Emerging Technology of Google's Project Tango

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Project Tango is a technology that is currently being developed by Google and many key partners for mobile devices, specifically tablets and smartphones. The main focus of the development for Google's Project Tango is to allow mobile devices to perceive the world as a physical space in a similar way to how we as humans do. The Tango is largely able to do this by through its proprietary motion tracking camera and 3D depth sensors.

There are currently two primary form factors being developed for Project Tango by Google and NVIDIA: a tablet and a mobile phone. The tablet form factor was originally priced at $1,024.00 when it was released in 2014 and it is now publically available as a development kits priced at $512.00. The tablet form factor is equipped with a 7 inch screen, an NVIDIA Tegra K1 processor, 4GB of RAM, and 128GB of storage. The mobile phone form factor does not have publically available information about its screen size or processor but it does share similar sensors in order to operate the same functions as the tablet form factor. The sensors include accelerometers, gyroscopes, GPS, barometers, compasses, RGB-IR motion tracking cameras, and 3D depth sensing cameras.

These series of sensors on Project Tango's two form factors allow it to perceive its positioning in relation to the physical environment around it. The applications of this emerging technology are constantly being explored and evolving as a result. Project lead Johnny Chung Lee states, "Mobile devices today assume that the physical world ends at the boundaries of the screen. Our goal is to give mobile devices a human-scale understanding of space and motion," while talking about the possibilities of Project Tango (Maisto, 2014). Examples of the potential of Project Tango include aiding the

visually impaired, more accurate tracking during augmented reality and augmented virtuality, use as a 3D scanner, and providing new forms interactive entertainment and commercial advertising.

The Project Tango is able to track its current position and orientation, or pose, in real-time. In order to do that, it needs to view the world through two lenses as most humans do with our two eyes which allow it to perceive depth. The use of multiple cameras allows Project Tango to exponentially gather physical information and keep track of its past positions through area learning. Once Project Tango has tracked enough of an area, it is able to recall this information to correct itself and prevent drifting if there are any inconsistencies or gaps in the calculations of its current pose.

While depth sensing technology is not entirely new, its past iterations have so far prevented it from being present in mobile devices until now. The most prominent past technology in recent depth sensing and motion tracking technology is the Microsoft Kinect. The original Microsoft Kinect was equipped with the PrimeSense chip which usually drew over 1 watt of power during use, much too high to be considered for use in mobile devices (Newman, 2014). This leap in compact technology through Project Technology will pave the way for future form factors such that it can eventually be utilized in wearable technology. Now that depth sensing and motion tracking are being advanced for mobile devices through Project Tango, mobile devices will soon be able to do more than just detect rotational data within its own confines.

Project Tango, even though it is still in the development phase, is used because it allows the user to track his or her position in 3D. Thanks to the sensor that is able to

perceive infrared rays sent from the Tango itself, the camera can detect the depth of the environment, and therefore, track its position. The sensor creates a point cloud of the environment out of the information generated from the behaviour of these infrared rays.

This technology, combined with the gyroscope, which tracks rotation or twist, enables the user to track the position of the Tango at all times. In other words, it allows you to walk around with the device and move it forwards, backwards, up, down, or tilt it in any direction. It also has the ability to tell you where it is in real space and which way it's facing (Google Developers, 2015).

Project Tango is being used because it opens a variety of possibilities since this technology was not able for a moderate price or a lot of hardware was needed.

Although there is no a specific place where Project Tango is used, there are only a few countries where the Development Kit can be purchased (Canada, Denmark, Finland, France, Germany, Ireland, Italy, Korea, Norway, Sweden, Switzerland, and the United Kingdom (Project Tango – Google 2015).

Several companies known worldwide are currently working with Google under the development of the device, including LG, Qualcomm and Intel.

Since the Project Tango is not yet commercialized or available on the market, it can be purchased by anyone for the purposes of development. We can assume then that the device is used by developers working on applications based on the technology run by the Tango.

We can find NASA working with this technology to help pave the way for the development of space-based robotic assistants or Trimbel’s SketchUp Scan which allows

for the Tango users to create pre-built SketchUp models of rooms using a simple scanning process. Even users closer to home, such as the Envision Center here at Purdue, use this device to create applications that are now being considered state of the art. These are a couple examples of users at the moment, but since it is a very innovative technology, we can only wait for the list of users to grow.

The Project Tango is an extension of the state of the art based exclusively on the fact that this technology is a combination of other state of the art technologies. One can assume that if NASA wants to use this technology in the same month that it is announced, that it must have some sort of qualification for state of the art. However, it is difficult to determine in what way this technology is “the new state of the art” when this device isn’t necessarily a replacement for other technologies, just a scientific advancement for our society.

The Project Tango device is based on the current state of supporting sciences. The Project Tango was actually a combination of Intel’s RealSense 3D camera tech and Google’s 3D mapping software (Bell 2015). These two companies already had this technology, while it is still relatively new. When Intel brought their latest iteration of their 3D camera technology to Intel’s Developer Forum in San Francisco, it was more or less an updated version of their previous 3D camera technology. As far as Google’s supporting sciences go, they had already been developing 3D mapping software for mobile devices. This kind of research being done at Google was likely in rivalry with Microsoft’s Hyperlapse technology, which stabilizes video feed by creating frames within a 3D mapped environment and determining new pixel generation based on an algorithm

that uses 3D positioning to determine what the generated values should be (Microsoft Hyperlapse 2015). Of course, Google has a version of this type of 3D mapping technology, and while not used in the world of hyperlapse video stabilization, is now being applied in the form of the Project Tango device.

There are not currently any competitive technologies for the Project Tango. As stated previously, this technology was a result of Intel and Google applying their respective 3D technologies and funnel it into one high-tech device. Normally, these two industry giants would be in the business of creating competitive technologies, as they both have the research divisions to build something like this. However, in this case, both companies had technologies that the other did not possess. And working in tandem, were able to create something entirely unique that no one has seen before. This is why this specific emerging technology is unique. It is so new that it is hard to grasp what it takes to create a competing version, as there is no real competition yet. Since it does not exist yet in the market, there is no need for competition and only the need for innovation.

The Project Tango has not made any previous technologies obsolete. Since this technology is so new, there is not much application available yet to de-incentivize people to use other types of technology. The only types of technology that this emerging technology has the ability to make obsolete would be less technologically advanced iterations of computer vision. And even in this case, the purpose of the Project Tango was not to create a new type of computer vision. This aspect of the project's technologies was mainly developed by Intel regardless. The true nature of this device comes from the fact that Intel and Google were able to mash together their 3D cameras

and 3D mapping technology to create something unique that is beginning to reach the marketplace.

The Project Tango is already on its way to becoming the foundation of new science and technology. While the market isn't necessarily ready for this type of device, nor is the means of pushing it into the smartphone market, the implications of this device scientifically is already creating news. Around the time that the project was announced, NASA began to work together with Google to use this technology aboard their Orbital Sciences Corp.'s Cygnus cargo spacecraft. This technology is currently being used for this spacecraft's prototype free-flying space robot. Currently these robots can only maneuver between small 2m-2m restraints so that they don't crash or run into objects that are part of the spacecraft. The project manager for this flying space-robot, Chris Provencher mentioned this on the topic of the Project Tango, "One hurdle we still need to get over is to fly that robot anywhere in the space station and this should do that." (Gaudin 2014). This robot will be able to scan the outside of the spacecraft to create a 3D geometry that is understandable by the robot. Once the spacecraft is scanned, the robot will know its position in respect to the spacecraft and will be able to constrain itself around the object that it knows is there. This will allow the robot to self-scan an object and to maneuver itself around that object, using only the Project Tango device.

The economics of the application market may see an increase in attention as AR and VR applications become more accessible as well and the opportunities for innovation in development. This increase in possibilities has already caught the attention of developers worldwide. Not just team AViRT has been working with this device. Google

has this device in beta with availability for developers to begin work on the possibilities while the hardware continues to be improved. With this huge potential for exploring virtual interaction and robotic autonomy, many small development teams can see the opportunity to make something revolutionary, because it is actually within their grasp. This is because of the limited availability to the device for the public and the downtime until commercial studios start serious development using these platforms. “Google just announced a developer contest that will pay out $95,000 in prizes.”(Sean Hollister 2015) This is just one of the many reasons developers of all shapes and sizes want to get their hands dirty.

The lifestyles of childhood will be radically affected by the introduction of this autonomous virtualization. With today's adolescent generations growing up with tablets in their hands and supercomputers in their homes, mobile and virtual technology is becoming a norm even in the household. Earlier this year there was an application released for the Tango that allows you to create realistic virtual forts in the living room with blanket forts forming virtual and interactable walls. Play time with your siblings or friends will quickly become multiplayer virtual experiences. And these don’t have to be carefully crafted applications due to the vast acceleration of automation and increased interactability.

However, it won’t be just children affected by this wave of technology innovation. Our phones will gain an understanding of indoor locations, allowing for a new level of GPS systems and guides throughout complex buildings and stores. The hardware has already been designed to fit into the size of an ordinary phone, allowing every person to

gain access to this virtual world being created. And with the population already getting used to paying large prices for advanced mobile hardware, a one hundred dollar increase in phone prices won't keep most tech savvy consumers away from the virtual possibilities. The newest design for mobile phones may make it a commercial possibility even sooner. "On this version, a time-of-flight camera can calculate depth all by itself, just by measuring how long it takes for light to shoot out, hit an object, and come back. Which means it can fit in a much smaller space, which in turn makes things way simpler for space-constrained phone designers." (Sean Hollister 2015) Google began the Tango project on mobile phone sized devices, and now we are seeing the mobility and accessibility inching its way closer to the market.

Almost every facet of our lives can will most likely be largely affected, if it has not been already, by the developments in virtual technology and our devices awareness of its surroundings. If we don't already consider our phones as intelligent, we will when it can guide our cars, and allow us to maneuver dreamscapes with one another. But the possibilities are not just for the everyday person, and are not restricted to entertainment and robotics. We can already see its impact on the medical field. Virtual surgery simulations have already made an appearance with the commercially available surgeon simulator. And these will only become higher fidelity, able to be used in medical education, and eventually leading to mechanically performed surgery in the distant future.

Education now has many opportunities for elaborate and interactive teaching methods. There is also a wonderful affordability of bringing virtual locations where you

typically take field trips that now only requires a classroom set of VR hardware. Or even recreated historical locations or replayable events that can get students excited and intrigued to learn about subjects that are typically difficult to motivate children in by allowing them context through satisfying interaction. Other learning tools are already on the horizon with new dimensions for puzzles and other cognitive exercises. One of these puzzle applications was created by students at a hackathon at Cogswell College called WeR Cubed, which was a simple cube based puzzle game making good use of the 3D environment. "WeR Cubed - Tango Edition," was created by Cogswell College students Christian Sasso and Steven Ulrich.

In terms of military uses, there are lots of possibilities for robotics and virtual training environments for soldiers to train in simulations. The spatial learning and positional tracking are already being used on drones and UAVs for search and rescue, which is a very important task for finding and rescuing soldiers in otherwise dangerous or potentially radiated areas in the future of warfare. As was stated earlier, this hardware is also being used for making flying robots for NASA a possibility in space stations. The purpose for NASA is to automate housekeeping tasks for the robots. SImilar applications for robotic automation could be used by the military for instance with drones and other unmanned vehicles, weapons and devices.

The only legal system impact we can fathom would be the indoor mapping capabilities of the Tango to be used in crime scene investigation and courtroom visualization of indoor environments. This would be a very niche use though and would

only be helpful in crime visualization for detectives that cannot be present at the physical scene.

In terms of legal repercussions of the technology, however, there are some potential roadblocks for commercial implementation. Just as there was backlash to the implementation of cameras on cellphones, there will be backlash to the social implementation of indoor mapping due to the use for criminals planning crimes such as bank robbery and other heists or criminal acts. There was also social backlash to the introduction of google glass. This introduction of the virtual world into our everyday lives may frighten some individuals, and if this hardware is added to everyone's phones, this new realm of possibilities will quickly become ingrained and will greatly affect our lives in unexpected ways. We may be optimistic about the progression of this technology, but a portion of the population may try to resist the onset of such sci-fi advancements.

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