NEW SCALE TECHNOLOGIES
Ingeniously Small Motion Systems

APPLICATION NOTE
May 3, 2010

Reference design

Auto focus for pico projectors using a SQUIGGLE RV micro motor, TRACKER position sensor and an ultrasonic rangefinder

New Scale has developed a reference design that demonstrates the smallest solution for adding auto focus to a pico projector. The design uses New Scale's piezoelectric SQL-RV-1.8 Reduced Voltage SQUIGGLE motor, NSD-2102 drive ASIC, NSE-5310 TRACKER position sensor, and a commercial ultrasonic rangefinder.

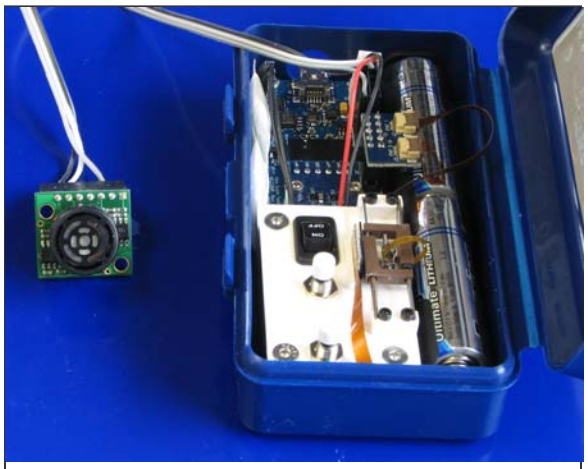


Figure 1: New Scale's closed-loop Developer's Kit, shown with the LV-MaxSonar-EZ0 ultrasonic rangefinder, is used to demonstrate a pico projector auto focus system. The developer's kit contains the SQUIGGLE RV micro motor, NSD-2101 drive ASIC, TRACKER position sensor and a PC interface board with development software.

Overview

Pico projectors that incorporate a focusing lens typically provide only a manual dial to adjust the focus of the projected image. An opportunity exists to automate the lens focus using a small microcontroller, a rangefinder, a lookup table or polynomial equation to convert projection distance to lens focus position, and a closed-loop motion system consisting of a piezoelectric SQUIGGLE micro motor and TRACKER non-contact position sensor. If the pico projector also includes a camera, the autofocus feature of the camera, instead of a separate rangefinder, could be used to establish focus.

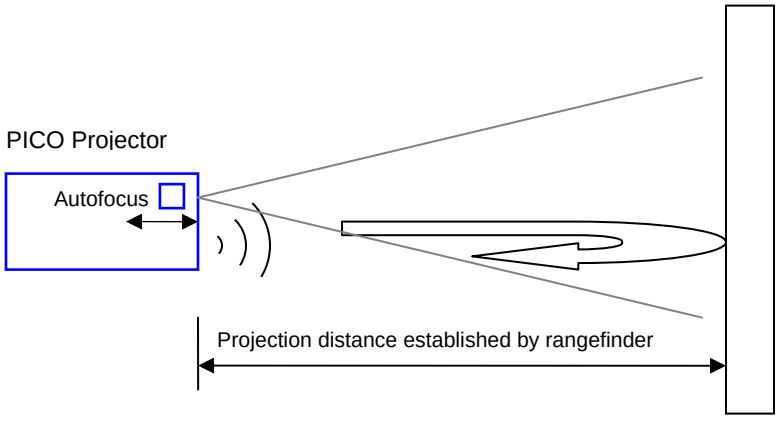


Figure 2: Pico projector with rangefinder

Any autofocus system for a pico projector must be very small, and draw very low power. New Scale has demonstrated the smallest possible autofocus system using the SQL-RV-1.8 SQUIGGLE motor with NSD-2101 drive ASIC and the TRACKER position sensor. The complete closed-loop system is very small, very precise, and offers extremely low power consumption, achieved through features such as off-power hold and proprietary motor control algorithms.

©2010 New Scale Technologies, Inc. ▪ 121 Victor Heights Pkwy ▪ Victor, NY 14564
Phone (585) 924-4450 ▪ FAX (585) 924-4468 ▪ **www.newscaletech.com**

System Description

The reference design features an SQL-RV-1.8 Reduced Voltage SQUIGGLE motor precisely controlled through a closed-loop feedback system which includes an ultrasonic rangefinder and our NSE-5310 TRACKER position sensor.

We used a developer's kit model DK-RV-1.8-TRK-33, which includes the SQUIGGLE motor, driver and TRACKER position sensor, and an off-the-shelf ultrasonic rangefinder (LV-MaxSonar-EZ0 from MaxBotix) to provide position information to the controller (figure 1)

Custom firmware on the MC-3300-RV controller (included in the kit) monitors the pulse width output of the rangefinder to determine the projection distance (figure 3). It then commands a move of the SQL-RV-1.8 motor to that position. *Note: Lens, lens mount and optical or electro-optical components are not included in this reference design.*

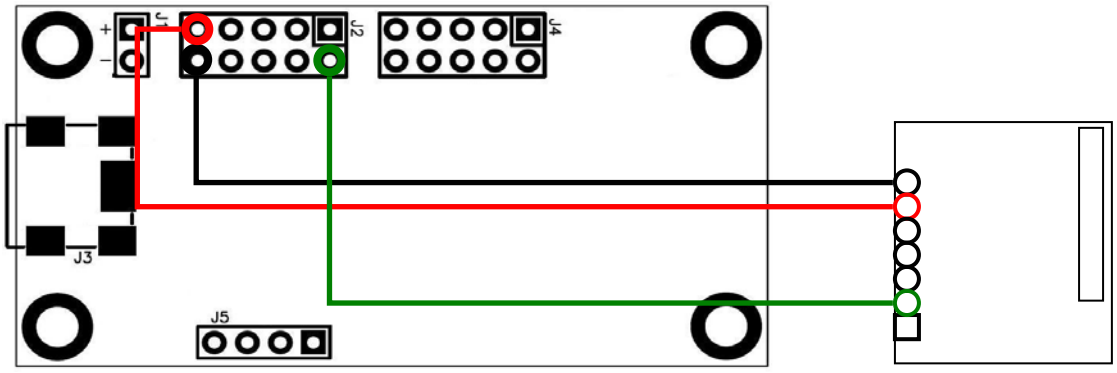
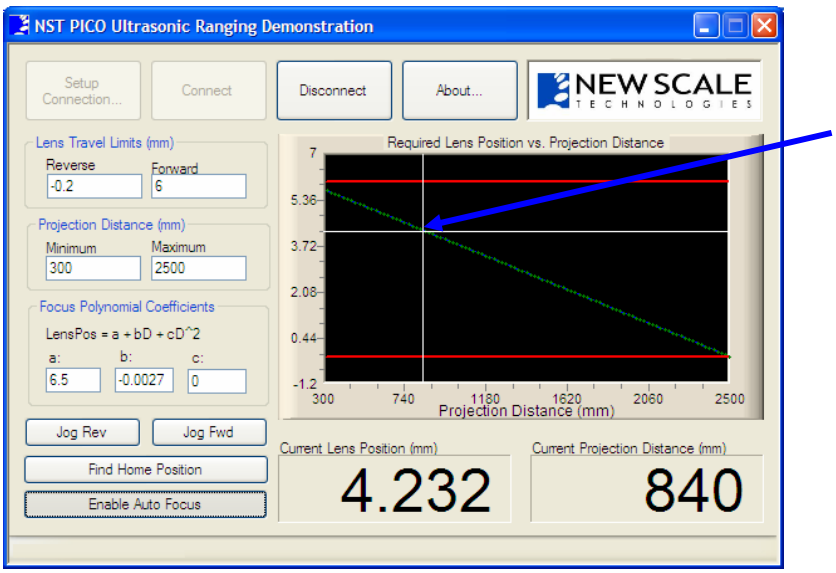


Figure 3: Connection between MC-3300-RV and MAXSonar-EZ0

A custom PC application was developed to configure a polynomial that establishes the relationship between the measured projection distance and the required lens position to focus the image. The polynomial coefficients are downloaded to the MC-3300-RV controller. The controller queries the rangefinder and adjusts the motor to maintain that relationship. The PC program shows autofocus in progress by displaying the actual lens position vs. desired position for focus, based on the current projection distance (figure 4).



Intersection is the current lens position and projection distance.

Figure 4: PC demonstration program showing projector auto focus in progress

Pico Auto Focus Implementation Scenarios

Figure 5 illustrates system configuration options. The microcontroller performs the following tasks:

- Queries projection distance from rangefinder (or ISP, if available). In New Scale's reference design, the rangefinder generates a pulse every 50 msec. The width of the pulse width is proportional to the distance.
- Uses distance either to index the lookup table, or as a coefficient in a polynomial, to get appropriate lens focus position.
- Initiates move-to-target process within its PID control loop.
- Schedules the next distance query.

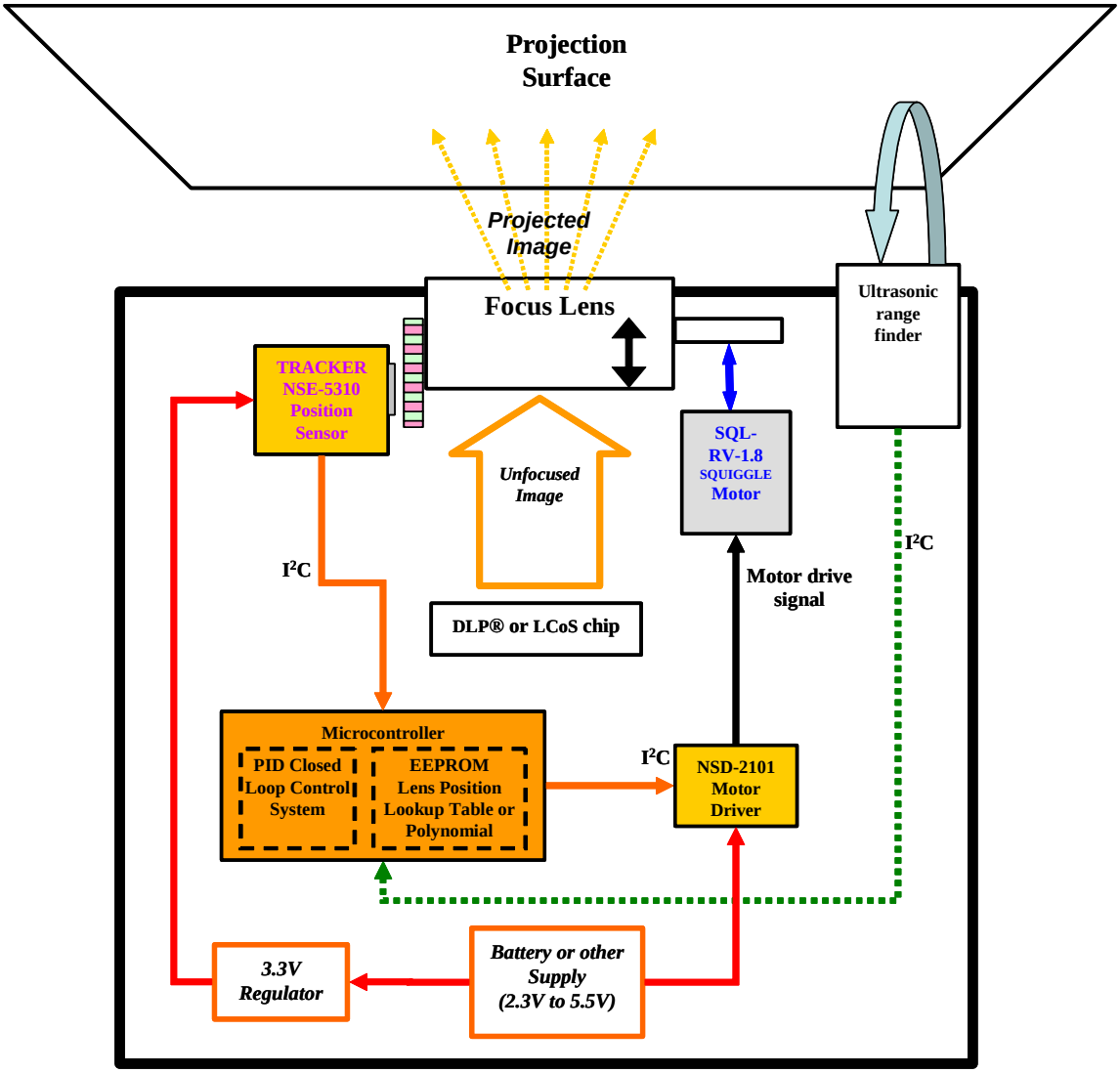


Figure 5: Pico projector autofocus

For more information

Purchase the DK-RV-1.8-TRK-33 developer's kit referenced in this design note at http://shop.newscaletech.com. For access to the custom PC application or for more information about auto focus applications, contact New Scale at +1 585 924-4450 or email sales@newscaletech.com.

SQUIGGLE is a registered trademark and TRACKER is a trademark of New Scale Technologies, Inc. DLP is a registered trademark of Texas Instruments.