

Fourth Year Project Proposal

Faculty of Systems and Computer Engineering

Project Name: TART

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4 pages incl.

Introduction

This document is a proposal for work on a fourth year engineering project to be undertaken by Brad Barnes (281671), a student in the Computer Systems Engineering program at Carleton University. The project is to be supervised by Prof. V. Aitken of the Systems and Computer Engineering faculty at Carleton University. The project has a duration of 8 months.

The project work will include the design, implementation, and testing of a control system for a pan and tilt unit for a camera on board an Unmanned Ground Vehicle (UGV). The work will also include the design, implementation, and testing of a video capturing device for the camera mounted upon the pan and tilt unit. Methods and media for project group coordination will also be examined and implemented with the emphasis placed on easing the communication between group members in order to decrease project overhead caused by miscommunication. The proposed work is an extension of the work already put forth by previous fourth year project students on the Tracked Autonomous Robotics Testbed (TART) project. As in previous years of the TART project, multiple students will be working on different areas of the project with a small amount of work overlapping. Other members of the TART project will be working on speed control and sensing as well as the operator terminal of the UGV. Included in this proposal is a section describing the project objective, a section describing the motivation for the project, background information relating to the project, a technical overview of the project, and finally a time line of the project's milestones is presented.

Objective

The objective of this project is to improve upon an already existing UGV named TART. Each group member will add new functionality to TART or improve upon an existing functionality. My objective is to improve upon the video camera system in order to provide more precise visual data to the operator while allowing for image processing to be performed on the video data for applications such as map making and autonomous navigation.

Motivation

The proposed work is motivated by the increasing applicability of work in the field of computer vision. Camera pan and tilt control system design will benefit me by giving me an introduction to the fields of robotics and control systems. The proposed work will allow for an image processing platform and solution to be developed in the future for this UGV. Computer vision for a UGV is important for non-interactive data collection in military applications and as well in planet exploration such as will be undertaken by NASA in the mars exploration project¹.

¹ Further Information available at <http://www.nasa.gov/>

Background

Unmanned Ground Vehicles have many applications in many industries. They are primarily operated in environments unsuitable for humans such as mining, military weapons testing, and disaster exploration.

At the time of writing, the existing TART UGV consists of two motor controlled treads, a body encasing, a video camera mounted on a pan and tilt unit, a computer running a real-time operating system to control the motors, and an industrial computer to negotiate commands from the operating terminal to the motors and to collect data. The UGV features two antennas: one for communication between the operating terminal and the on-board industrial computer and the other for sending the video feed to the operating terminal. The tread motors are open-loop controlled, as are the motors for the video camera's pan and tilt unit. The open-loop control of the motors means that they are open to alteration by, but not able to compensate for, external disturbances². The video camera's feed is sent directly to the operating terminal to provide visual aid to the operator. It would be beneficial for all motor controllers to accept feedback and account for errors given by external disturbances. As well, the video camera's feed could be saved for image processing purposes.

Technical Overview

Initially, the examination and implementation of a system to ease the communication and simplify resource sharing between group members will be undertaken. This will involve the creation of a website dedicated to the project on which important news and deadlines may be displayed, as well as a section where data and information can be shared. A web message board or a mailing list will be created in order to ease communication between group members. The entire process will be documented so that other project groups can easily implement a similar communication system.

The pan and tilt unit for the camera will be closely modeled using techniques presented in the course Automatic Control Systems I³. A decision will be made regarding the necessity of replacing the existing open-loop control system with a closed-loop control system in which feedback will be used to account for errors due to external disturbances. If required, a closed-loop control system will be designed, implemented and tested according to techniques presented in the previously mentioned control systems course. This will be accomplished by measuring the output from the motors using potentiometers and comparing the measured signal to a reference signal and adjusting the controls based on this difference. A Handy Board⁴ computer will be used for the pan and tilt motor control. A Handy Board computer is a small and minimalist computing device commonly used to drive DC motors. The Handy Board is capable of controlling four DC motors and features a Motorola 68k series MC68HC11 microprocessor capable of addressing 32K of memory. Software must be developed to control the board and this can be downloaded from a personal computer device by means of a serial link. The board

2 Katsuhiko Ogata, *Modern Control Engineering*. New Jersey: Prentice Hall, 2002.

3 Course description available at <http://www.carleton.ca/cuuc/courses/SYSC/4505.html>

4 Further details available at <http://www.handyboard.com>

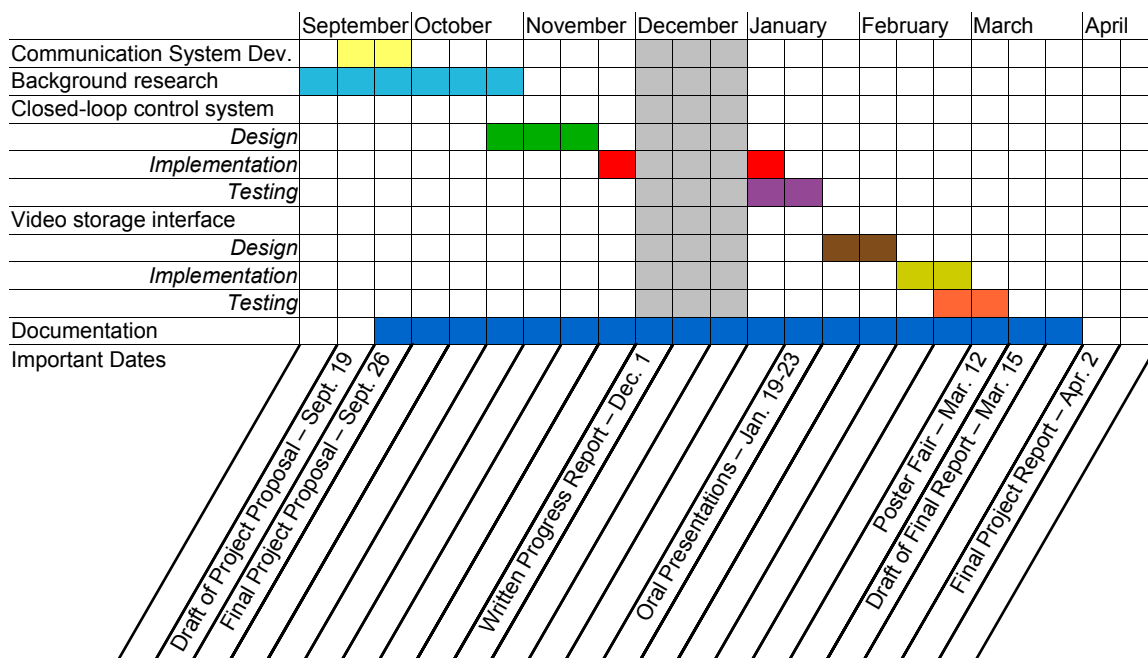
also has several inputs and outputs for digital and analog signals which would make it useful for analog to digital conversion of the feedback signal from the motors being controlled and digital to analog conversion of the signals to control them.

A software driver and an interface to the on-board computer will be developed that will store desired video data on the local hard disk. The software driver may be written from scratch or possibly be extended from an existing video frame grabber that has been developed for the Linux operating system. This video data will be archived as a set of single images with corresponding timestamps, vehicle location information, and camera viewing angle. This will allow for the images to be processed to recognize objects, create maps of foreign environments, or for the images to simply be stored for recording vehicle use. A set of image processing tools from the HIPR2 image processing reference⁵ will be used to test this environment.

All work will be documented and presented for future project or research use.

Schedule

A proposed schedule for the project follows.



Please note that the month of December is reserved for exam writing and vacation time.

⁵ More information available at <http://www.dai.ed.ac.uk/HIPR2/>