Affordable Application of Rocker-Bogie Suspension
Matt Collard, Isaac Brooks, Stephen Rencher, Miguel Guerrero
Colorado State University Robotics Team: SandRams

Abstract

Sand Rams is seeking to provide the consortium with a small rover that is capable of autonomous navigation over terrain similar to that on mars without the use of GPS or similar positioning systems. The system will prioritize affordability, durability, and functionality throughout the design process. The final rover will not only demonstrate the team’s technical capabilities (given our late-starting period) but will also demonstrate an understanding of the future of Martian exploration. Primary goals include designing a method of locomotion and navigation that can withstand the conditions of an unpredictable environment.

Introduction

In the field of robotics there is a constant struggle to balance the overall reliability with the necessary functionality within a given design. The increasing complexity of a machine comes with an increasing number of issues regarding its mechanical reliability as well as the costs associated with its construction. In an effort to reduce these failings, Sand Rams researched suspension systems that took advantage of as few moving parts as possible while retaining fluidity and stability. Additionally, it’s necessary to integrate common materials that use mass manufacturing processes that maintain consistency in material specifications and offer easy part exchangeability.

Frame

The first design component considered was the method of locomotion. Throughout the process of researching the various options, 3 methods stood out for this application: treads, 4-wheel drive, and 6-wheel drive. Treads offer reliable mobility on sand as well as favorable climbing ability but would require too many components and make the robot too heavy. Six wheel drive offered all the advantages of 4-wheel drive but with the added potential of implementing a rocker-bogie suspension, and would be far cheaper to implement than a tread system. In the end we came to the same conclusion NASA did, that the 6-wheel rocker-bogie system would prove to be most effective for our application. Parts can become expensive due to both raw material costs and the physical forming. Sand Rams initially created an aluminum frame. While light weight, it struggled with stability and adaptability. 3d printing was considered and experimented with but yielded heat-warped parts that took too long to make. The final design saw the implementation of PVC used for the majority of the frame parts but also included features from the aluminum design and utilized 3d printing to form uniquely shaped parts.

Design Evolution

The initial design included an ABS plastic body, limbs, and electronics housing. The design proved to be affordable, but lacked the durability to withstand the sand dunes and was susceptible to warping.

The second design iteration was made up of an entirely aluminum frame. The design was also affordable, but was not rigid enough to successfully navigate the terrain, and the rocker-bogie suspension was ineffective due to the flexible nature.

The final design iteration involved an aluminum electronics housing, aluminum joints, PVC limbs, and an ABS housing connector. This design proved to be the most effective, being affordable as well as more than strong enough to withstand the sand dunes and provide an effective rocker-bogie system.

Electronics

A variety of sensors were tested and analysed to determine their applicability within the scope of the project. The main board of the rover was a droboad Romeo board, based on the Arduino Leonardo.

A primary sensor for the robots spatial reference was its compass. As one of the first systems implemented, we ensured we had a calibration procedure.

Ultrasonic sensors were experimented early on in the design evolution but lacked precision for the desired tasks when in sandy environments.

Rotational lidar was considered, but deemed impractical to complete before the deadline. Stationary lidar was chosen for obstacle detection with 3 sensors and a 60 degree FOV.

Conclusion

The primary goal for this project was to develop a small autonomous robot, capable of navigating unconventional terrain. With a late start, the Sand Rams have designed an effective and accessible system that proves an explorative rover can be developed at an affordable cost. Our time was cut short with only the frame of the rover being complete without the electronics being mounted. The electronics functioned as intended in our testing rig with us getting data from the compass, ultrasonic sensor, and motors. Given more time, integration of the electronics and general debugging could have resulted in a complete working rover.