would benefit to have a single program that switches between the two signals.

The Calliope's color recognition can be improved when color segmentation is properly defined. It is unfortunate that light and shade play a major role in color recognition. In some case, orange or pink can be seen as red; while green as blue. Therefore, color calibration should be done prior to any deployment. Unfortunately, it is unlikely to calibrate colors due to uncertainty on lighting.

What can be improved?

Because Calliope only has a 2D-Arm (Figure 1), which means it can only pick up a standing object (i.e. with height that Calliope 2D-Arm can grab). However, it will not be able to pick up any object that lies down in a tray or on the floor. Therefore, a toolkit tray must be in vertical arrangement. If Calliope has a 5D-Arm (Figure 7, a prototype), it can be maneuvered to pick up both standing-up and laying-down objects.

Figure 7: Calliope with 5D-Arm[1]

The robot should be able to navigate through known and unknown area. Mapping and localization should be integrated with a robot navigation system such that its position is known in the map, including origin and destination.

Drawback: Calliope (i.e. iRobot Create) is not an ideal robot for a space mission that requires a robot to navigate on a planet surface, such as Mars. Calliope can move on a smooth surface; therefore, its body has to be modified to support less ideal surface. Larger or stronger wheels and more body-height from the ground are potential solutions.

Potential applications: While an outer space mission is unlikely, Calliope with 5D-Arm can be used in other area such as a mechanic working underneath a car and needing different tools. Instead of getting out and up for them, the mechanic can tell the robot what tool to retrieve.

References

Olson, E. (2011). AprilTag: A robust and flexible visual fiducial system. *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, 3000-3407, IEEE.

Tira-Thompson, E.J., & Touretzky, D.S. (2011). The Tekkotsu robotics development framework. *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, 6086-6089.

Touretzky, D.S. (2010). Preparing computer science students for the robotics revolution. *Communications of the ACM, 53*(8): 27-29. New York, NY.

---

[1] http://wiki.tekkotsu.org/index.php/File:Calliope-armv4.jpg