An Overview of the Stanford SLASR Sensor

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Abstract:
The SLASR (**S**harp **LAS**er **R**angefinder) measures range using a LASER diode, and an augmented infrared range sensor, such as the Sharp GP2Y0A02YK. In addition to LASER modifications, the optical path and circuit were revised to reduce noise and provide a greater range measuring capacity. The SLASR has been tested on a hopping leg platform that is part of a galloping robotic project. Compared to GP2Y0A02YK, the SLASR features significantly reduced noise (<10% RMS) and wider range. This allows for it to be used as part of a drift control mechanism and related precision robotic applications.

Introduction and Modifications:
The SLASR is a general, low-cost visible rangefinder designed to be simple and straightforward (shown in Fig. 1). It is based on the inexpensive and popular Sharp rangefinder series.

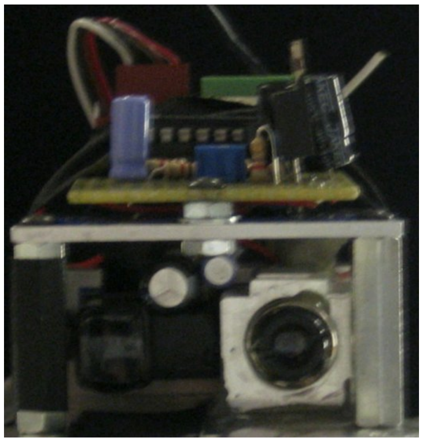

Figure 1. The Stanford SLASR adds a diode laser, aspherical camera lens, and tuned filtering circuitry to the Sharp GP2Y0A02YK sensor

The SLASR has an adjustable range of 10 *mm* to 4 *m* and a detection envelope of 1 *cm* to 3 *m*. It uses the existing Sharp detection array to detect a separate laser beam emitted and synchronized with the device. Additional circuitry is used to filter the Sharp driver and sensor output. The SLASR response time is determined by the detection array on the Sharp unit, which is fixed at approximately 30Hz. It keeps the Sharp sensor's 3-wire analog interface (i.e., +5, Ground, and Signal), and its favorable economics – an approximately $20 parts cost.

Compared to commercial laser range finders the SLASR has less accuracy and resolution, and is more color/angle sensitive. However, the SLASR has a very light weight (< 50 grams), no moving mechanical parts, is tunable to custom specifications, and has very good economics. This make the SLASR more robust in the high-acceleration environment encountered in a galloping quadruped and results in minimal interference by the sensor with the robot's dynamics. In addition, the unit adds a low-pass filter to the laser drive signal, and a second-order active filter (Sallen-key type) to the sensor output. Additional modifications include mechanisms for aligning the LASER, and setting the sensor array distance precisely for the detection range and envelope desired. This construction is complicated by the need for an aspherical focus lens and precise LASER alignment.

Experiment:
The principal application for the Stanford SLASR is the KOLT galloping robot, pictured in Figs. 2 and 3. Range to ground is used in order to better control robot attitude. Tests were performed on a passive boom arm mechanism (see also Fig. 4) in order to test the SLASR and the attitude updating method. The sensor results from these experiments, depicted in Fig. 5, show improved range sensitivity and significant noise reduction.

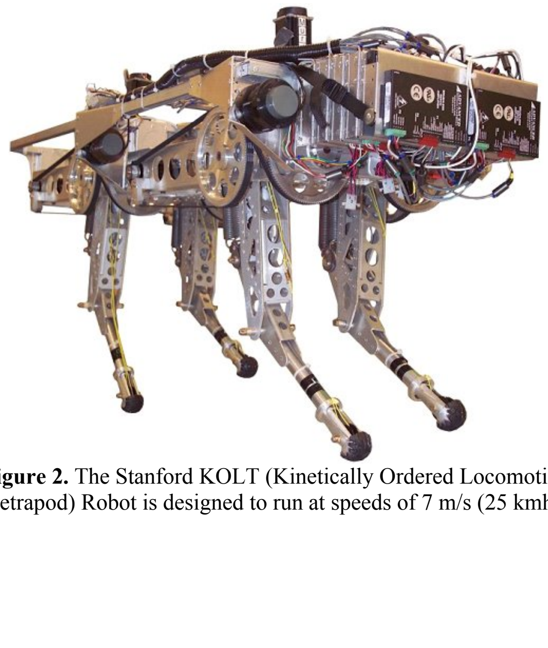

Figure 2. The Stanford KOLT (Kinetically Ordered Locomotion Tetrapod) Robot is designed to run at speeds of 7 m/s (25 kmh).

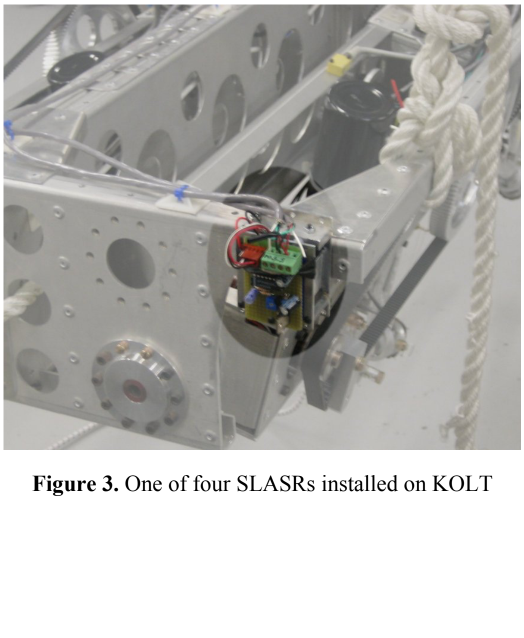

Figure 3. One of four SLASRs installed on KOLT

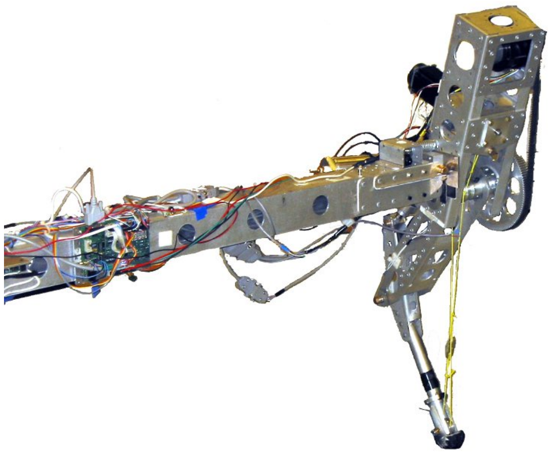

Figure 4. The KOLT leg connected to an instrumented (and passive) boom arm.

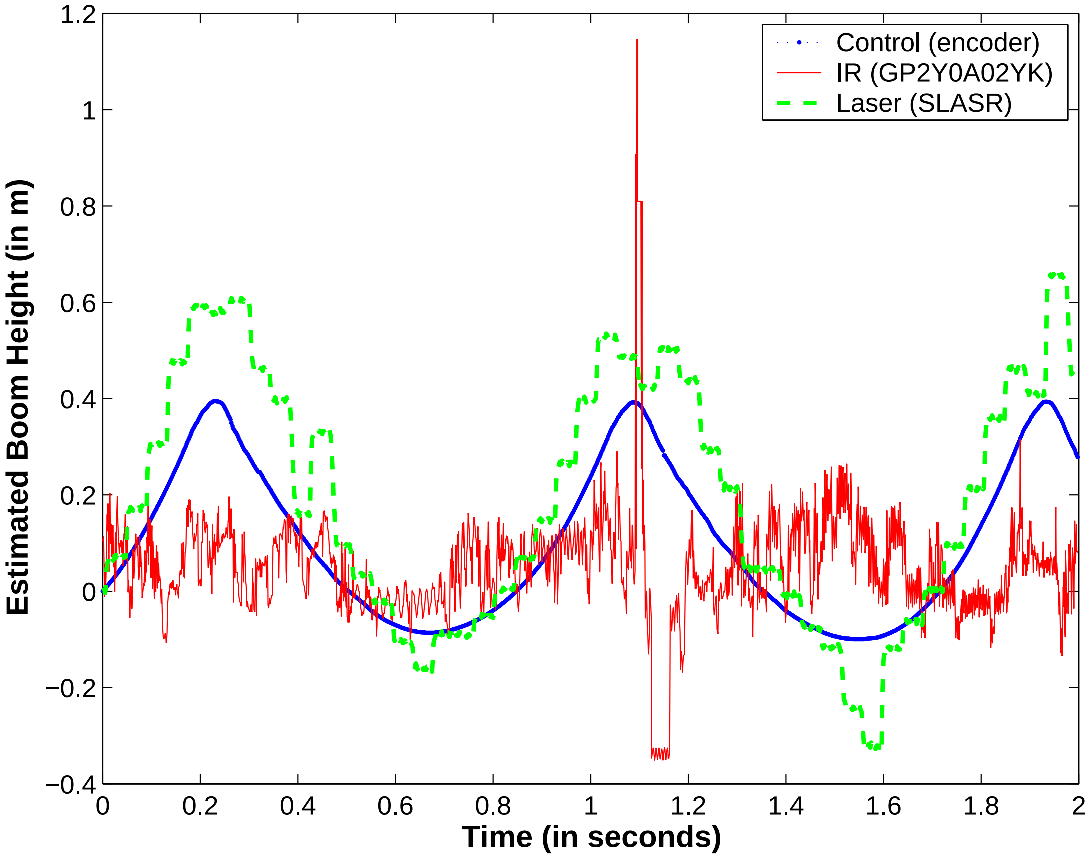

Figure 5. Range measurements as sensed by the Sharp infrared unit and the SLASR.
Reference values are provided from a 24,000 count/revolution encoder connected to the boom arm.

Conclusions and Future Work:

The modifications to a commercial Sharp rangefinder allow for distance detection on a dynamic quadruped. The range sensor is compact, easy-to-use, and available at a price-point that allows for multiple installations on the robot and for its use in various robotic projects.

The SLASR is promising, but remains color sensitive. While the latest tests show that on its specific target surface, lighter scuffs, footprints, some amounts of dirt, and various other marks do not affect the measurements in any significant manner, more significant alterations to the surface can cause sensor error. Its output, like that of the commercial Sharp part, is non-linear and requires additional processing (and/or linearization circuitry) to provide precision operation. The unit presents several opportunities for improvement that will allow for future uses, including the addition of a separate microcontroller to manage the output