Living Learning Community Project: Low-Cost Dual-Extrusion 3-D Printer

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Each year the residents of the Engineering Living Learning Community (or Engineering House) at Lake Superior State University (LSSU) designs and builds an engineering project intended to provide real world experience to those students. For the 2012-2013 academic year the Engineering House has designed and built a rapid prototyping (RP) machine that will increase the capabilities and reduce the rapid prototyping costs for the School of Engineering and Technology at LSSU.

LSSU currently owns an RP machine which cost approximately $36,000. The goal of this year's project was to develop an RP machine of equivalent accuracy and capabilities while staying within a budget of $2,000. To meet this goal, off-the-self components were utilized wherever possible, not only did this reduce the initial cost but also the operating and maintenance costs as well. For those components that could not be purchased, the parts were machined in-house by the students. While there are other low-cost designs for RP machines, such as the MakerBot Replicator 2x ($2,800) [1], this custom RP machine offers several advantages.

First, the structure is primarily comprised of machined aluminum components giving a more ridged structure than competing designs constructed from non-metallic materials [1]. This additional rigidity reduces vibrations within the machine allowing for more accurate printing. To provide accurate movement of the extrusion head, the y and z axes are controlled using an acme-screw drive system powered by stepper motors, providing high torque along with the required accuracy. To compare relative accuracies, the MakerBot Replicator 2x has a positioning precision of 0.0004in. [1] compared to 0.00091in. calculated for the Engineering House 3D printer.

Secondly, instead of a proprietary control system, this RP machine uses an Arduino based microcontroller with an open source firmware (Marlin) [2] and 3D printing software (ReplicatorG) [3]. The use of open source software not only reduces the cost of the RP machine, but also provides additional flexibility. Future additions and/or modifications (such as additional features) can be implemented with an update to the software.

With the heated bed requiring up to 20A [4] and the remaining electrical components requiring approximately 10A, a sizable power source was required. To power the system, two independent 430W power supplies were purchased, one of which is dedicated solely to the heated bed. With this configuration, the control system is isolated from voltage transients that can occur as the heating bed is turned on/off. This also allows smaller, less expensive power supplies to be purchase reducing startup and maintenance costs.

Overall, the Engineering House has explored many avenues to reduce the cost of building and maintaining this RP machine and as a result, has produced a machine that is of significantly lower cost than the current RP machine owned by LSSU.

Bibliography

[1] "MakerBot," MakerBot Replicator 2x, [Online]. Available: http://store.makerbot.com/replicator2x.html. [Accessed 07 March 2013].

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[3] "ReplicatorG," [Online]. Available: replicat.org/start. [Accessed 13 March 2013].

[4] "12V Silicone Rubber Heater Bed," QU-BD Store, [Online]. Available: http://store.qu-bd.com/product.php?id_product=29. [Accessed 08 March 2013].