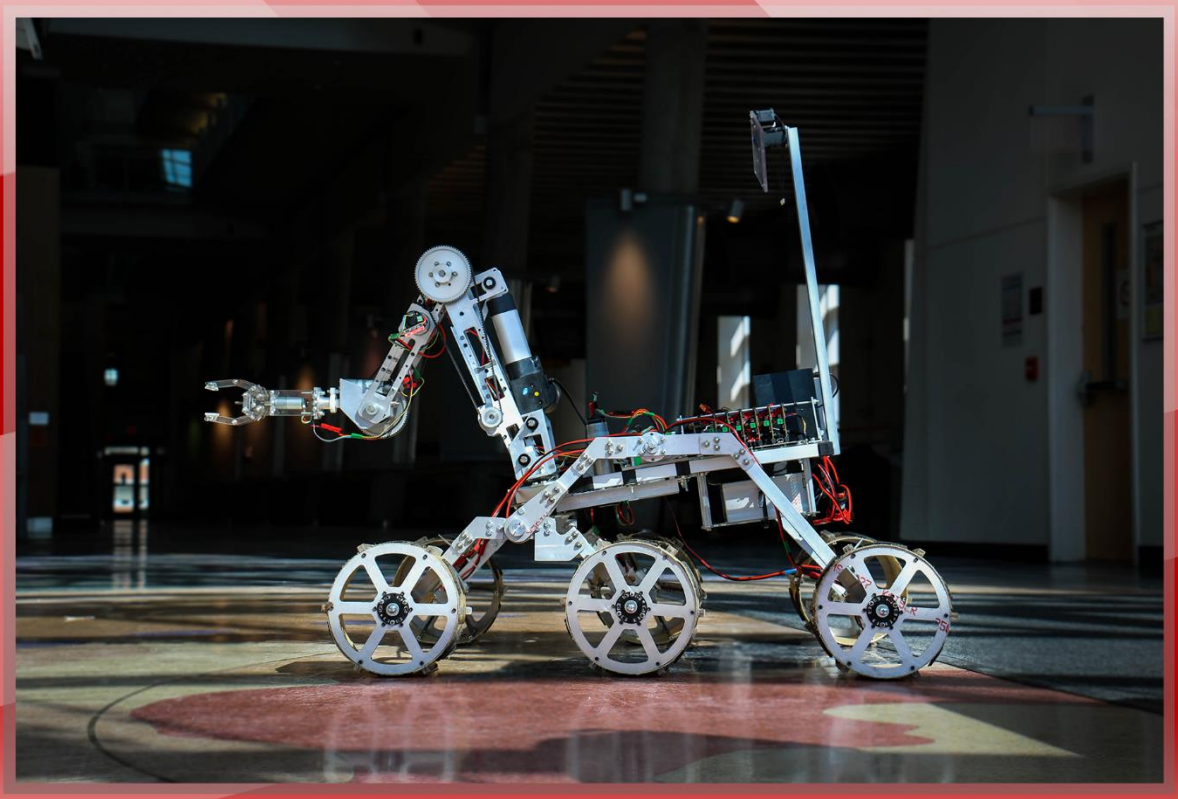
# Wisconsin Robotics

## Spring Newsletter



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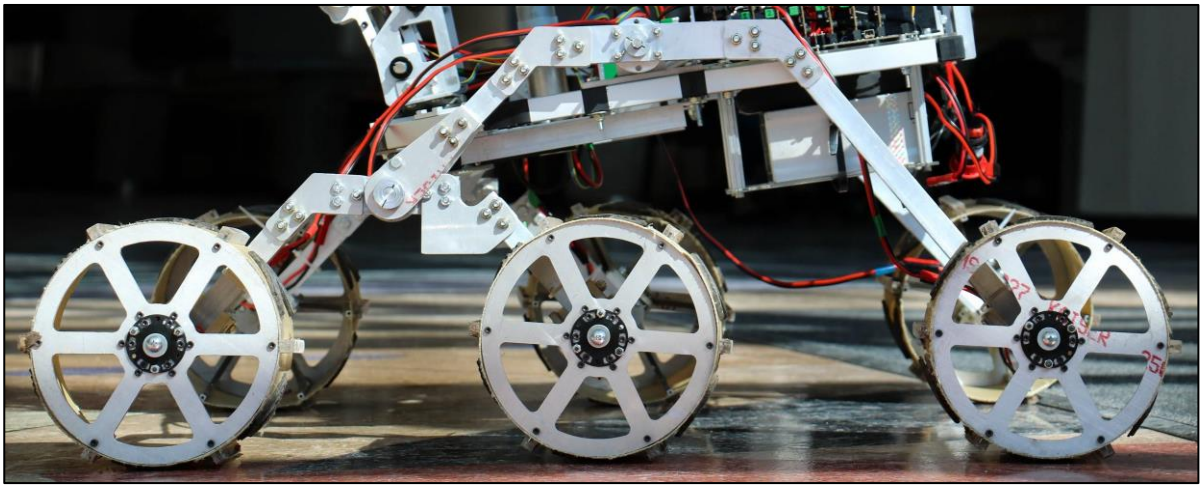
# The Team and Ascent

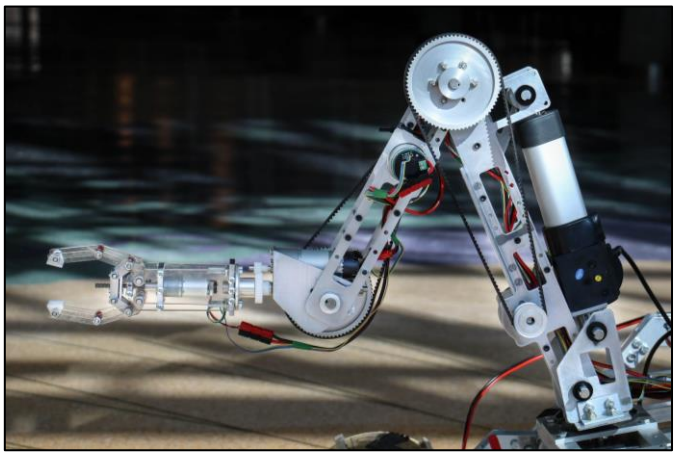
Wisconsin Robotics is made possible through generous donations from our sponsors. These contributions, both financial and in-kind, allow the team to develop advanced robotic systems for international competitions and remain involved in community outreach to inspire K-12 students to pursue STEM. We are grateful for the continued support of our sponsors, University, and extended community. To this end, we have compiled a newsletter detailing our work and activity thus far in the 2016-2017 academic year.

Wisconsin Robotics spent the fall and early spring semester designing and creating prototypes for the University Rover Challenge (URC), and has recently completed the first iteration of our competition rover, Ascent. Per the competition rules, the team submitted a design proposal which served as a competitive down selection, determining which teams will be invited to test their rovers at the Mars Desert Research Station in June. With great pride, Wisconsin Robotics is excited to announce that out of eighty-two teams to apply, we one of thirty-six to be given the opportunity to compete at URC. Our video submission for this design review can be viewed on our YouTube channel.



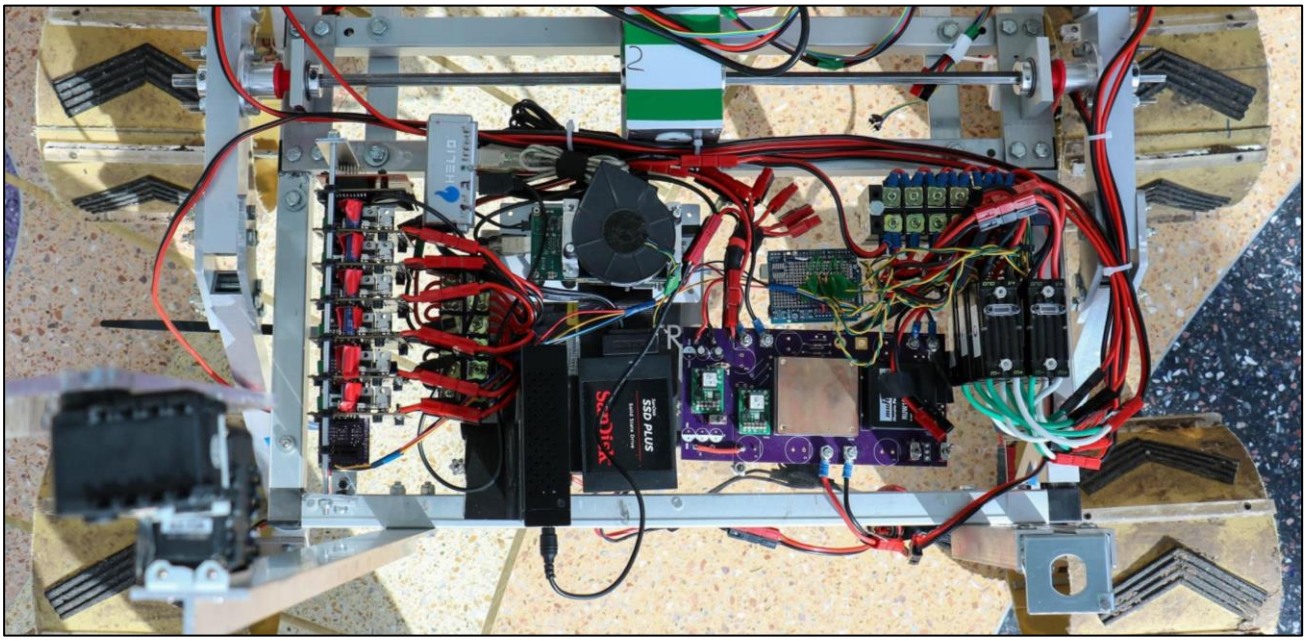
## Mechanical

Ascent's drive system is the rocker bogie, inspired by NASA's Curiosity Rover. This allows Ascent to navigate a multitude of terrain from sandy fields to rocky slopes in excess of 45°. Ascent also features a robotic arm to accomplish the manipulation focused tasks. The design priorities of the arm include ease of control and strength to complete all tasks at URC.



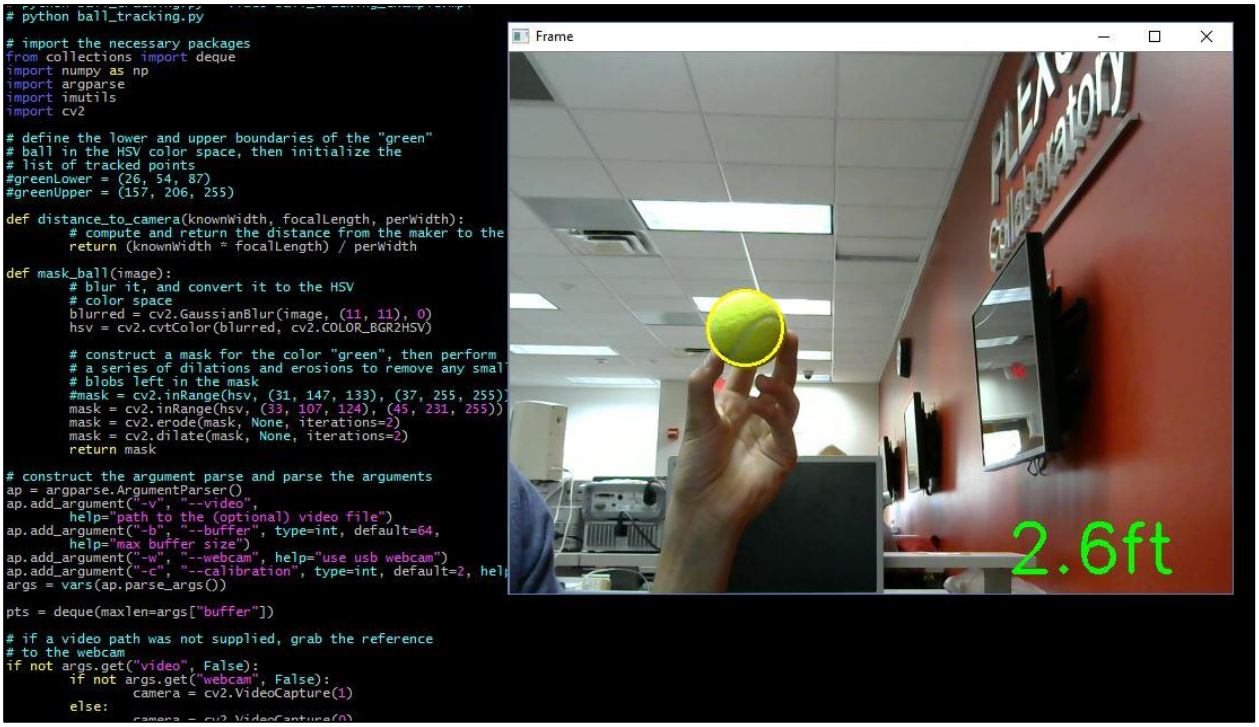
## Electronics

The main body of Ascent houses all onboard electronics, science equipment, and cameras. All electronics are housed in the back half of the rover, including the antenna and a two degree of freedom camera mast. Two additional cameras under the front corners provide overlapping views in front of the rover. With multiple tests throughout the year, the communications system has proven to work wirelessly at 1 km line-of-sight. The base station will include a directional antenna to allow for greater throughput and better penetration through obstructions.




## AI and Simulation

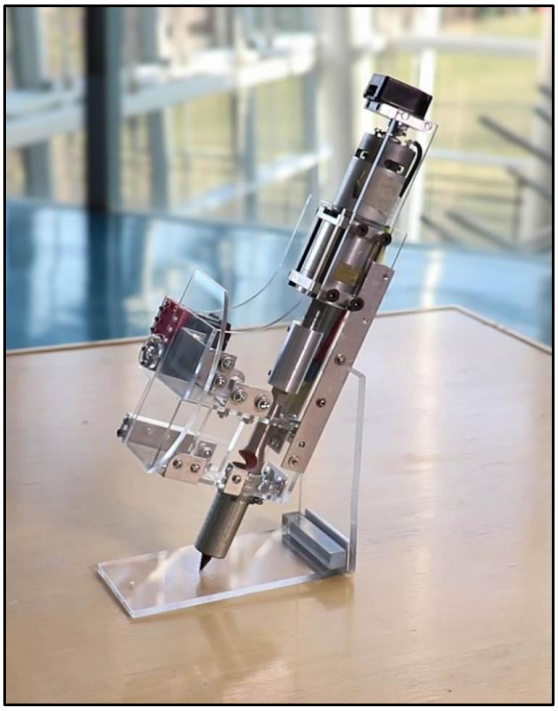
The AI & Simulation team has been hard at work preparing for the Autonomous Traversal task. For obstacle avoidance, obstacles are detected using the onboard 360-degree scanning Robopeak RPLIDAR. When an obstruction enters within 2 meters, the obstacle avoidance code notifies the robot to avoid the obstruction. Once avoided, Ascent will continue to drive toward the gate. The color of the ball at the gate is detected by specifying a range of acceptable HSV (hue, saturation, value) values and keeping only the pixels within that range. Distance to the ball is estimated by comparing the width in pixels of the detected ball to a reference. In order to test our code before the rover is fully assembled, the AI & Simulation team uses Gazebo, a physics-based simulation environment, to emulate the onboard software and simulate the entire rover. We have been able to test well before Ascent was fully assembled, allowing for a far more advanced development cycle.




```
# python ball_tracking.py

# import the necessary packages
from collections import deque
import numpy as np
import argparse
import imutils
import cv2

# define the lower and upper boundaries of the "green"
# ball in the HSV color space, then initialize the
# list of tracked points
#greenLower = (26, 54, 87)
#greenUpper = (157, 206, 255)

def distance_to_camera(knownWidth, focalLength, perWidth):
        # compute and return the distance from the maker to the
        return (knownWidth * focalLength) / perWidth

def mask_ball(image):
        # blur it, and convert it to the HSV
        # color space
        blurred = cv2.GaussianBlur(image, (11, 11), 0)
        hsv = cv2.cvtColor(blurred, cv2.COLOR_BGR2HSV)

        # construct a mask for the color "green", then perform
        # a series of dilations and erosions to remove any smal
        # blobs left in the mask
        #mask = cv2.inRange(hsv, (31, 147, 133), (37, 255, 255))
        mask = cv2.inRange(hsv, (33, 107, 124), (45, 231, 255))
        mask = cv2.erode(mask, None, iterations=2)
        mask = cv2.dilate(mask, None, iterations=2)
        return mask

# construct the argument parse and parse the arguments
ap = argparse.ArgumentParser()
ap.add_argument("-v", "--video",
        help="path to the (optional) video file")
ap.add_argument("-b", "--buffer", type=int, default=64,
        help="max buffer size")
ap.add_argument("-w", "--webcam", help="use usb webcam")
ap.add_argument("-c", "--calibration", type=int, default=2, help
args = vars(ap.parse_args())

pts = deque(maxlen=args["buffer"])

# if a video path was not supplied, grab the reference
# to the webcam
if not args.get("video", False):
        if not args.get("webcam", False):
                camera = cv2.VideoCapture(1)
        else:
                camera = cv2.VideoCapture(0)
```

## Science

The science team has selected a wide variety of scientific instruments for this year's competition, both for onboard the rover and for the lab analysis. Onboard the rover, a soil temperature and humidity sensor and a microscopic imager will provide methods in which we can analyze our acquired sample. For the lab portion, the primary focus will be on the chemical composition of the soil. A number of chemical tests including Benedict's Test, Lugol's Test, the Sudan IV Test, and the Biuret Test will be conducted to test for simple macromolecules needed to sustain plant life.



## Minibots

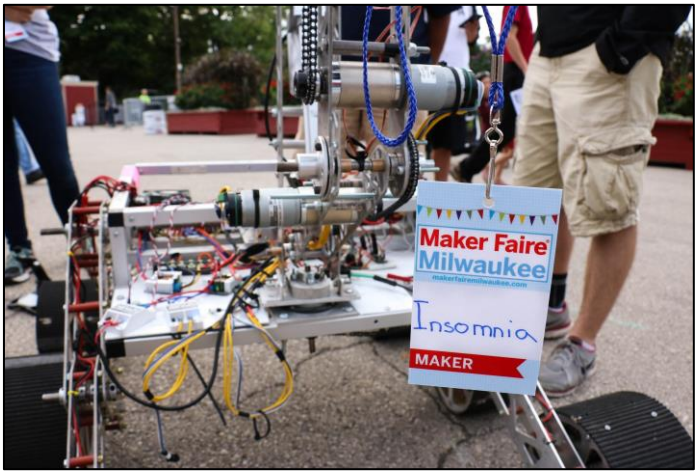
This year, we also have a minibot subteam dedicated to creating fun, interactive robots for use at our outreach events. The minibot team is creating laser tag-playing robots and is nearing the first completed prototype with a goal of having an operating fleet soon thereafter.

# Community Outreach and Events

Over the last year, we have attended nine outreach events, interacting with over 18,000 individuals. At these public events, we demonstrate our current projects which include our competition rover and Atlas - an autonomous tour guide project - as well as having minibots and our 3D printer to explain how we design and prototype parts. Our goal at these events is to inspire interest in STEM fields, particularly in robotics, while showing our appreciation of our sponsors.

## Maker Faire Milwaukee

In late 2016, Wisconsin Robotics attended Maker Faire Milwaukee, an event taking place on the state fair grounds. Aimed at showcasing various community 'makers', Maker Faire is a great opportunity for the team to show our projects to the Milwaukee community. At Maker Faire, the team showed off its 2016 competition rover, Atlas, as well as one of our older minibots, Rascal.



## Science Festival

A state-wide event, Science Festival in Madison is hosted by the Wisconsin Institutes for Discovery (WID). Aimed at K-12 students, Science Festival is a great opportunity for Wisconsin Robotics to talk about our projects and help build our relationship with the WID.

## Glenn Stephens

Glenn Stephens Elementary School hosts a yearly science fair and asks Wisconsin Robotics to attend. We take great pride in being able to interact with our community on such a personal basis, and to also show why the pursuit of robotics is exciting to K-12 students.

## Girl Scouts Activate

Girl Scouts Activate is an event centered around showing exciting STEM exhibits, in early December. Inspiring young women to pursue STEM careers is important to Wisconsin Robotics. We were able to bring our 2016 competition rover as well as Atlas.



## Saturday Science

Another event hosted by the WID, Saturday Science is a monthly event featuring interactive stations focused on a particular project. Wisconsin Robotics attended the Robotics themed Saturday Science in early December 2016.

Wisconsin Robotics is able to pursue and ultimately succeed at challenging and educational projects thanks to our sponsors. With your help, we are able to develop our skills, create our robots, and inspire interest and excitement in STEM fields. For this, this we are sincerely thankful--this could not be done without your help.

# A Special Thank You to our Sponsors!

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