2013 ASABE Robotics Competition Challenge

Introduction

The 7th annual ASABE Robotics Competition will be held in Kansas City, Missouri. The competition is a part of the 2013 Annual International ASABE Meeting and will last from July 21 to July 24. The challenge theme is taken from an agricultural practice of the host region. The theme this year comes from the hay industry of which Missouri (and Kansas) plays a large part. For this challenge, the theme is to pick up hay bales and stack them in barns. Hauling hay has historically been a very physical, labor-intensive job. Mechanization has reduced most of the heavy lifting by humans with machinery. Automation in the hay industry will nearly completely eliminate human interaction with hay and will require robots to make decisions that would otherwise be made by humans operating machinery.

Figure 1. A farmer hauling round bales using his tractor and a trailer.
The Challenge

The challenge will be held on an 8ft x 8ft flat, smooth board. The board will be marked in a grid marking every square foot and colored sections in the corners to designate hay stacking areas. The stacking areas are intended to hold a specific color of hay bale. Robots are tasked to pick up, haul, and then stack the hay bales within a 5 minute time limit.

There is no limit on the number of robots allowed in the competition. However, all of the competing robots must fit into two cubes of 12in X 12in X 12in at the beginning and end of the run. A single robot will be limited in size such that it fits into a cube 12in X 12in X 12in at the beginning and end of the run. However, it is permissible for the robot to increase its overall size during the run. There are no limits to budgets or technologies utilized. Be creative.

Hay Bales

Scott 1000 toilet paper will be the basic hay bale. There will be 12 hay bales: 3 different colors with each color including 4 bales. The paper rolls will be spray painted using FAST DRY SPRAY PAINT available at Wal-Mart, in red (25005 Fire Red), green (25002 Kelly Green), and blue (25001 Royal Blue). The bales will be placed at random and centered on the nodes of the competition board by the judges. However, bales should not be placed on the outside nodes. The bales should be
placed with their flat ends orthogonal to the board. The teams are allowed to
designate the bales orientation.

**Hauling**
The bales should not be dragged, pushed, rolled, or damaged by the robots. Robots
should not collide with the hay bales or with other robots. There is no rule limiting
the number of bales that a robot can carry.

**Stacking**
The hay will be stacked in its designated stack areas according to color. The
designated stack areas are at the corners of the board. The bales will be stacked
with their flat ends parallel to the ground. More points will be awarded to higher
stacks. A stack must stand for at least one minute to be designated so many high.

![Figure 3. Hay stacked in designated locations and as high as possible.](image)

**Guidance**
The board will have a grid of standard 0.75 inch black, vinyl electrical tape (or paint)
for basic guidance. The grid will include 7 lines for both the x and y coordinates of
the board, thus marking the board into square feet. Other guidance systems, such as
a laser system, are permissible but may require additional modifications to the side
rails and are the responsibility of the design team. The MDF board itself cannot
have any modifications. See “Development of a Tabletop Guidance System for
Educational Robots” for an example of a laser guidance system.

**Report and Presentation**
The competition also includes a report and presentation of the team's design. The
report should be limited to 10 pages. Each team should provide three printed copies
of their report to the judges at least 48 hours prior to the competition. The
presentation will be limited to 10 minutes per team. A computer and projector will be available with PowerPoint at the time of presentations. The presentation will be followed by a short question and answer period.

**Scoring**

For the challenge, teams will be evaluated on their speed, handling of the hay, barn selection accuracy, and on stack neatness. This competition encourages communication between robots and a remote station and awards bonus points for such activity. For each additional and cooperating robot, 20 bonus points will be awarded and for a remote station displaying robot activity, 60 bonus points will be rewarded.

Placement of the bales within their correct stack locations is worth 10 points per bale for a maximum 120 points.

Stacking bales 2, 3, or 4 high will be worth 20, 35, or 50 points, respectively, for each stack.

Runs will have a time limit of 5 minutes. Teams will be rewarded a point for each second that is under their time limit.

Human interaction with the robot, after the beginning of the run will cost teams 20 points per interaction. Human interactions are explained further in the FAQ section.
Board Overview
FAQ

What is “Human Interaction,” and how does it apply to the prescription phase? Human interaction occurs when a person interferes with or assists the robot. For example, if the robot is following the black grid and loses its way, a human moving it back to the line would cause a penalty. Human interaction also includes moving hay bales or adjusting a guidance system during the run.

How is the competition board constructed? What do we need to know to build our own?
The board will be constructed of 3/4” Medium-Density Fiberboard (MDF), available from any building supply store. The side rails will be standard 2x4 dimensional lumber, ripped to 1 inch by 3.25 inch. The board and rails will be painted with a white paint available from Lowes. If your local Lowes doesn’t have it in stock, you can special order it and pick it up within three days, typically. Lowes item 346385. Standard sheets of MDF have an actual width X length of 49” X 97”. This is important to note: you will either have to cut the sheets, or put your rails inside the edges. Also, get a gallon of paint if paint fresh MDF. A quart won’t cut it because the MDF soaks it up. The board will be built of four pieces of MDF to make it easier to move and to store. Dimensions for building a board that can be nested to take up less room will be available soon.