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A GREAT TIME FOR MAKERS

The last few months have been especially exciting for the DIY and Maker scene. We have witnessed a wave of equipment that used to cost many tens of thousands of dollars but has now become more affordable. In this column, we do a whirlwind tour of the categories that excite us the most.

LASER CUTTERS

First up is laser cutting. Unlike 3D printers, which deposit material one layer at a time (an instance of additive manufacturing), laser cutters use a powerful laser to cut or engrave material (subtractive manufacturing). While laser cutting has been around for some years, your best bet as an independent maker to get access to one was to join a local hackerspace that already had one of these beauties. Not only were these devices heavy and expensive, they required complicated exhaust and ventilation systems.

Recently, a successful crowdfunding campaign hatched the Glowforge "3D laser printer"– a laser cutting device targeted for home use by enthusiasts [Figure 1]. The laser isn't as powerful as some of the larger systems (the basic model comes with a 40W laser while the pro model offers 45W). But this is likely adequate to cut and etch material such as acrylic, wood and leather. What is most exciting is that this is being designed with home use in mind. You still need to deal with fumes – external venting is a default but it also supports a filter attachment that obviates the need for ventilation. With cheap 3D printers, there have been several reported complaints of foul smelling fumes when used in closed spaces (inhaling the odor of plastic burning is likely never a good thing!). Time will tell how well these filtration solutions work in practice.

VIRTUAL REALITY AND AUGMENTED REALITY HEADSETS

In the coming months, we are going to experience a tsunami of immersive Virtual Reality (VR) headsets. At the forefront of the revolution is Oculus VR. The highly anticipated Oculus Rift headset is slated to come out shortly. For people with appropriate high-end mobile phones, another option is Samsung's Galaxy VR. The $99 price point should support wide adoption (assuming you already have a compatible phone); moreover, it can work without being tethered to a PC. Another option is Google Cardboard and its variants. It's a clever device that's fun to assemble. Especially creative is the use of the phone's magnetic sensor as a switch (reminiscent of the ViewMaster toy from our youth!). What's interesting about low cost headsets such as the Gear VR and Cardboard is that they can be used widely as an educational tool. Be they field trips to exotic locations or a useful way to visualize a mathematical function in 3D, there seem to be a wide range of possibilities to make learning more immersive.

Augmented Reality (AR) has also seen a resurgence. Unlike VR, in which your entire view is rendered, in AR you see the world around you as it is but overlaid (or augmented) with computer generated objects. On the gaming front, augmented

reality made quite a splash some years ago on devices such as the Playstation 3 (PS3) and the Nintendo 3DS. For instance, there was a popular game on the PS3 called "Eye of Judgment" in which players would lay out fiducial markers in front of them. When they did so, various animated monsters would "spring to life" on the TV set. But of course, the camera is fixed in these cases and is hardly a truly mobile experience. On the other hand, Google's Glass may be considered an AR system but it is perhaps better categorized as a wearable head mounted display. While Glass did have a front-mounted camera and could have theoretically supported applications that used object recognition by the camera to overlay virtual objects on top of real ones, we did not encounter any ourselves. Most recently, Microsoft demoed their HoloLens system to great positive response. The system doesn't rely on fiduciary markers and the demos of games and computer aided design (CAD) applications have been impressive. One criticism seems to be with respect to the field of view (FOV) of the headset. When the FOV is limited, the computer-generated image can occupy only a small part of your view. This might be fine if the rendered object is far away or tiny. Again, real world use will tell.

While the consumer marketing push for both VR and AR has been around games, a side effect that will emerge is a new generation of computer design tools aimed at non-professionals. It is one thing to design a drone in CAD software on a 2D screen, and quite another to be able to move around and see it from various perspectives. One gap in this regard might be appropriate control mechanisms. There are already some 3D gesture devices like the Kinect or Leap Motion, and the latter has seen some enthusiastic use by CAD professionals. What control mechanism works best for head mounted AR/VR wearables remains to be seen.

HOME AUTOMATION

Home Automation is another area that has been getting a lot of retail shelf space recently. One can walk up to their local home hardware store and pick up a slew of smart gadgets. Lighting control seems to be a popular application. At the most basic level, this technology lets one control their home lighting via their smart phone. The Philips Hue bulb has been fairly well received and a host of lower cost bulbs are making their way through supply chains. Cree and GE have lightbulbs that cost under $15 at many local hardware stores. One challenge with this initial wave is interoperability. Having multiple IoT control hubs in one home starts to get unwieldy (and pairing a device to a new hub or WiFi network is often a painful process).

There are also a number of devices that aim to provide home security. This ranges from Internet-enabled door-locks to traditional IP cameras. One problem with IP cameras is how to detect events of interest. This is solved in varying ways by different systems. For instance, the Nest Cam (formerly DropCam) provides the user with a UI with which they can define Activity Zones and only motion within the activity zone will trigger an alert to the user [1]. Alternatively, the Flir FX camera offers a nifty feature called Rapid Recap that attempts to show the user many hours of interesting video in a short period of time. This is an instance of Video Synopsis [2] and it works by tracking moving objects, and then showing the user a single video with multiple instances of the moving object overlaid with a time key. On the other hand, the Samsung SmartThings v2 Hub [Figure 2] can be used to create a configuration whereby the last 30 seconds of camera footage will be captured whenever an interesting event is detected. For instance, the door opening could be such an event (easily detected via Motion Sensors or Hall-Effect sensors).

Enthusiast users and makers have made good use of a web-oriented application called If-This-Than-That (IFTTT) to add smarts to their homes. In the last few months, voice control has become easier to link with home automation solutions and is consequently starting to get popular. For example, a cool demo [3] shows how Amazon's Echo [Figure 3] hub can be linked to a Samsung SmartThing's hub so that the user can just speak commands to their connected devices. The programming model for doing speech recognition is quite different from what one might expect. Instead of having the system just give a third-party developer the text of what an end-user has said, the Alexa Skills Kit (ASK, which is sort of like an SDK) requires the developer to pre-specify a large number of samples (different ways of saying the same thing) and also define intents (specification of "slots" that indicate datum of interest). This is an interesting idea and takes care of some security concerns – if an end-user inadvertently says things not intended for the application, they can be filtered away by the system. If you don't happen to have an Echo handy, an open source project called Jasper [4] can be used to do speech

FIGURE 1. Glowforge Laser Cutter (courtesy Glowforge)

FIGURE 2. Samsung SmartThings v2 Hub (courtesy Samsung)

recognition on a Raspberry Pi. YouTube features many cool demos of users creating home automation applications using this platform. Making purchases from Amazon using the Echo seems like a reasonably secure experience. For instance, the user gets a confirmation of their purchase and could conceivably cancel the order if it was not authorized. It may be a bigger security issue when someone outside your premises merely yells "open the garage door" and gains entry. Given the nature of acoustics of your construction, this may or may not be major issue. We suspect voice-based biometrics will find their way into this class of systems in the near future.

CONCLUDING THOUGHTS

We are in an exciting period characterized by low-cost prototyping tools, accessible software platforms and widespread enthusiasm for new and interesting things. Going forward, we see this trend continuing in a new dimension – communication. Low–cost, wide-area connectivity has been the bane of maker projects for a long time. The latest plans on 5G cellular communications seem to have zeroed in on the Internet of Things (IoT) as a motivating application. One interesting idea is to have cellular networks offer differentiated services whereby it would become possible

FIGURE 3. Amazon's Echo

to have cellular service tiers of varying costs and service guarantees.

As makers, we would be ecstatic if cellular providers would offer a low-cost service tier for building wide-area sensing infrastructure (instead of paying for a SIM card for every single sensor node, perhaps a single plan can be shared by all the nodes that make up an application). While these kinds of differentiated services exist today via business plans, we believe a plethora of new applications will emerge when these plans are available to the

maker community. One example that Prof. Alberto Leon-Garcia of the University of Toronto demonstrated at a recent symposium on 5G organized by the IEEE [5] showed drones that took off and landed vertically to capture the state of traffic flow on a busy highway. Given the high cost of installing fixed cameras to ubiquitously cover roadways, this was a great example of a useful application; moreover, it is built with off-the-shelf technology used by enthusiasts. An alternative in the quest for wide area connectivity is to bypass cellular networks all together. A recent kickstarter project called The Thing Network [6], aims to create a wide-area mesh infrastructure for hobbyists building IoT applications. This project is using LoRaWAN radio technology, which offers low-power network links over a wide geographical area. One way or another, wide-area communication technologies will become more accessible. All in all, we are convinced that this is a great time for makers! ∎

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