Impact of Mobile Computing in Civil Engineering

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ABSTRACT
This papers attempts to review the impact of smart phones, tablets and their application eco systems on various areas in Civil engineering. This paper begins by understanding the growth of such devices in the recent years and tries to predict their impact in the near future. We look at the current trend in mobile computing, image processing systems, camera arrays and other add on hardware while bringing focus on new innovations that are entering the market currently. While citing examples of latest technologies we try to explain the shorter design and implementation cycles that these devices enable us in Civil Engineering.

General Terms
Civil engineering, mobile computing, smart phones, apps, crowd funding, App ecosystems

Keywords
Add on hardware, App Store.

1. INTRODUCTION
Many attribute the year 2013 as the "Year of the Tablet" primarily because there has been a tremendous growth in sales which this has directly resulted in the decline of PC's, hence bringing an end to the era of the PC. And with such huge market penetration of the tablets, their App store eco systems are seeing growing traffic, better and diverse apps, easy user experience and ultimately growing revenues. This can be extended to all devices in mobile computing which include smart phones, tablets and other portable computing devices which have a good user base and a mature environment for App delivery. Android, ios and Windows platforms have the current leading app ecosystems available.

Fields like Civil and Mechanical engineering relied heavily on use of PCs for design, simulation, analysis and modeling for many years. But in the present, explained by Moore's law, tablets and smart phones are becoming increasingly powerful enough to handle such graphic intensive applications. And many types of softwares that have near equal capabilities as their PC counterparts for Civil and Mechanical applications have made their way into the App eco systems. Many app developers are concentrating on such niche markets as many such markets are using tablets in their main stream processes. These mobile computing devices also offer other functionality that make using them very attractive for instance they can be carried on site, have wireless network capabilities (through 3G and 4G communication technologies), are out of the box equipped with touch screen and camera (absent in many PC's) etc.

2. GROWTH IN MOBILE COMPUTING
The push in supply of mobile computing devices and their ecosystems as well as the pull of demand from niche markets like civil and mechanical engineering have created a good potential for value creation for all. Along with development of apps, manufacturers are also coming up with add on hardware that can increase the potential of the devices. Add on hardware include adding external sensors, additional computing power etc, and these extra hardware communicate to the parent mobile device through standardized technologies like Bluetooth, NFC, Wi-Fi and USB which make designing and adding them very modular. Such devices bring in additional potential and capabilities in answering problems faced by a variety of markets at large and Civil engineering in specific. Also, Growth in trends like Crowd funding and Crowd Sourcing also have helped developers quickly identify specific needs of niche markets faster and have resulted in shorter product development life cycle.

3. CURRENT APPLICATIONS

3.1 Capturing Dimensions and Models
Like in many other engineering streams, Measurements and dimensions take a center stage in Civil engineering. Tasks revolve around calculating, estimating and playing around with dimensional data. In a virtual platform like modeling and analysis, adding a measurement adds information and value to any model. For ages, a ruler or a measuring tape have been good friends to a civil engineering, helping him/her to find out those key attributes.

Today with the advance of mobile computing, we are looking at an era where physical data can be directly fed into a software platform and various measurements can be captured accurately at an instant and can be played around with. There have been other devices that used laser technologies that could get such data, but they were stand alone devices and were not integrated into mobile computing environment, but having such integration saves a lot time, reduces errors and leads to better collaboration, hence takes value creation in civil engineering to a next level.
One of such recent technology is Structure Sensor: It is a device (Refer Fig 1) that gives mobile devices the ability to capture and understand the world in three dimensions [1]. With the structure sensor attached to a mobile device it scans any sort of object/structure and instantly captures it in a digital form. The Structure Sensor has a mobile-optimized range that begins at 40 centimeters and stretches to over 3.5 meters (Refer Fig 2). This means it can easily capture anything from a toy to an entire room. It has dual infrared LEDs attached to it which will emit uniform light to capture the world in uniform infrared. It will work on smart phones as well as tablets. This means 3D map of an indoor space with its accurate dimensions can be captured with ease.

Fig 1 - Structure Sensor device

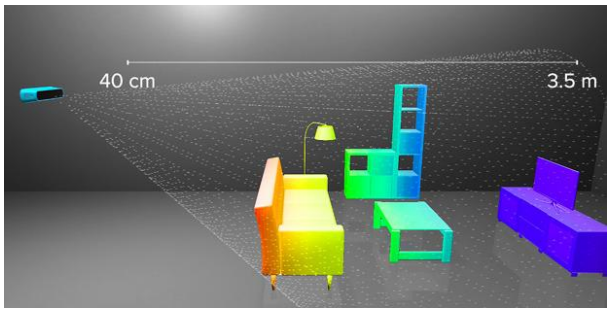

Fig 2 – Range of Structure Sensor

Another device in discussion is Spike. Spike is a laser based device that attaches to the phone to rapidly & accurately measure & model an object up to 200 yards away [2] just by taking a snapshot of it (Refer Fig 3). Spike incorporates a Smartphone's current technology with some specialized features of its own. It amalgamates a digital camera, a 3D compass, a laser range finder and GPS. It measures the distance of an object using laser range finder. It can measure area and volume of an object and get laser accurate measurement from any angle. It verifies exact location of a target and also identifies the relative and bearing altitude of an object. It can model an object in 3D. Spike's measurement functionality is all driven from the Spike app, within which users can select their chosen measurement criteria. Spike beats all the odds of traditional methods of surveying and measuring where it is prone to human and natural errors. It is an easy replacement for the pricey and delicate instruments used for accurate survey and measurement.

Such technologies when used for models bring real data into a virtual platform, where lot of analysis could be done with significantly less effort. And this will change the way models of any size can be viewed, analyzed and shared.

Fig 3 – Spike, laser ranging showing measurements

3.2 Image Processing and Live Video

As far as live image processing and live video goes, one of the challenges faced by civil engineers is the need of capturing full images and processing them in real time to provide more unambiguous data to the viewer. This is helpful in variety of places in Civil engineering, like understanding environment of a structure, studying mines, aerial view etc. Some of the latest innovations are:

The Panono camera: This is a throwable panoramic ball camera [3] that delivers 360 degree panoramic images that capture everything in every direction (Refer Fig 4). Panono has 36 cameras embedded in the ball each of 108 megapixel high resolution. The ball is tossed in the air and an accelerometer inside the camera measures the launch acceleration to calculate when the camera is at its highest point and barely moving. At that point, all 36 cameras are triggered and the moment is captured, all 360 degrees of it. Pictures captured in the Panono can be seen right away with the help of Panono app available in Smartphones. This camera helps in recreating the memory of the complete situation with the help of photos taken.

Fig 4– Panono camera

Autodesk 123D catch [4]: An application available in app store which automatically converts captured pictures of people, sculptures, buildings in different angles into interactive 3D models (Refer Fig 5).123D Catch Creates 3D models from series of photographs taken at various angles using photogrammetry. It allows manipulation of virtual clay into a model on iPad. It also allows creation of low-tech LOM (laminated object manufacturing)-style solid models. It has simplified program to create 3D models

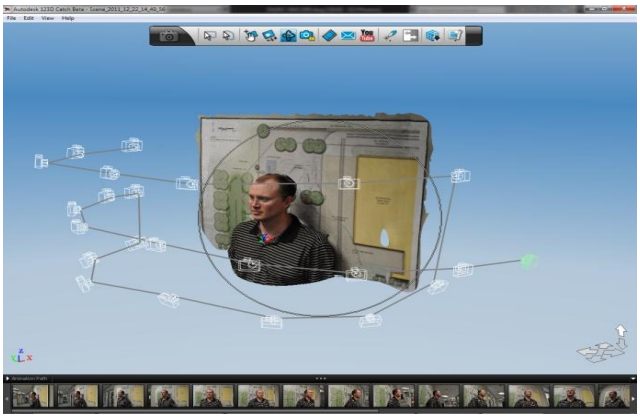

Fig 5 – Autodesk 123D catch capturing 3D picture.

Project Tango: It is a smart phone [6] currently being developed by Google and other partners, containing customized hardware and software which is designed to track full 3D motion of the device, while simultaneously creating map of the environment. The phone outfits a compass and gyros also with multiple sensors and cameras. User using tango phones just has to roam around the places required, and a 3D sketch of the place covered is formed with the tracking GPS map appears. It allows the recreation of the position of previous points in same and accurate position, which is a vital and challenging task.

These technologies give additional data at the finger tips of the viewer and reduce error and processing time. We will no longer be limited with two dimensions of an image but can work with another dimension to better understand the environment.

3.3 Other Apps

There are plenty of other apps surfacing every day in app stores. Couple of them address specific needs and are worth mentioning.

Vidente: An attempt towards visualization of underground infrastructure using augmented reality. System provides users with a natural visualization of the local underground network infrastructure in their immediate environment. Scenes are assembled at the user device in time by combining continuously streamed video footage with geo-referenced computer graphics considering the user's currently tracked position and orientation. Accordingly, the reduced augmented reality scenes are adjusted continuously as the user moves around.

RC Design: an application which lets user to design and analyze reinforced concrete columns, slabs, and corbels [7]. RC Design is a tool for engineers as well as students to design reinforced concrete members. All the required calculations for the design can be done through this application.

4. FUTURE PREDICTIONS

Smart phones and tablets continue to grow and outperform sales of PC throughout the world. Competition between various eco systems will continue, and apps created in one eco systems will be replicated in other too by developers. Added to this, the growth of 4G/3G coverage throughout countries will push people to use networking on mobile devices, and allowing them to carry their data to the place of work. Wearable technology like the Pebble Smart Watch and Google glass bring more features for developers to work with to deliver enhanced benefits to users. All these technological advancements will push growth in Engineering Apps supported by additional hardware that is quite modular, and cater to a huge number of niche needs instead of just the main stream market.

5. CONCLUSION

We have tried to explain the impact of mobile computing with the help of technologies available today. Mature environment of the smart phone architecture, open source designs and application ecosystems are major contributors to push development of mobile computing. These developments have a huge impact on the life cycles of civil projects. They reduce errors, extend collaboration capabilities and enable providing solutions quicker. Mobile devices also bring designers to work on site instead of offices located elsewhere and help in concurrent engineering. The prime impact would be in the reduction in time of various activities and cost savings that could be passed on to the end consumer, this is how Mobile computing brings a dual benefit of time and money to the industry.

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