Locomotive Platform for Colony Robot

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Abstract

Research of multi-robot cooperation, mesh networking, social interaction, epidemic simulation, traffic congestion management, and much more can take place in a robot colony. This research is often more successful, and always more interesting to watch due to the physical nature of the colony. It is this project's aim to develop and build a prototype mechanical base that could be mass-produced to create robot colonies.

1 Background

Traditional robot colonies have been limited by available hardware. The robots have to be large to hold large computers and large batteries to carry them. Moving a large robot requires large motors and wheels, further increasing the overall size. If you have a large number of large robots, the environment in which they exist must be enormous. All of this increases the cost of building and maintaining the colony.

Robot colonies have also been limited in terms of mobility. The vast majority of colonies have been built with tracked or differential drive robots. Due to the nature of these kinds of drive systems, these robots can turn in place, but must turn toward the direction they wish to translate before translating. Since there is this 'front' of the robot, any constantly scanning sensor must be mounted on an additional actuator so that it can point away from the direction of motion. These additional actuators also increase size and weight of the robot.

2 Our Approach

Available hardware has limited the size and capabilities of previous colony robots. Recently, however powerful computers have physically shrunk thus consume less power, requiring smaller batteries. Motor systems and gear trains are now able to be manufactured with greater precision, and thus can be made smaller. Sensor systems have also shrunk with the onset of smaller surface mount components and micro-controllers. All of these technological improvements will allow our hardware base to be smaller and cheaper than traditional colony robots.

Our prototype colony robot will use a holonomic drive system. This kind of drive system allows for independent rotation and translation, that is, the robot can point in one direction and drive in a completely different direction. This has a few distinct advantages over traditional locomotion systems. First, it allows for faster response time, since the robot can directly translate in any direction. Thus there is no longer the delay of waiting for the robot to first turn to that direction. Secondly, all sensors on the robot are effectively mounted on a pan head since rotation and translation are decoupled. This allows the main sensors of the robot to point at a target object while the robot moves at any vector around the object. Sensors will not have to be mounted on additional actuators, which will decrease size, weight, and cost of the robot.

When designing the prototype colony robot we are going to consider simplicity, reliability, and cost in that order. Of course, simple designs are often more reliable and less expensive. Robot reliability includes how often the robots break, how easy they are to diagnose, and how easy they are to fix. When a large colony of robots exists, reliability concerns are key, otherwise more time might be spent fixing robots in the colony than running the colony. The prototype colony robot will address this concern by doing as much self-diagnosis as possible and intentionally being designed for simplicity. It will be outfitted with a variety of sensors that will allow it to diagnose battery failure, motor overheating, motor failure, increased friction in the drive train, and loose connectors.

Fundamentally we want to develop a inexpensive, stable, and reliable colony robot. We want a robot that will operate for an extended period of time, be self-diagnosing when things do go wrong, and be designed for easy maintenance. These are high aims, and we know we have to start low, so we expect many design iterations.

The electronic and software systems will be developed in parallel with the mechanical base. They can be developed and tested in test stands before the mechanical base is complete. This sister-project has a separate SURG grant proposal and is named 'Electronic Platform for Colony Robot.'

3 Participants

Chris Atwood	Junior	Mechanical Engineering
Richard Juchniewicz	Sophmore	Mechanical Engineering
Felix Duvallet	Freshman	Electrical and Computer Engineering
Ryan Kellogg	Freshman	Electrical and Computer Engineering

Many of these students have taken classes in the mechanical engineering department that have taught basic mechanical engineering principals. Additionally many of these students are familiar with the software package that we will be using to draft and model the robot in Solidworks.

Chris Atwood, project leader, has also had a lot of experience in robot design for manufacturing, which will be our primary concern in designing the prototype. He has also worked on past Robotics Club projects, last year helping to lead the Urban Search and Rescue Team.

4 Research Plan: Milestones & Results

I: Specifications November 1, 2003

This milestone will produce a detailed specification document. The document will outline minimum performance specifications and list the constraints and assumptions of the project.

II: Initial Design November 29, 2003

This milestone will produce computer models of our initial subsystem designs. All sub-systems, batteries, drive train, sensors, as well as custom control electronics mounting will have been investigated and preliminary subsystem designs will be integrated into a complete prototype design.

III: Initial Design Built December 13, 2003

This milestone will produce an initial physical prototype that is ready for reliability and performance testing. All aspects of the design will be subjected to an exhaustive and extended duty test to locate points of failure in the design.

IV: Refined Design March 21, 2004

By this date a second design iteration of the base should be complete and tested, ready for the third and final design iteration if necessary. At this point the electronics should be out of bench test phase, so both will be tested together for the final design iteration.

V: Refined Prototype June 18, 2004

This milestone will produce a complete refined prototype that will be mass-produced to make our colony the following year.

At this point the project will be in its second year. We have not planned this far in advance but fundamentally we will prepare to build a colony of the robots we have designed. Additional funding will be procured and necessary materials will be purchased. When the environment and robots are complete, benchmarks will be taken, documentation produced, and the colony open for public use.

5 Dissemination of Knowledge

The robot design developed from this project will be presented at the Meeting of the Minds in May of 2004. We also plan on entering the AAAI exhibition at the AAAI conference. Furthermore, we will submit a paper to the newly established undergraduate research journal describing the final robot design developed, as well as the performance characteristics of the robot.

6 Budget

The budget this year is for the sole purpose of building the several prototype robots.

Estimated costs:

6 Batteries:	$100
6 Motors:	$200
6 Encoders:	$200
Gears:	$100
Custom machining:	$300
6 Wheels:	$100
Total:	$1000