Robot MicroTract

ROS Agriculture (ROS-A) is a focused initiative using the Robot Operating System (ROS) for agriculture.
The guiding principles of ROS-A are Do No Harm and Isaac Asimov's "Three Laws of Robotics"

Functional Safety

A **robot** may not injure a human being or, through inaction, allow a human being to come to harm. A **robot** must obey orders given it by human beings except where such orders would conflict with the First **Law**. A **robot** must protect its own existence as long as such protection does not conflict with the First or Second **Law**.

Safe operating area
Building a remote kill switch
Vehicle Estop
Robot Bumper

MicroTrac Build Documentation

- Matt Log
- Twitter - @ROSAgriculture
- ROS-A Discussion thread - https://discourse.ros.org/t/ros-a-microtractor-build-with-open-source-ecology/2830

Notes: Working Visit at the Open Source Ecology site

Nov 4th, 2017

- Update ROS Driver for Razor IMU
- Order Relay

October 24, 2017

- Sensor fusion
- State Estimation Nodes - from ROS
- Move_basic - face direction of motion and go
- Follow_waypoints
- Sohin - ssohin@autlook.com - joined us - Yamaha just donated a vehicle to make it autonomous. Grad student at U. Indiana, will publish all work. Including weed detection for corn.

Project Use Case - Self Driving Chicken Tractor

[Video example]

- 50’ x 300’ field - chicken tractor application

Vehicle Automation Resources

http://ardupilot.org/rover/

GPS overview - http://ardupilot.org/rover/docs/common-positioning-landing-page.html
How GPS works - http://ardupilot.org/rover/docs/common-gps-how-it-works.html
Inertial measurement unit (IMU)

How an IMU works

Software

Robot Operating System - ros.org - Getting Started Guide
Gazebo Simulation - gazebosim.org
Tutorial - http://wiki.ros.org/ROS/Tutorials
Online Training - http://www.theconstructsim.com/
Books - Programming Robots with ROS

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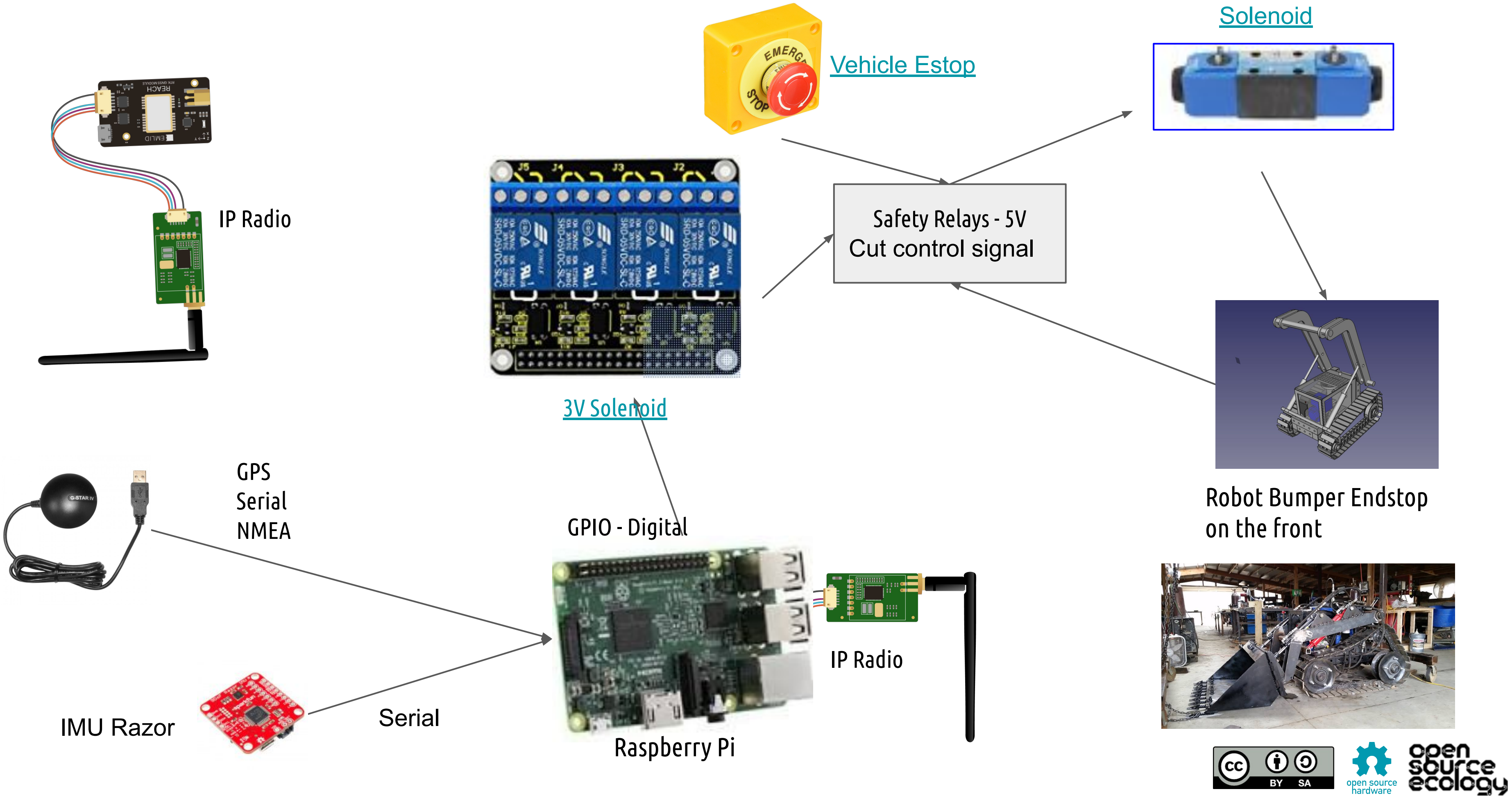
ROS Tractor MVP

Ground Control Station



Hardware

Hardware

- Raspberry Pi 3
- Keyestudio 5V DC\AC 4-Channel Relay Shield Module Expansion Board for Raspberry Pi 3
- SparkFun 9DoF Razor IMU MO
- Waterproof SiRFIV USB GPS Receiver
- Radio - Ethernet
- Vehicle Estop and Remote Estop
- hydraulic solenoid

Automation

Simulation

- 3D model of microtractor
- Gazebo Simulation - gazebosim.org
- **MicroTrac Simulator Repo**
- **Hightmap for Gazebo**
    - Digital Elevation Model - first link on top of this
        - Google Map coordinates - Factor e Farm
        - Create a DEM for Gazebo http://gazebosim.org/tutorials?tut=dem

Software

Software

- Project Repository
- Packages
  - Gps http://wiki.ros.org/nmea_navsat_driver
  - Imu https://github.com/jeremy-a/razor_imu_9dof
  - Gps to pose http://wiki.ros.org/gps_common
  - Nav stack http://wiki.ros.org/robot_pose_ekf
    - Notes https://answers.ros.org/question/12663/gps-navigation/
  - Move basic https://github.com/UbiquityRobotics/move_basic
  - Follow waypoints https://github.com/danielsnider/follow_waypoints
  - Geonav_transform? - Simple transforms for using GPS-based estimates for local odometry in ROS
  - To-be-developed raspberry pi track control for microtrac (Jeremy has basic starter python code)
    - Basis https://sourceforge.net/p/raspberry-gpio-python/wiki/BasicUsage/
    - https://github.com/chrisspen/rpi_gpio
    -

Considerations

- Remote monitoring
  - Long range wifi from Pi
  - Remote access using DDS and ROS1_bridge?
- Future simple goal based navigation
  - Is the soil suitable to host chickens? If not, move on
  - Deep learning soil characterization

Raspberry Pi Base Image

Future Tests using:

- Beagle Bone Black
- Beagle Bone Blue - essentially BBB with better connectors
- ErleBrain2 - MCU, runs on a raspberry pi
- Pixhawk - runs on a Cortex M4.
- SwiftNav Piksi -
- PX4Flow
- Vision Tracking using Pixy
- Intel RealSense
- Zed Stereo Camera

Industry Standards - Examples

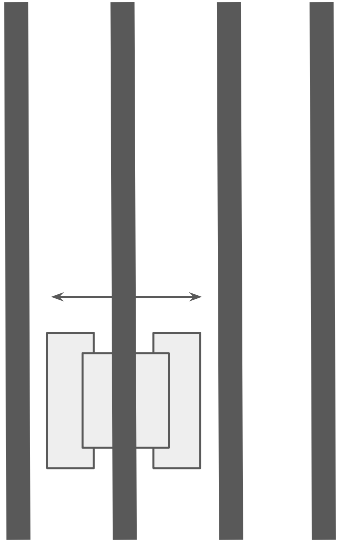
- Weed detection in 3D images paper
- An Autonomous Robot for Weed Control paper
- A Vision System for Autonomous Weed Detection Robot paper
- Plant localization with kinect paper
- Machine vision system for weed detection paper
- Commercial system: Garford robocrop more..
- European project Galileo

OpenCV Tractor - Motion Strategy

- Tractor file
- Swift Navigation
- Strategy - marker every 4 meters - machine straddles markers
  - Calibration marker at start
- Application - weeding a 1.5 acre field - about 100m by 20 meters
- Accuracy desired - 3” from plants

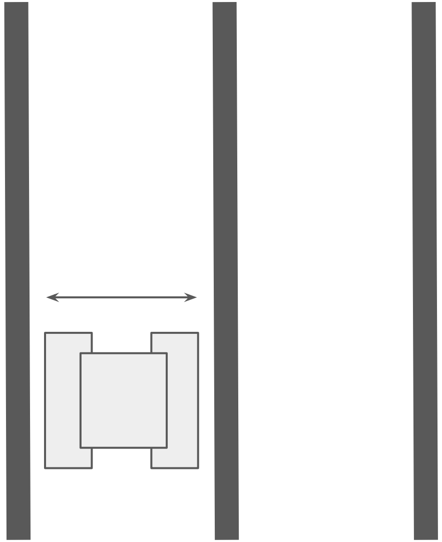
Case 1 - easier as it looks over a line

Case 1

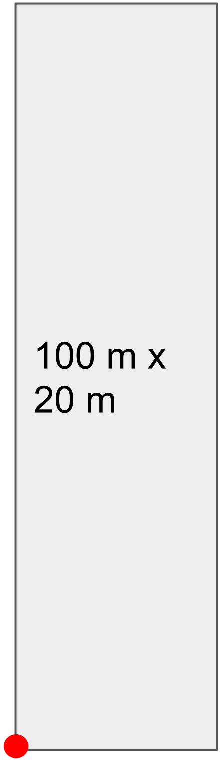


~¾ meter plant spacing

Case 2

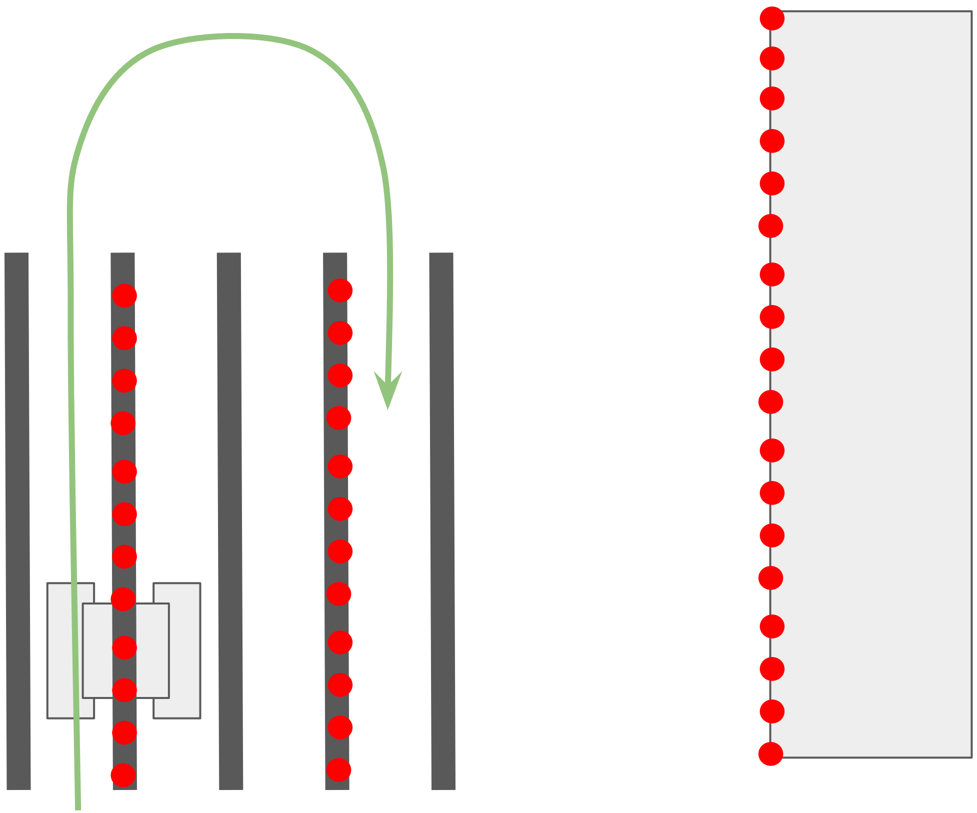


~1.5 meter plant spacing



Turning

- Space at both ends
- Hardware -
    - Raspberry Pi 3 -> Raspberry Pi 0
    - Camera - also amazon
    - Solenoids - $400 for 4
    - Relay - 8 channels
        - 4 channels for 2 sides of tracks
        - 2 channels for a raising/lowering cylinder
        - 2 channels for a Power Takeoff motor
    - Power Cube v17.018
        - FreeCAD file Download
    - Solar Power Cube
        - 14 fpm at 1 kw, we expect 2 fpm at 200W - 720 feet per day for a 6 hour sun day - or 250m per day 1750 meters per week - or 34 rows or about 25 meters width of 100 m
            - Whole 20x100 meter field in less than a week



Next Step: Sample Data

Take a picture of this area:
From what height? Height of camera, or 1 m.