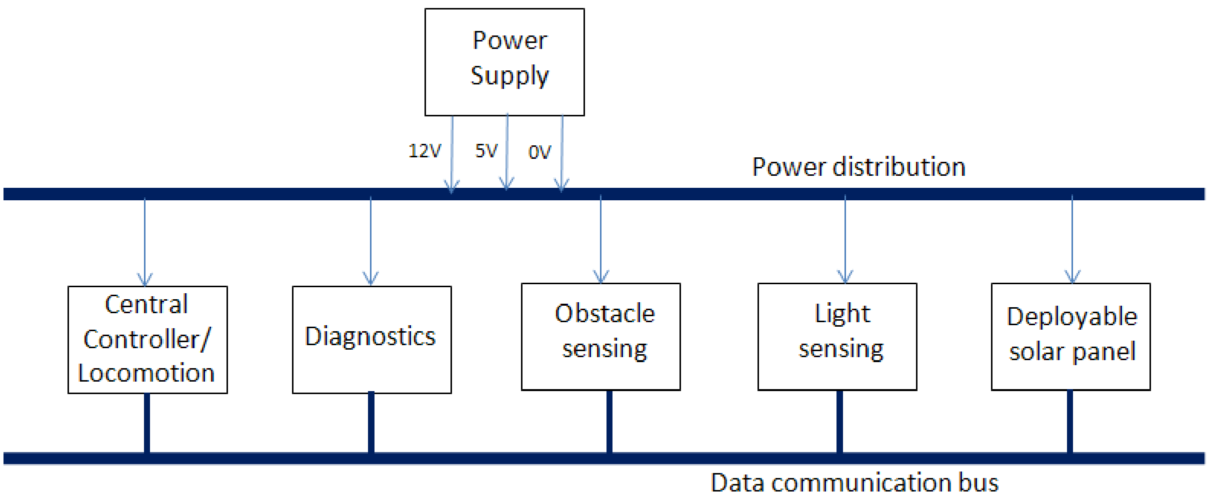
Appendix 2: Some Figures

Chassis and Wheels





Sub-System Internconnection



Obstacle Avoidance