

Automating 3D April Tag Collecting

Manuel Meraz

Moses Biological Computation
Laboratory



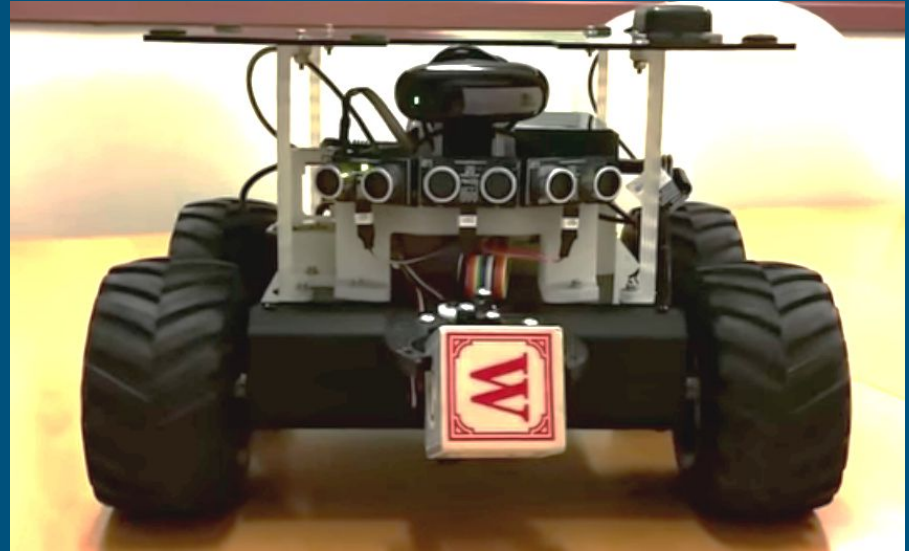
How I learned about the **NASA Swarmathon**

- Participated in the inaugural of the Swarmathon competition held in 2016
- Helped form the Arduino Inventions & Robotics club at Southwestern College
- Club Mentor introduced me to the Swarmathon
- Received DREU internship here at UNM



Building a **Swarmie**

- Provided feedback on assembly manual for future competitions
- Improvement in understanding of how the rovers function from the inside out



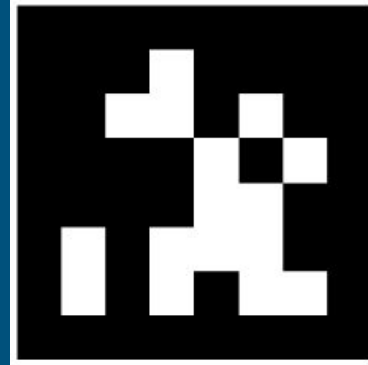
Tracking April Tags

- Goal: The detection of April Tag coordinates to locate and track 3D objects
- Steps required:
 1. Read through April Tag library and see where April Tag data is stored
 2. Convert April Tag data to a ROS data type and share it through a topic
 3. Use a ROS message to draw a polygon frame by frame in GUI

About the April Tag **Data**

- The library provides us with a 2D array container that contains april tag corner coordinates and the center coordinate
- The library keeps track of the orientation of the april tag and maintains, so the top left corner is always unique and constant

Top Left



Top Left

Sending Tag Data Through a **Topic**

- Inserted data into custom message type in *shared_messages* package
- Originally wanted to grab specific corners and draw a square
- Realized the a polygon would be necessary, rather than a square due to warping from 3D world to 2D plane
- Order of coordinates is irrelevant to connect lines



Drawing the tags in the GUI

- Receive ROS message containing coordinates
- As each frame is processed, use Qt library to draw a polygon frame by frame
- Message contains all april tags detected by the rover at all times

```
void QPainter::drawPolygon(const QPointF * points, int pointCount, Qt::FillRule fillRule = Qt::OddEvenFill)
```

Draws the polygon defined by the first *pointCount* points in the array *points* using the current pen and brush.



```
static const QPointF points[4] = {  
    QPointF(10.0, 80.0),  
    QPointF(20.0, 10.0),  
    QPointF(80.0, 30.0),  
    QPointF(90.0, 70.0)  
};
```

```
QPainter painter(this);  
painter.drawPolygon(points, 4);
```

New tool to visually debug

We can now:

1. Visually test how April Tags are detected by the rovers and under what conditions they do not detect april tags
2. Approximate distance of tags
3. Create subscribers to easily access April Tag coordinate information through the `/rover_name/targets` topic

Miscellaneous Work

- Troubleshooting network issues with laptops and rovers
- Set up mesh network with old routers in new lab to provide ethernet access to desktops
- Set up new router for the 14 rover demonstration
- Installed network printer and wrote script for driver installation on Ubuntu machines
- Simple bash script for one tap of power button of rovers to send the proper shutdown signal
- Help teach other interns whenever they have questions about ROS and the rovers

New Mexico

South Sandia Peak



Winsor Trail in Santa Fe

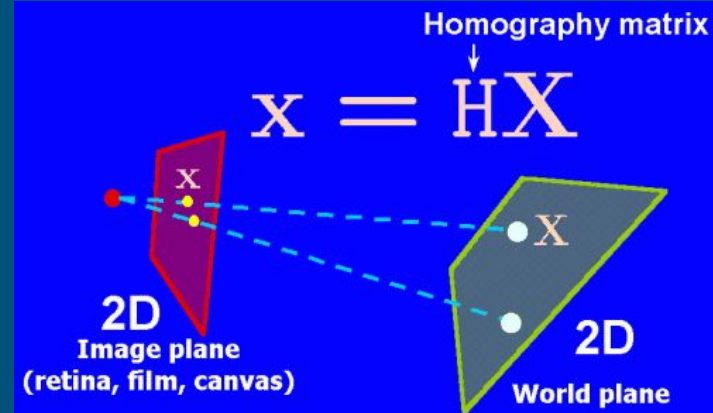


Wheeler Peak in Taos



The next **step**

- April Tag library comes with homography matrix
- Calibrate camera and use data to calculate real world coordinates relative to camera
- Unsure how accurate this will be
- Alternative method would be triangle similarity



$$z_c \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = K \begin{bmatrix} R & T \end{bmatrix} \begin{bmatrix} x_w \\ y_w \\ z_w \\ 1 \end{bmatrix}$$