
**INSIGHTS AND
MASTERCLASSES**

NOKIA Developer

IMAGING TECHNOLOGIES

How successful developers are embracing new
mobile imaging technologies

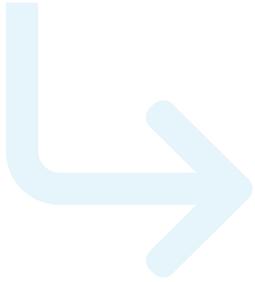
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IMAGING TECHNOLOGIES

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IMAGING, AND HOW IT AFFECTS THE SENSES



Mobile technology is an extraordinarily potent platform that can chop, change, augment and enhance every aspect of our everyday lives. No corner of life is immune to mobile – from the simplest communications (SMS messaging) to 24-hour body function monitoring (self-monitoring) and far, far beyond. Somewhere in the middle are the ways that mobile can capture and amplify our senses. Our most essential sense, **sight**, is primed for augmentation with imaging technology: medical professionals conducting surgery, security forces defusing explosive devices, manufacturing plants engineering precision components, architects printing building impressions in three dimensions, soccer officials using goal line technology,

Instagrammers adding new filters to self-portraits. These are just a few ways that imaging technology can be used to augment our sight, and with many more in development, it is important for developers to get to grips with the possibilities, and the opportunities they create.

In truth, developers have not wasted any time engaging with the technology so far – the variety and sheer number of imaging apps is impressive. A quick search for image-related apps on app search website XYO returned 2,291 for Android and 1,989 for iOS¹. About 50% were video, with 936 for Android and 1,082 for iOS. Though the volumes for Windows Phone were fewer, these are growing quickly in number.

The camera has been a constant on mobile phones since the early 2000s – very few reasonably priced mobile devices do not have one. It is one of the most talked about features and there is little doubt that the camera on a phone gets people excited. People love talking about megapixels, branded lenses, HD resolution, low light capabilities, shutter lag and the like. Keeping this passion for the camera in mind, this document will focus on imaging, video and audio technologies and apps that empower people to capture, manipulate, share and engage socially with others.

1. Xyo (June, 2013)

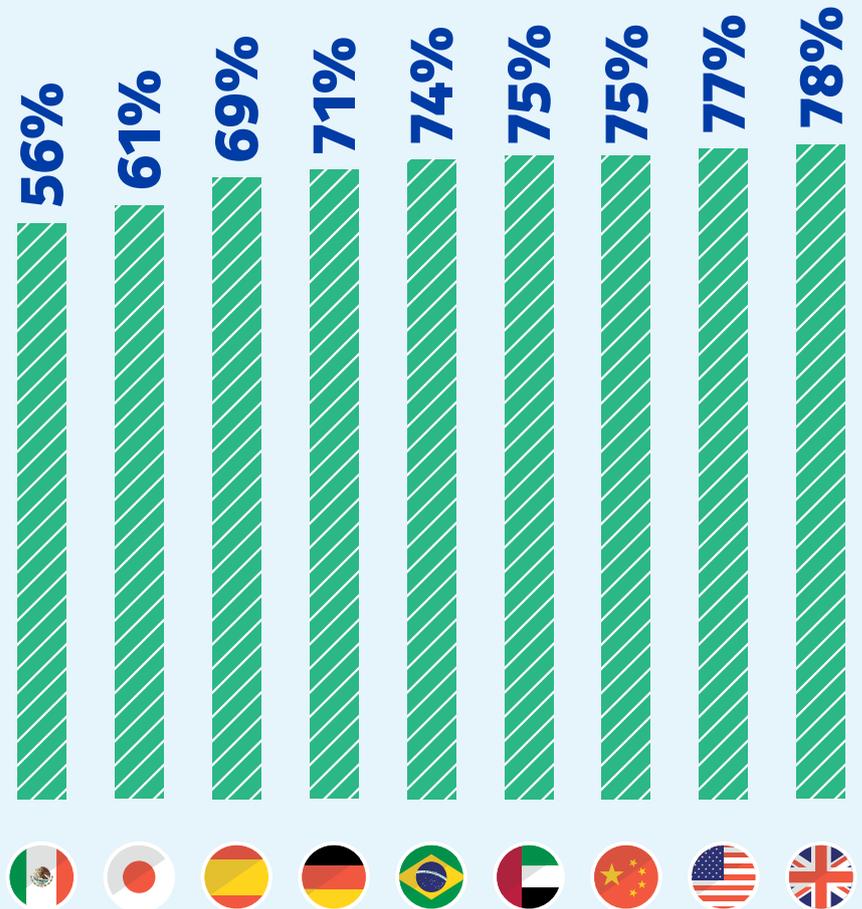
02

How mobile apps are changing people's behavior

In the last few years, imaging has had a significant impact on popular culture and our lives. These days, anyone can turn themselves into a photographer, exhibiting their art in New York, Tokyo and London via the world's biggest gallery – the internet. We see it every day on any street where tomorrow's insta-artists are using their phones to find that elusive perfect image. We are experiencing a significant shift in behavior, from the occasional snapping of shots on a family holiday or at social gatherings to creating a constantly captured stream of images every day.

The cultural shift is even more prominent if we add manipulating and sharing to the act of taking photos. Photo editing was once the exclusive domain of accomplished photographers, and then later, Photoshop-trained designers. But any pre-teen can now completely change their images, making everyone not just capturers of the moment, but also transformers of that moment. With the surge in creativity comes the urge to express ourselves. Where before most of us would passively consume content, we can now create and disseminate our own creations, uploading 300 million photos to Facebook, and 40 million to Instagram³, every single day.

Percentage of smartphone owners using their phone camera to take photos or videos²

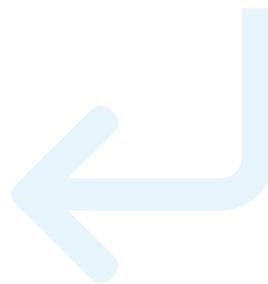


**300
MILLION
PHOTOS
UPLOADED
TO FACEBOOK
EVERYDAY**

2. Our Mobile Planet 'General Smartphone Activity' (2012)
3. iStockphoto 'Pocketography: The Democratization Of Photography' (2013)

“In the early 2000s you would rarely see a person in the restaurant spending time looking at a phone, and now you see people get together and they spend all their time with the phone; flicking through photos, looking at their timeline on Facebook and Twitter... it has dramatically changed the way people behave socially.”

Alexey Ivanov, Owner, PhotoFunia



The average time a user spends on photo and video apps has increased to 231 minutes per month in 2012, from 87 minutes in 2011⁴. Downloads for photo and video capture and sharing apps also keep growing. These are the top free and paid photo and video apps across app stores as of June 2013⁵:

	DOWNLOADS (M)
CAMERA +:	1.6M
CAMERA ZOOM FX:	2.6M
SNAPCHAT:	11.9M
PIXLR EXPRESS:	13.3M
ADOBE PHOTOSHOP:	32M
INSTAGRAM:	242M
YOUTUBE:	415M



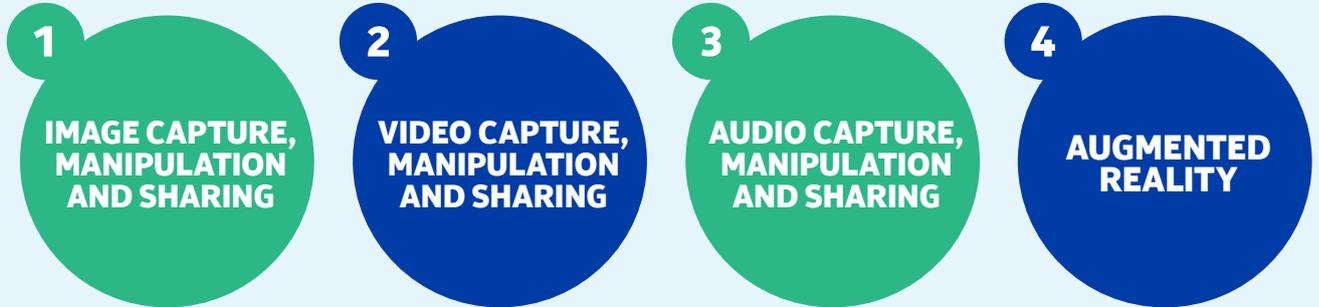
231
MINUTES
AVERAGE TIME
SPENT ON VIDEO
AND PHOTO
APPS PER MONTH

4. Flurry 'Mobile App Growth Led by Video Sharing: YouTube In The Crosshairs?' (2012)
5. Based on App Annie and Xio data (June 2013)

03

Today's opportunities

Apps for consumers can be split into four groups:



Up to now, apps primarily related to still images have experienced tremendous growth, but in the future it is expected that these will be overtaken by video and Augmented Reality apps, with audio apps maintaining a modest share.

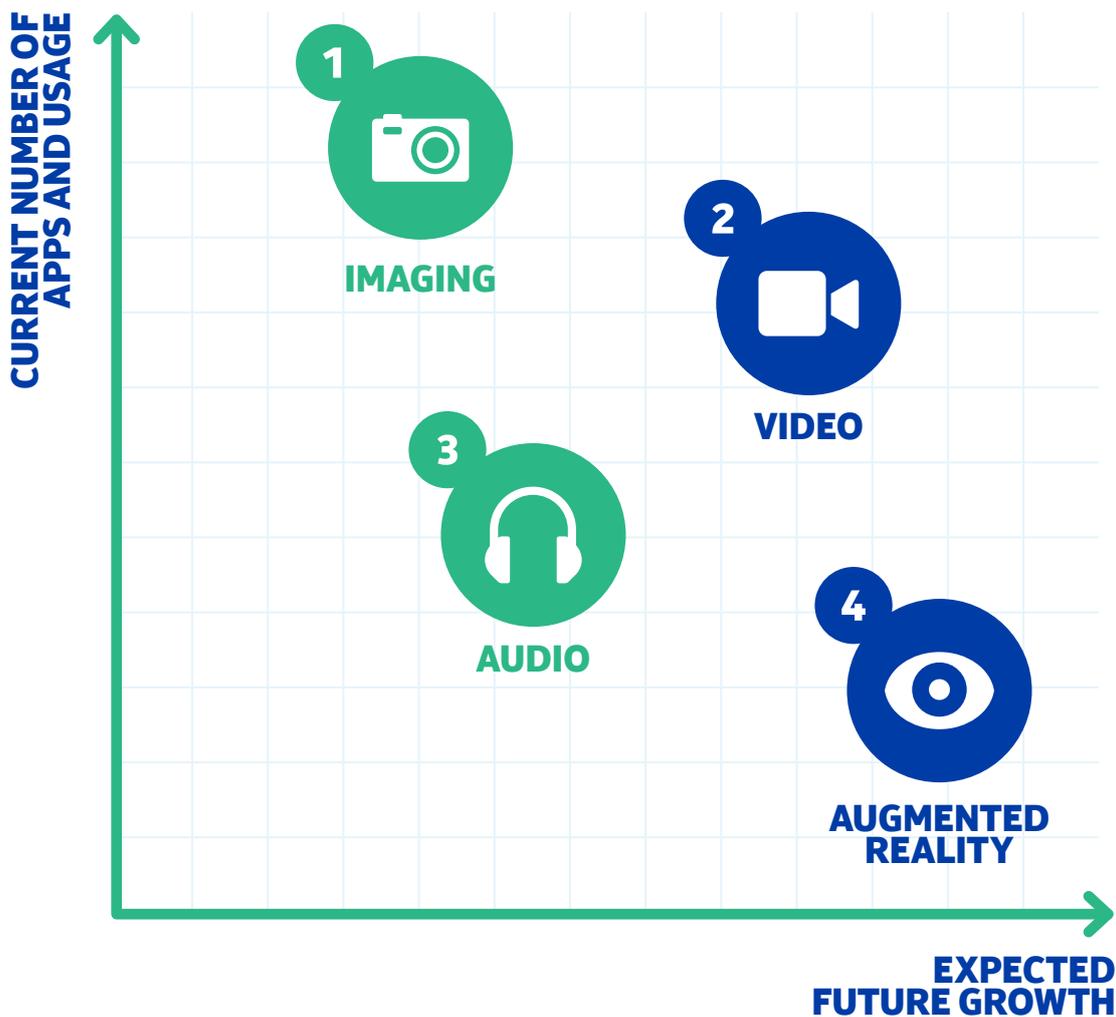


Image capture, manipulation and sharing

Imaging apps that offer fun and artistic effects, with varied functionality for sharing, have consistently enjoyed great popularity. There are thousands of apps, but some of the most notable, both in terms of popular appeal and in offering a unique user experience, are:

INSTAGRAM

HIPSTAMATIC

LOMOGRAM

PHOTOFUNIA

PHOTOSPOTLAND

BLINK

INSTACAM

FHOTOROOM

PICTURE PERFECT

PHOTOBEAMER

CREATIVE STUDIO

PHOTOSYNTH

CINEMAGRAPH

CINEMAGRAM



1

**IMAGE CAPTURE,
MANIPULATION
AND SHARING**



Lomogram

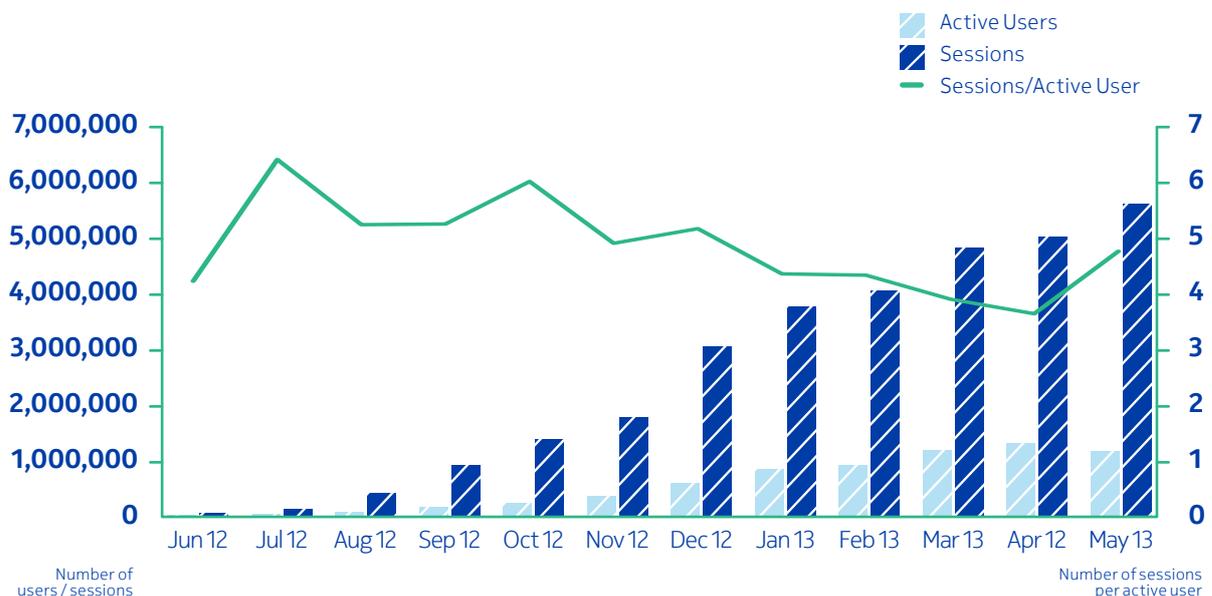
You don't have to be a big consumer brand to be successful. Lomogram is considered one of the best photo editing apps for Windows Phone, competing with Instagram, Hipstamatic and Pixlr-o-matic in terms of functionality if not volumes of users. But it was built and is run by just one person in his free time.

Results with modest resources

Lomogram was able to pass 1 million downloads in only 219 days, and in just one year is nearing 2 million. Though the active user base levelled off in May, overall sessions rose, confirming the stickiness of the app.

“This is my hobby and I've got a full-time job as a web developer. I looked at the market and saw there were not many photo apps for Windows Phone, so I decided to make one. I started from scratch and had to build my own filtering libraries – that was a real challenge but also very satisfying.”

— Pavlo Tkhir, Lomogram



Video capture, manipulation and sharing

Some apps in this group are limited to video capture and editing but others go beyond this to include enhancements, collaborative creation and sharing functionalities. Though there are fewer apps for video than for still imaging, it is an area that has been growing steadily. The shooting and sharing of short videos via mobile has become a key trend upon which major players are already starting to capitalize. **Vine**, the mobile app owned by Twitter which allows users to share videos of up to 6 seconds is estimated to have more than 13 million users⁶. **Instagram** launched video functionality in June

this year allowing users to and share up to 15 second videos. Users can also manipulate their videos by using specific filters before sharing them, a natural differentiator for Instagram. Popular video apps include:

VINE

INSTAGRAM

8MM VINTAGE CAMERA

VIDDY

VYCLONE

YOUTUBE

EVERYDAY

CLINCH

6. TechCrunch 'Twitter Releases Vine For Android Smartphones As It Tops 13M Users' (2013)

2

**VIDEO CAPTURE,
MANIPULATION
AND SHARING**

Sezion

Sezion started out as an app for the collaborative creation of audio clips, but is fast becoming an app for collaborative video creation. Users can create their own videos either by mashing up videos already published on the web, with automatic synchronization of both video and audio, or they can create videos with other users, each contributing their own portion of audio and video. Another option is a mix of the two – users can pick their favourite Lady Gaga video and mix themselves and their friends in.

Fun and functionality

Sezion plans on combining the best of both worlds with a freemium model. So it is free for amateur users wanting to just play around and have fun making silly mash-ups, but by paying a bit more, serious aficionados and professionals will get advanced functionality, like distributing and working on professional videos.

Fan videos and a brand pilot

Sezion recently landed its first branding pilot project, providing the technology for the fan video behind the launch of a joint Vichy and Red Cross campaign for communicating the dangers of heat and sun overexposure during the hot summer months in Spain. A selection of stars dance and sing in the video, while fans are encouraged to make their own version by adding themselves.

“What we created is unique, combining videos, combining audio, the automatic synchronization, and more. But if we are not able to give that to a grandfather, or to my eight-8 year old nephew, if they are not able to use it, it will be rubbish for them.”

— **Josías De La Espada, Sezion**



3

AUDIO CAPTURE, MANIPULATION AND SHARING

Audio capture, manipulation and sharing

For audiophiles there is a robust selection of apps that bring studio-like mixing capabilities and effects to mobiles such as **RØDE Rec** or **GarageBand**. But the offer is not limited to the professionally trained, and includes apps that help the untrained find their inner musician, like **Magic Piano**, **Songify** and **AutoRap**. For quick audio communication, **Dubbler** is an app integrated with a social platform for sharing short audio snippets. Popular audio apps include:

RØDE REC

GARAGEBAND

MAGIC PIANO

SONGIFY

AUTORAP

DUBBLER

SOUND METER

STITCHER

GIGBABY!

SPL

4

AUGMENTED REALITY

Augmented Reality

Augmented reality (AR) is the integration of the user's real-time environment with additional digital information. The most common AR apps are those where users can hold up their device to see the world around them and augment the view with anything from commercial to historical information. Popular examples include **HERE City Lens**, **Tagwhat** and **Yelp**. Less commercial, but certainly entertaining, are apps that track the positions of the stars, planets and satellites like **SkyView**. Still others delve into fantasy realms by placing users in the presence of aliens or ghosts such as **AR Invaders** and **SpecTrek**. So imaging technology begins to bridge the gap between the real world and the kind of imagination previously limited to videogames, leading us into the 'gamification' of reality. Popular AR apps include:

TAGWHAT

YELP

SKYVIEW

LAYAR

AUGMENT

SUN SEEKER

AR INVADERS

SPECTREK

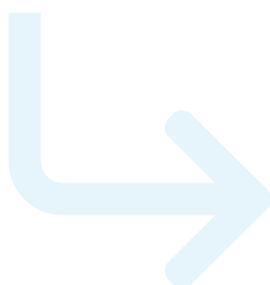
But gamification is not just limited to Augmented Reality. All these apps include social/sharing/gamification functionalities and communities to varying degrees. Perhaps the best-known example is **Instagram**, which is deeply integrated with the social network which fueled its meteoric growth. But not all apps have to double as a social network – it is often enough to provide easy in-app sharing to existing networks like Facebook, Twitter and Pinterest. Others put the emphasis on competition, moving gamification beyond mere 'likes' or followers, and rewarding users with incentives like an improved social reputation, or other actual or virtual values such as experience points. This trend is sure to grow as gamification leads to heightened socialization and viral infectiousness across all types of multimedia apps, with teams and collaborators engaging in games and competitions worldwide.



Increased ‘hybridization’ is another trend that is gaining momentum. Location services and imaging may appear in apps that feature a suite of services including information, e-commerce, video, music, events and social. These are especially relevant when focused on a particular area of interest. The **Burton** app for ski and snowboard enthusiasts, for instance, comes with photo sequencing to capture and share epic jumps and tricks, bundled with snow forecasts, Burton gear and access to Burton music playlists while on the slopes. It also brings the ability to watch Burton open events while the lift sweeps users up for another run. It is a great example of how advanced imaging technology, combined with creative and talented developers, can be a really powerful tool to help a good app become great by finding those extra ingredients that can help propel it to success.

Also, imaging has the power to connect with the offline world and generate money-making opportunities, from printing out personalized posters, mugs and T-shirts of photos, to creating an online buzz that directly impacts the sales of real-world products.

For many people, the plethora of options creates both excitement and confusion, causing them to turn to their social networks for recommendations on which apps to use. So it is imperative that developers take care to provide a positive experience from the beginning. One way to make sure that happens is to avoid doing too much, and focus instead on a specific set of core services to a very high standard.



“On Instagram users are sharing photos of dresses or nail polish and they are boosting the sales of these items. You can boost your business if you sell something.”

— **Alexey Ivanov, PhotoFunia**

“Never hurry. It’s vital to test everything before you submit. Also, I receive lots of requests to implement features but they really won’t fit in. So don’t do it if you don’t want to. You need to be good at one thing, not everything.”

— **Pavlo Tkhir, Lomogram**



According to data from AppAnnie, photo and video apps have grown in Q1 2013 to become the **3rd** largest category in app downloads⁸.

More innovative business models are also emerging in this space.

Hipstamatic allows users to buy additional in-app photo kits, but also offers the possibility to order photo prints as well as offline merchandising. The developers behind Hipstamatic have now launched **Oggl**, a photo sharing app similar to Instagram where users can access a variety of photo effects. Oggl's new business model will enable users to access the library of photo effects on a subscription basis (charges could range from \$0.99 a month to \$9.99 a year), introducing the subscription model to the world of photo applications⁹.

As far as business models are concerned, photo, video and audio apps tend to be offered for free or on a pay-per-download basis and often include **in-app purchase** as a business model.

Among the top 100 free photo and video apps about 28% include **in-app purchase** in their business model. Among the top 100 paid-for apps, this figure rises to

EyeEm is a photo community app that is looking to use its engaged community of smartphone photographers to build additional revenue streams via third party brands. Brands looking to engage in social media campaigns can sponsor EyeEm 'photo missions' asking users to take pictures related to a specific theme.

↳ **55%**

7. App Annie (June 2013). Data based on iOS figures for the United States
8. App Annie 'App Annie Index: Market Report Q1 2013 – iOS App Store Revenue 2.6x That Of Google Play' (2013). Data limited to iOS only.
9. Endgadget 'Hipstamatic Launches Oggl, An All New Photo App With Subscription Model' (2013)

04

How the latest advances are driving rapid change

Current and imminent advances in hardware and software are set to offer exciting new capabilities for apps. The PureView technology in Nokia Lumia devices for instance will continue to be enhanced. This includes enhanced display rendering (no more jumpy videos), low-light capabilities, high pixel count HD+ images, and enhanced outdoor screen visibility. All these, combined with the Nokia imaging features in the recent Amber software update, will set a considerably higher bar for all camera phones.

Introducing the next generation of imaging technology

Building on Nokia's pioneering PureView technology, the latest device – the Nokia Lumia 1020 – comes with a 41 megapixel camera sensor, PureView technology, optical image stabilization and high-resolution zoom. It introduces the second generation of optical image stabilization, combined with the most sophisticated xenon flash and video-light LED ever seen on a Nokia phone.

One of the main reasons why the Nokia Lumia 1020 is different from other camera phones is the ability to shoot in super high resolution, which lets users zoom in much closer to their shot after it has been taken. Users are also afforded exceptional control through Nokia Pro Camera, with adjustable focus, shutter speed, white balance and more.



Sharpness is more than just megapixels

Lens quality is just as important as the number of megapixels, so Nokia increased the number of lenses from five to six, including one made of high precision glass.



Oversampling produces amazing detail

In an average-level 5 megapixel picture, the camera sensor does not capture the full five million pixels. Instead, the data is spread across multiple pixels causing blurring and artifacts. But the oversampling technology in the Lumia 1020 captures full detail, visible as increased levels of sharpness, naturalness and low noise.



High resolution zoom

High resolution zoom is lossless, so there is no drop in picture quality, and photos look as sharp in close-up as they do in normal resolution.



Getting rid of hand-shake

Nokia's new OIS (optical image stabilizer) has been designed to overcome shaky images. Instead of moving just one lens element in the lens stack, the whole optical assembly moves to cancel out unwanted camera movements, enabling super-sharp images.



Photos in the dark

There is a lot more to good-quality low-light pictures than the amount of visible noise.

- **Back side illuminated (BSI) sensor**

Nokia's modern-generation BSI sensor allows significantly more light to reach the photosensitive area of each pixel. This means that Nokia can amplify the signal created by much lower levels of light, significantly reducing the amount of visible noise.

- **Exposure time**

The longer the shutter is open, the more light can be gathered by the sensor. With its OIS system, the Nokia Lumia 1020 can tolerate three to five times longer exposures than traditional mobile cameras.

- **Flash**

With the Lumia 1020, Nokia uses a no-compromise xenon flash with very high light output and extremely short flash pulse duration. High flash output provides excellent illumination up to three meters away, and the short pulse makes sure the image is extremely sharp while preserving the ambient lighting of the background.



Real life sharpness

The Nokia Lumia 1020 resolves very close to the theoretical maximum of the image in good lighting conditions, but the combination of OIS and xenon flash means it can also provide the same huge resolution in extremely dark conditions.



Nokia Pro Camera

Nokia's Pro Camera app turns complex settings into easy adjustments, with features previously only found in digital SLR cameras. With the Lumia 1020, Nokia Pro Camera also introduces dual capture, which stores both a quality optimized 5MP image and the original full resolution image.



Zoom reinvented and reframing

Unlike optical zoom, the Lumia 1020 zoom is not permanent – users can open the photo afterwards and remove the zoom to reveal the full scene. Or they can move around and zoom in to another part of the image and reveal details that were not initially visible.



Nokia Rich Recording

The 32-bit Nokia Rich Recording technology preserves the dynamic range of the stereo image across the full audio bandwidth, but it really excels in its ability to record high sound pressure levels at rock concerts and the like where high sound levels can be cut off or clipped by conventional recording solutions.

Nokia's white paper outlines the vast array of features available through the Nokia Lumia 1020 and the latest developments in imaging technology. It can be viewed at:

<http://i.nokia.com/blob/view/-/2723846/data/1/-/Lumia1020-whitepaper.pdf>



Nokia Imaging SDK

At the same time as the recent launch of the Nokia Lumia 1020, Nokia announced the beta release of its Imaging SDK (Software Development Kit) for the Windows Phone platform (available for all Windows Phone 8 devices). The Imaging SDK is designed from the ground up with a focus on high performance and low demand on the phone's memory. The SDK uses the same technology that Nokia implements in its own imaging apps such as Creative Studio. Below are some of the benefits of the Nokia Imaging SDK which developers can download from:

http://www.developer.nokia.com/forms/imaging_sdk_download.xhtml

CROP, RESIZE, ROTATE & UNDO

Cropping, rotating and resizing are all supported and there is an unlimited undo function.

PARTIAL JPEG DECODING

Using RAJPEG technology, users can access image data without decoding a whole JPEG image for extremely fast previews, application of effects, rotation, and cropping of high resolution images.

EASY-TO-USE API

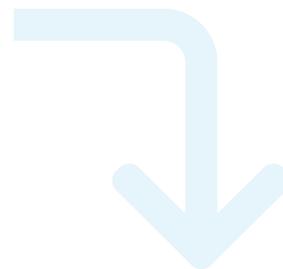
The Nokia Imaging SDK delivers the WinPRT library for imaging apps. The API is available from both managed (C# and VB) and native (C++) code, is really simple to use, and comes with a range of intuitive classes and methods.

OVER 50 FILTERS, EFFECTS AND ENHANCEMENTS

The library comes packed with effects, filters and enhancements, from the simple (auto-enhance, frame and brightness) to those with advanced capabilities (adjusting RGB levels, hue and saturation).

“As CPUs get faster and sensors become bigger, there will be lots of video apps coming, where you can do lots of manipulation on the phone, from filters changing colours to computer effects. With PhotoFunia we're able to detect the face and superimpose it on the template. We could do this with video where we detect the face and apply a mask to it – the possibilities are endless. The hardware is limiting now, but it will evolve.”

— Alexey Ivanov, PhotoFunia



There will also soon be significant boosts in both video and audio quality as well as processing capability. In fact, the first cases of stylized shots for cinema films are already with us. Award winning documentary Searching For Sugar Man included stylized shots filmed on an iPhone with an app called 8mm Vintage Camera¹⁰. An Australian director has also created an award-winning short film shot entirely on a Nokia 920¹¹ and the world's largest stop-motion animation was captured on a Nokia N8¹².

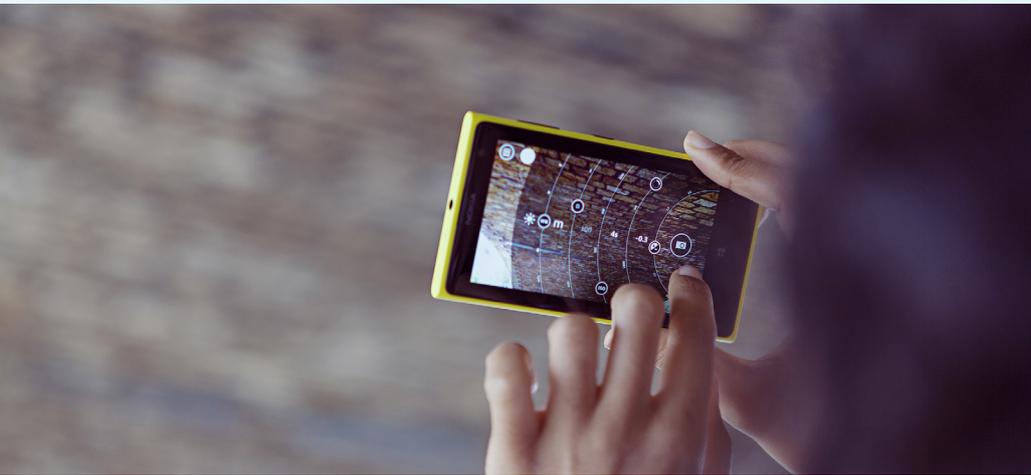
The smartphone user of the future will become increasingly more demanding, especially those digital natives who have lived all their lives experiencing rapid advances in technology.

The market landscape of the future will evolve even more rapidly, driven not only by increasing consumer demand but also increased pressure on the major players to introduce innovations with increasing agility. The end result will be a proliferation of hardware and ecosystems that rely increasingly on third-party developers.

10. Wikipedia 'Searching For Sugar Man' 2013

11. Tech Guide 'Aussie Wins Film Festival With Movie Shot On Nokia Lumia 920 Smartphone' (2013)

12. DigitalBuzz 'Nokia N8: The World's Largest Stop Motion Film' (2011)



Latest advances¹³

- Mega megapixels**
 Nokia's PureView technology, with its first implementation in the Nokia 808 PureView, lifted the megapixel bar to its limit so far for a camera phone, at 41MP. This has been further emphasised in the Nokia Lumia 1020, which takes photos and video that no other smartphone can match with a 41 megapixel camera sensor, optical image stabilisation and very high-resolution zoom.
- More with less**
 Aside from increasing megapixels, current advances in image quality are being propelled by improved lens quality, noise reduction and image reduction technology, back-illuminated sensors, as well as fewer but larger megapixels. In addition to enhanced image quality, other major benefits are the ability to shoot in low-light situations and better image stabilization.
- Sharper, more versatile focus**
 Microelectromechanical systems (MEMS) technology improves autofocus speed at sizes and power consumption levels compatible with camera phones. Prices are expected

to come down enough in the near future to make its incorporation viable.

- Video advances**
 While HDR has been helpful for backlit still shots for some time, Nvidia is making it available for videos with its new Chimera architecture. Recent advances in enhanced display rendering are making viewing videos on mobile device screens a much more fluid experience, eliminating jumps and blurs.
- Low light**
 Recently, a team of researchers at Nanyang Technological University (NTU) in Singapore announced a new sensor that is highly sensitive to both visible and infrared light through 'light-trapping' nanostructures that use graphene as a base. The recent developments in PureView technology provide the best current mobile low-light performance.

Imminent and future advances

- Sensor architecture**
 Although still in experimental phases, the future will likely bring advances in compressive sensing, stacked sensors and on-chip innovation.
- Computational photography**
 Array cameras and multiple lenses and sensors, as well as increased megapixels, will lead to the rise of computational photography. Data points which only the computer can detect will be automatically processed to create the highest quality images.
- Zero-lag global shutters**
 Although available now, expect these shutters which eliminate motion blur by reading out the entire frame at once to become commonplace.
- Real optical zooms and add-on lenses**
 Expect optical zooms to be incorporated more and more into phone cameras, even as the options for add-on lenses also increase.
- 3D image processing**
 Apps already exist for converting 2D images into 3D, but new advances will allow for both display and capture to become fully automatic, as well as improving 3D video capabilities.
- Morph wear**
 In the more distant future, phones and cameras will be transformed in their shapes and sizes, permitting small modules to be easily added and removed according to a shooter's needs. They will even become bendable so that they can be incorporated into clothing.

13. Slashgear 'Nokia Smartphone Chief Teases Lytro-Style "Computational Photography" UpNext' (2013), Spiedigitalibrary '3D Image Processing Architecture For Camera Phones' (2011), Motherboard 'This Lensless Camera Never Needs Focusing, Has Already Taken Cat Pics' (2013), Uswitch 'Future Of Mobile Phones', Gizmodo 'Nokia's New Lumia 925: See What You Are Missing' (2013), ExtremeTech 'Beyond Megapixels: The Future Evolution Of Smartphone Cameras' (2013)

05

What's next for imaging?

With increasingly open and varied ecosystems, the importance of developers will grow, as will their opportunities in imaging.

USING IMMINENT TECHNOLOGY DEVELOPMENTS

Developers need to keep track of the spectrum of imminent developments such as upcoming innovations in hardware, increased processing speeds and more potent sensors, as well as more device and hardware types. Thinking about the uses for these new technologies is a great source of inspiration for unique and different applications.

FINDING A NICHE, AND FILLING IT

The uses for imaging technology are widespread and profound and developers will benefit from exploring the possibilities and filling a niche with a product that has the potential to be used on a daily basis and loved by its users.

CONSIDER THE FEATURE RANGE CAREFULLY

It can be tempting to pack an app full of features to display the full range of a developer's skills and to please customers. But it is



entirely possible to be successful with just one grandstand feature which is supported by a strong depth of additional, intuitive functionality. Instagram is the most obvious example – at its core it is a filter-based photo sharing app, supported by a caption option, a tagging system, a hash tag system and a picture map. This approach is not overwhelming for the consumer, and offers a compellingly simple proposition.

IT IS MORE THAN JUST PICTURES

Apps like Vine for video and Dubbler for audio are demonstrating how user appeal for capturing and sharing goes well beyond pictures. Developers willing to make the most of video and audio capturing technology have strong opportunities to bring innovative and unique user experiences to paying consumers.

CONTENT MANIPULATION

From images to notes, from tweets to videos, smartphones are increasingly being used for the creation and sharing of content. But users have become used to creating and modifying content while on the move. Tapping into this space with content manipulation opportunities that go beyond filters will offer more opportunities for developers.

EMBRACING THE BEST HARDWARE

Developers need to make the most of the latest advances in image, video and audio capturing technologies to maximize the use, appeal and potential of their apps. Making sure that the app experience will not be hindered in low light conditions or while moving can be done only by enabling the app on the very best hardware technology.