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WEARABLE ELECTRONICS IN THE NEXT YEARS

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Abstract: *The term 'Wearable Technologies', 'Wearable Electronics', or 'Smart Garments', is associated to those clothing and soft or hard accessories which integrate electronic components, or which are made of smart textiles. Smart textiles research represents a new model for generating creative and novel solutions for integrating electronics into unusual environments and will result in new discoveries that push the boundaries of science forward. Last few years there are several hundreds or maybe thousands of research teams that works and develop such materials and products. But the key driver of the success of the wearable electronics is the acceptance from the end user. It is estimates that only for the next three years the sales in the wearables will be almost multiply by ten times. The flexible wearable computer industry's patent applications arrived at 429 in the second quarter of 2014, up 27.7% year on year, and witnessed a record high in the report's tracking period starting from the first quarter of 2012. The market has already in the shelf commercial products as wristbands (Fitness/wellbeing/sports devices), smart jewels, smart watches, mobile health devices, tech clothing, and augmented reality glasses.*
The recently developed enabling technologies eliminates the barriers and help the scientists and developers to launch new types of "wearables". The life style of a large share of population, the low cost of 3D printing for rapid prototyping locally, the large available platforms, the lower cost of sensors and components give a an impetus for large scale of products.
In the same time the direct ordering channels to manufacturers of components facilitates the small producers and the scientists for prototype development.
In this article we identify key challenges for the success of the wearables and we provide an outlook over the field and a prediction for the near future.

Key words: *Wearable Electronics, Smart Textiles, Flexible membranes, Conductive textile Materials*

1. INTRODUCTION

The term 'Wearable Technologies', 'Wearable Electronics', or 'Smart Garments', is associated to those clothing and soft or hard accessories which integrate electronic components, or which are made of smart textiles [1].

Smart textiles research represents a new model for generating creative and novel solutions for integrating electronics into unusual environments and will result in new discoveries that push the boundaries of science forward [2]. A key driver for smart textiles research is the fact that both textile and electronics fabrication processes are capable of functionalizing large-area surfaces at very high speeds. In this article we are presented the progress of the last years and the estimation for the next years based in various researches.

The «Wearables» Market moves fast. Many developers and manufacturers emerge in the sector. The flexible wearable computer industry report finds that the industry's patent applications arrived at 429 in the second quarter of 2014, up 27.7% year on year, and witnessed a record high in the report's tracking period starting from the first quarter of 2012.

2. WEARABLE TECHNOLOGY

The last 50 years many things has been changed. From the personal computer of 1980s, we went to the desktop internet computer of 1990s and the mobile internet computer for the early 2000s. But the last 10 years the computers are become more tiny and wearabled. The reason is obvious and the occasion was the progress on the microprossesors and microcomputers. Tiny obgects that can be embeeded to any structure especially textile structure [3].

Fig. 1: *Source: KPCB, Internet trends report, May 2013*

3. TYPES AND PROPERTIES OF WEARABLE TECHNOLOGY

Imagine a world in which electronics are freed from their rigid, confining encapsulation, are intimately integrated into the fiber of our daily lives, and distributed throughout our ambient environment. This is impossible to do using conventional electronic circuits, which are limited by the maximum substrate size available for processing, substrate rigidity, and fragility. Textiles represent an attractive medium for electronic integration as they have been a fundamental and transformational component of our everyday lives for hundreds of years. Smart textiles represent the drive to integrate new sensing functionalities into hitherto inaccessible surfaces and are a new step in the continuing evolution of textiles.

Wearable technology mainly concerns two types of wearables:

- Devices
- Apparel and textiles

Few examples that are arready in the market and the most of them belogns to the first category. These are the glasses, jewellery, headgear, belts, armwear, wristwear, legwear, footwear, skin patches, and exoskeletons. Everything is "wearable".

Sometimes smart textiles are also classified according to the design paradigm chosen to integrate electronic functions into the textile architecture. At the one extreme, one finds smart textiles in which the textile simply acts as a substrate for attachment of sensors, output devices, and printed circuit boards (garment and fabric level integration). Such textiles are similar to wearable computers (i.e., electronic systems including sensors and computational components that is built with standard off-the-shelf components that can be strapped to the body), and there is very little integration of devices into the textile. Subsequent development in this field has seen a drive to integrate the desired functionalities “disappearingly” inside the textile architecture. This implies creating smart textiles in which the electronic/optical sensors and output devices are introduced at the fiber level (fiber level integration). Separating these two extremes are various “hybrid” smart textile efforts that combine various functional fibers (with differing degrees of complexity) with attached integrated circuit components and off-the-shelf sensors. Here the textile may often form a part of the textile devices, e.g., forming electrodes in foam capacitors [4].

4. CHALLENGES FACING SMART TEXTILE DEVELOPMENT

To understand the challenges facing facing smart textile designers and researchers who want to develop smart textiles, consider some of the requirements textile circuits need to fulfill. Circuits need to be extremely rugged as they will be exposed to mechanically demanding environments during fabrication and use of smart textile in daily life (for example wearing the textiles in clothing). The comfort and washability of the smart textile should not be affected by the presence of the circuits, i.e., it should be rugged enough to survive being used in daily life. Circuits require power supplies that are light-weight and have a high capacity to ensure autonomous operation for several hours (or more depending on the targeted end-user application). Commercial smart textiles need to comply with requirements from both the textile and electronics field. These specifications can often be very stringent and may be contradictory. Here are some of the critical challenges facing smart textile development:

• Mechanical environment: In comparison to flexible display applications that are intended to be rolled around cylinders with diameters of a few cm, smart textile fibers may be exposed to bending radii much smaller than 1mm and large tensile strains. Textile fibers within shirts and jackets experience the highest stress levels near the upper back. Simulations of textiles have shown that the strain in a shirt can be up to 20% at the shoulder blades.

• Washability: There are two major cetegories. The smart textiles required the wearer to remove all electronic components (including wiring) prior to washing, and the smart textiles rely on waterproof packaging to protect sensitive electronics from damage during washing.

• Power supplies: Most smart textiles are powered by traditional rechargeable batteries, but these are large and bulky and impossible to integrate fully with the textile architecture. There is a strong drive to develop alternative conformal and lightweight power generation and storage devices as elastic batteries, supercapacitors, and solar cells.

• Product development and commercialization: Successful design and development requires a multidisciplinary team of professionals including textile scientists, polymer chemists, physicists, bioengineers, software engineers, consumer specialists, and fashion designers. Finding a common meeting and sorting out the jargon associated with each field can be challenging. Furthermore, there is a lack of a coherent vision for smart textile development between different research laboratories and universities.

5. FORECAST ON WEARABLES FUNCTION

The forecast for the wearables market it is very promising [5]. According to several research there will be a boom in the market in the next years. Hereby we see the forcast according to the 5 categories of wearables (wristband, jewelry , glasses, clothing, embeeded) fig 2 and the prediction of the wearables electronic market sales fig 3 from the IDTechEX, Wearable Technology 2014-2024 Technologies Markets Forecasts[6] .

The research separates the market to five product categories, from the simplest to more complex. The wristband is the simplest category of wearables and from the 2014 it is really emerged to the market. Several companies have offered various products. Some of them has their own processor, and some they only communicate with the mobile phone of the tablet that should be in the acceptance range according to the protocol connection. They offer data streamed care manage personal health (support), record weaver experience and data to a cloud memory (record), and responsive coaching for better behaviour (nudge).

The second category of wearable is that of the jewerly, which are relatively smaller. Only few are already in the market. They are designed for communication, i.e. connected experiences promote long distance together (communicate), interact with the world through an onboard interface (control), for verification i.e. password provided by one's authentificated self (verify), and reflect one's wellbeing through an emotional mirror (Mirror).

It is forseen that the 2016 the wearable jewerly will be able to do responsive coaching for better behaviour (nudge), and enhance natural ability through augmented sensory perception (augment).

The third category is the glasses. There are few in the market as commercial products but for

the time being they only enhance natural ability through augmented sensory perception (augment). It is forseen that from next year companies will lanch to the market glasses that nurse, communicate and interact with the world through an onboard interface (control).

Nevertheless the big boom will come with the clothing. The first commercial products are expected in 2015. The first generation will be able to do responsive coaching for better behaviour (nudge), and offer data streamed care manage personal health (support). In 2016 it is expected to be able to offer record weaver experience and data to a cloud memory (record), and communicate, i.e. connected experiences promote long distance together (communicate). According to the estimations only in 2017 the smart clothing will have features in order to regain movement with the aid of bespoke biotech (restore), reflect one's wellbeing through an emotional mirror (Mirror), and allign i.e. biometrically attuned systems personalised one's surroundings (allign).

The last category is this of embeeded. Embeeded wearables can be printed in the skin og the user or made by 3D printer as printed clothing. Only after three years can be expected to arise as commercial products and gradually can give all features as support, nudge, augment, record, control, verify, restore ans align.

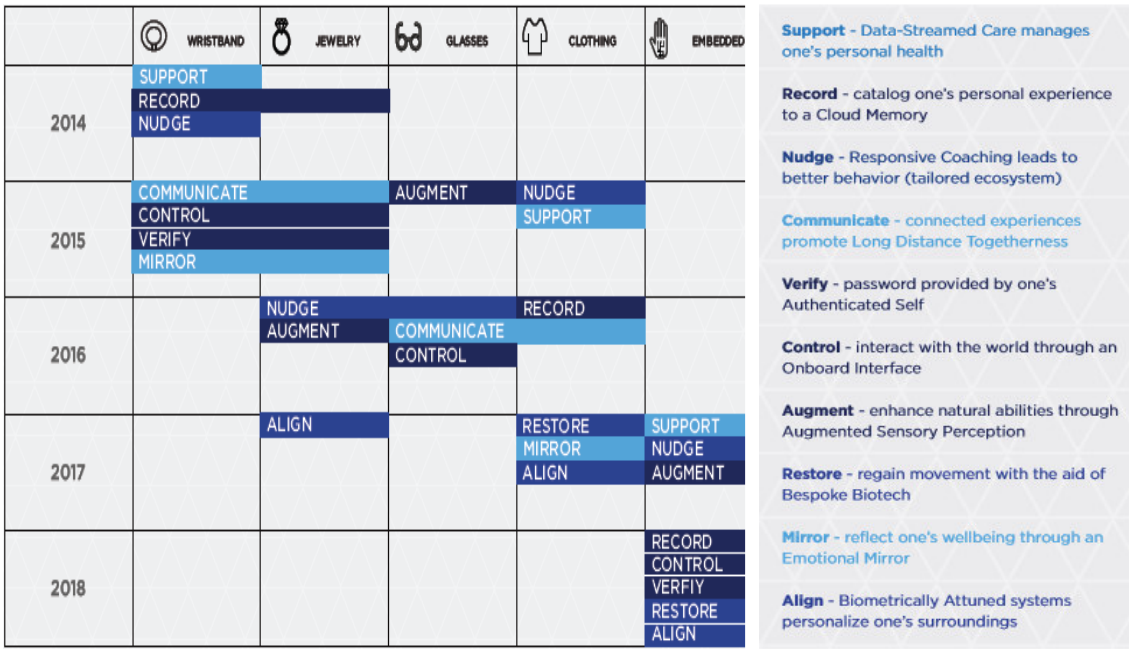

Fig. 2: *Categories of Wearables and forecast of the new products categories for the next 3 years*

6. PREDICTION ON WEARABLE ELECTRONICS MARKET SALES

The IDTechEX did a huge research in 2014 for the market of Wearable Technologies for the next 10 years. The "Wearable Technology 2014-2024 Technologies" report shows remarkable results. In the following table (fig 3) shows the estimate Markets Forecasts Sales in $ BN.

There we can see a extremely increase of sales from 0,75BN in 2012 to 70 BN.

There are several Big and small manufacturers in the area. To name some of these, Nike, Samsung, Adidas, Sony, Motorola, Apple, Garmin, Google, Weartech, Fitbug, Jawbone, Pebble, Fitbit, TomTom Misfit, Withings, Polar, Suunto, etc.

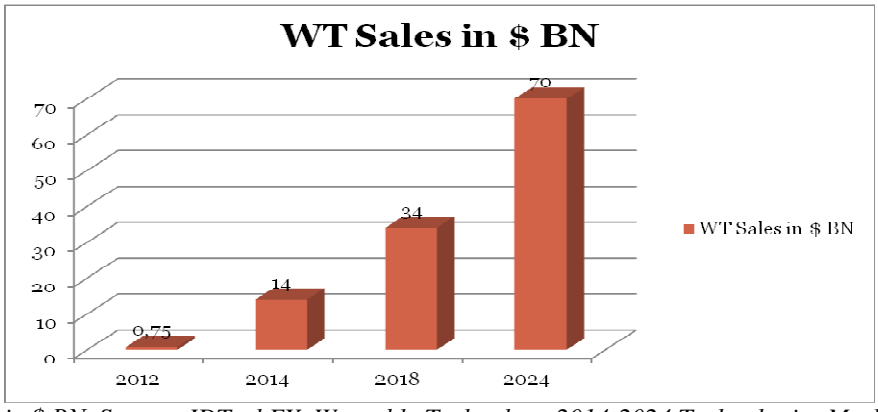

Fig. 3: *Sales in $ BN. Source: IDTechEX, Wearable Technology 2014-2024 Technologies Markets Forecasts*

[6]

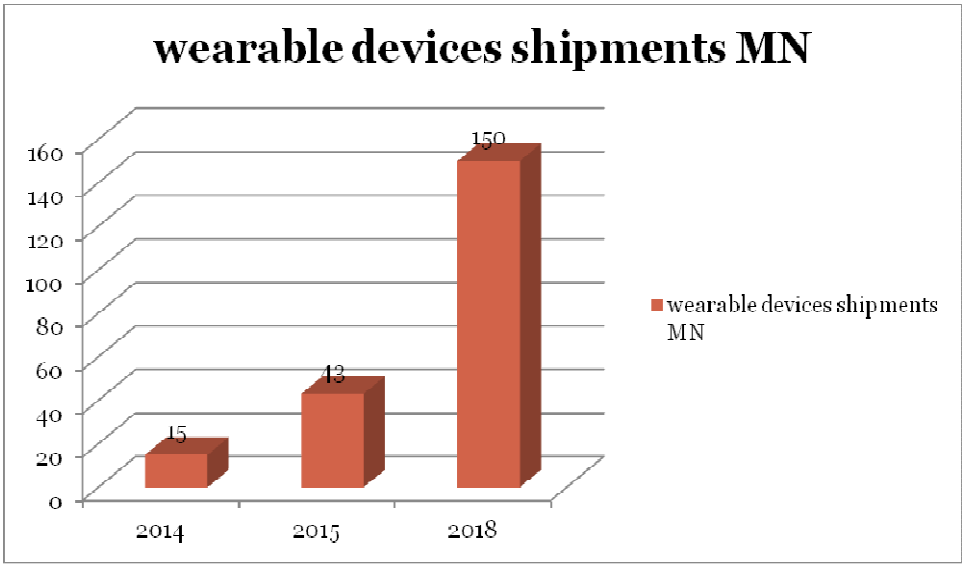

Fig. 4: *Wearables devices shipments in MN. Source: Juniper Research, 2014*

According to the research (Source: Nielsen, Connected life report, March 2014) the 70% of consumers are aware of wearable tech. 15% of them are already using wearable tech [7]. Wearable tech owners today are:

- Young ages (18 – 34 years)
- Male and Female (48%/52%)

The 75% consider themselves an early adopter and 29% household income greater than $100K

Fitness bands the most popular (61%), Smart watches (45%), mobile Health devices (17%) [8], [9].

What it is important according to the end users:

- Performance and perceived benefits when device applied to daily life
- Convenience, extend user's Smartphone addiction
- Design (62% desire other form factors)
- Energy efficiency, Sustainability
- Cost (72% wish wearables were less expensive)
- Fashion (53% want products be more fashionable)
- Benefits
- Daily usability
- Cost
- Functionality
- Accuracy
- Reliability
- Comfort
- Appearance

7. CONCLUSIONS

The forecast for the wearables market it is very promising. Thousands of companies invest in the area. Analysts of the companies and individual specialists are predicting that wearable technology markets will be experiencing a significant growth during the next coming years.

Several factors will boost the efforts next years. These are:

- More enabling technologies
- Low cost 3D printing for rapid prototyping locally
- Funding platforms available
- Lower cost of sensors and components
- Direct ordering channels to manufacturers of components

- More sensors kits available to developers
- Flexible displays
- More uses
- Ability to transform
- Personalization
- Link to apps
- Users are eager for bulks of personal data
- Consumer demand is growing

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