

## Aesthetics of Light-Emitting Diode (LED) in Illuminating Women Smart Fashion Design

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### Abstract:

The growing popularity of the term "Wearable technology" made a remarkable change in the idea of human subjectivity by creating new concepts of identity, new types of behavior and extensions of the body itself. Clothes always integrated between the body and the external world, but "Wearables" are not exception. They pave the way to introduce the intelligent clothing which perform its functions according to the body's needs and requirements that is to adapt with the surrounding environments. Recently, contemporary fashion is considered as consumer product which is able to transfer wearers' thoughts and beliefs through depicting their lifestyle. Depending on the various means of modern technology, contemporary fashion designers and practitioners now playing an important role to reinforce individual's ability to express his or her unique identity in the society. According to this study, the main objective is to integrate scientific rationales and principles artistic creativity, with engineering technical methods to design high-value fashion for women's wear namely "Illuminative Smart Fashion" by using light-emitting diode (LED). The importance of this study is to cast a spotlight on "Illuminative Smart Fashion" according to the artistic and functional viewpoints. The theoretical design process model of "Illuminative Smart Fashion" was totally developed and to manifest the innovative design for the "wearable technology". Thus, the high fashion industry practitioners and fashion educators can be benefited

### Keywords:

*Light-emitting diode (LED), Organic light-emitting diode (OLED), Wearable technology, Illuminated smart fashion.*

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### 1. Introduction:

Due to the significant role of contemporary fashion in strengthening the socio-cultural relations among different people, this practice-based research study combined the theories of wearable technologies with the practical and physical perspectives of wearable technologies, reaching a high-value fashion designs.

Though, we found some difficulty in introducing the latest illuminative fashion products in the Arabic market.

### **Research objectives:**

- Creating fashion designs for women's wear using Light-Emitting Diode (LED).
- Investigating the illuminative fashion products in the market and these applications, and also companies and fashion designers working in illuminative smart fashion.
- Investigating the technologies of various illuminative materials such as, LED and OLED, that were used into fashion.

### **Research limitations:**

The study has been implemented in the Faculty of Applied Arts with the first-year students, Apparel department. The objective was creating illuminated smart fashion design for women.

### **Research methodology:**

Descriptive and analytical method

### 2. Theoretical Framework:

#### Illuminative Smart Fashion:

As it was previously stated in "Wearable Computer", the latest report by BCC Research, it is expected for the global wearable computer equipment market to show growth with a compound annual growth rate of 43.4% over the next five years aiming to achieve \$30.2 billion by end of 2018. Specially, it is expected for quickly evolving consumer market of apps to reach an average annual growth rate of 52%. By the end of 2018, the consumer apps such as smart glasses, smart clothes, smart watches, activity trackers, wearable cameras, augmented reality and games are expected to show extreme growth rate estimated by \$22.1 billion. Alike wearable computers, a number of new smart fashion products employing LEDs which can easily express visual information have been newly published. (Jaehoon Chun, Myungsu Lee, 2016)

The traditional smart fashion products employing LEDs could only provide images or show a simple patterns or motifs with light. Nevertheless, over time, the smart fashion products have been remodeled to provide shapes or present images using LEDs by the virtue of that new function of recognizing changes in the conditions of wearers or their surroundings.

Lately, people who have smart phones were allowed to share a variety of information on the internet. In such a way, among many of smart fashion products which employing LEDs, some will be linked to smart phones (Jaehoon Chun, Myungsu Lee, 2016).

## 2.1. Technologies and Applications of Various Illuminative Materials:

### 2.1.1. Small lights with big capabilities: light emitting diodes (LEDS) & organic light emitting diodes (OLEDS):

LED can be defined as a light source which depends on the semiconductors and electroluminescence to create light. There are two major kinds of light emitting diodes: LED and OLED (Fig.1). The difference between LED and EL lamp is the use of small semiconductor crystal with reflectors and other parts to make the light brighter and focused into a single point. The OLED and EL lamp have the same design, using a flat sandwich of materials. Unlike the LED and EL lamp, the OLED employs organic (carbon) molecules in the layer that emits light. (Whelan M, 2013)

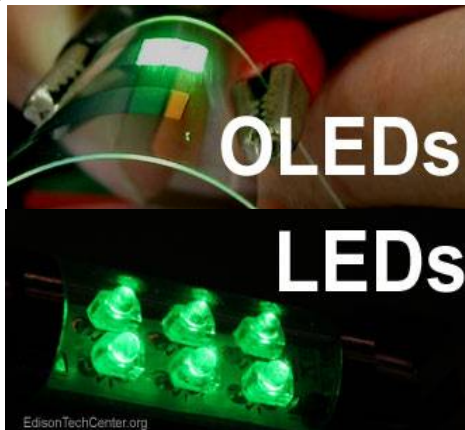


Figure 1. light emitting diodes (LEDS) & organic light emitting diodes (OLEDS).

#### 2.1.1.1. Light-emitting Diode (LED):

The light-emitting diode "LED" is a dual-lead semiconductor which emits light when the electric current pass through the front direction from the anode to the cathode. Depending on the use of electroluminescence inorganic materials lights could be emitted in different colors. (Kate, Harmen, 2014) For examples, Aluminum gallium indium phosphide for yellow light, Aluminum Gallium Phosphide (AlGaP) for green, Aluminum Gallium Arsenide (AlGaAs) for red and Zinc Selenide (ZnSe) for blue. (YavuzŞenol, TanerAkkan, 2011)

The LEDs were used in many shapes, with a wide range of applications from indicator single light to the solid-state lighting. This can be applied in traffic lights, signs and street lighting, small and large lamps and in the large video screens.

(Jaehoon Chun, Myungsu Lee, 2016). For the sake of developing a SEIL gradually, they used to replace the traditional radiation sources such as flashlights and area lightings with their charming features indication lights. (Pakhchyan, Syuzi, 2008)

#### 2.1.1.2. Advantages of LEDs:

The advantages of using LEDs as an illuminating tool are represented in the followings:

- Requires less energy to emit light than incandescent bulbs so it is ideal for battery powered devices.
- Produces higher brightness for a given electrical power. (Rouse, Margaret, 2017)
- Emits different colors without the need for filtering, which means a lower manufacturing cost.
- Requires small electrical current to do its function and if dimming is required, the color tent will not be affected. (DINA Mole, 2002).
- Ideal for applications that based on frequent on-off cycling.
- Rapid lighting up with full brightness.
- Cannot be easily damaged due to the solid construction. (Matteo Stoppa, Alessandro Chiolerio, 2014)

#### 2.1.1.3. Disadvantages of LEDs:

- In outside applications with great variations in summer/winter temperatures, it may be unreliable, however, a lot of efforts will be accomplished in order to solve this problem. (neseParkova, IvarsParkovs, Ausma Vilumsone, 2015)
- Because of its sensitivity, semiconductors can be damaged by heat so large heat sinks must be employed to keep powerful arrays cool, and sometimes a fan is required. Consequently, this will increase the costs and the use of fan will greatly diminish the energy efficient advantage of LEDs, it is also prone to failure which accordingly leads to the unit failure
- In case of flexing, the thin copper connections and the circuit board solder are going to be cracked and the sections of arrays will be collapsed.
- Due to the price control monopolies applied in certain nations, rare earth metals in LEDs are affected.
- Gradual reduction of lumen output over time. (Whelan M, 2013)

#### 2.1.1.4. Organic Light-emitting Diode (OLED):

The organic light-emitting diode is a composition of a luminescent organic material inserted between cathode and the metallic anode. If the diode is polarized, holes from anode and electrons from cathode are inserted into the organic layer.

Concerning developing OLEDs, there are two main types of technologies. The first one is based on small molecules while the second one is based on employing polymers. It turns flexible to tune the properties of OLEDs by controlling the composition of the applied organic materials chemically. In addition, the efficiency of the electroluminescence devices can be improved through the multi-layer OLEDs. (Him Lam Chi, 2012)

OLEDs can be used for displays such as computer monitors, television screens, mobile phones and indication of information. OLEDs also used as lamps for short distance indoor lamps. Despite its early development in the field, the intensity of emitted light is less than the inorganic LED light sources. (Whelan M, 2013)

#### 2.1.1.5. Advantages of OLEDs:

Ability of operation using lower operating voltages with reducing the power consumption. Besides, they are compatible with high efficient light-emitting devices (Yersin, H. & Finkenzeller, W.J. 2008).

- Ability of providing bigger viewing angles with high brightness and contrast ratios. Thus, OLEDs are considered the best choice for the portable applications.
- Can be printed into any suitable substrate by spin-coating, inkjet printing, vacuum deposition or even screen printing. Thus, the cost of OLED display can be lower than the liquid crystal or plasma displays.
- Possibility to develop OLED roll-up display embedded in textiles due to the light weight and the flexible plastic substrates. (Him Lam Chi, 2012).

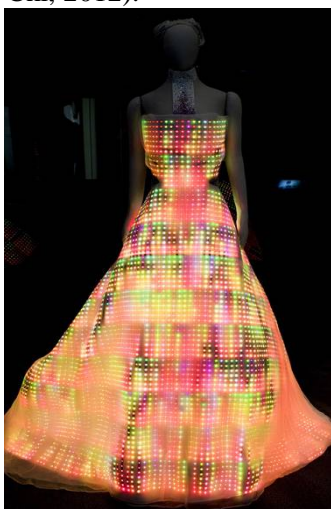


Figure 2. The Galaxy dress



Figure3. Illuminated black dress



Figure 4. "Bubelle" dress

#### 2.2.1.2. Moon Berlin:

Moon Berlin is one of the German fashion companies based in Berlin. Its main objective is to combine light technique with high fashion aiming

- Quick response time of OLED display screens in comparison with the standard liquid crystal screens.

#### 2.1.1.6. Disadvantages of OLEDs:

- The High cost of OLEDs which prevent it from producing a number of lumen like normal LED
- The use of OLED as a new material is under development, as it is still subjected to more tests and researches. (Whelan M, 2013)

#### 2.2. Companies and fashion designers working in illuminative smart fashion:

Many companies and fashion designers combined design skills and art with technological innovations to create fashion by using illuminative materials like light emitting diodes (LEDs). (Stroescu Mary Ruppert, 2009)

#### 2.2.1. Companies working in illuminative smart fashion:

##### 2.2.1.1. CuteCircuit:

In London, CuteCircuit company was founded at 2004. It is the world's leading fashion label establishing fashion wearable technology collections. The company's excellency is apparently represented in Prêt-à-Porter Collection, Haut Couture Collection and in a number of special projects reflecting unique performances. (Berglin Lena, 2013) The Majority of the garment designs focus on the technique of clothing using the LED technology and reflective materials. For example, at the Museum of Science and Industry in Chicago the "Galaxy Dress" (Fig.2) - the center piece of the "Fast Forward: Inventing the Future" - was exhibited. Being inlaid with 24000 full color LEDs beside this mesmerizing design, "The Galaxy Dress" is considered the best wearable display in the world. (CuteCircuit, 2017)

to create a dynamic light and shadow effects. It was founded by Christian Bruns in 2010 as he started to deal with innovative ways of production developments of the future. The first collection

was launched in the market during Berlin Fashion Week at 2011 January. (Berglin Lena, 2013) By virtue of these subtle and integrated electronic lighting effects, the fashion label is interestingly distinguished to highlight this innovative endeavor. For example, the "Illuminated Black Dress" (Fig.3) made of cotton, illuminated by LEDs and woven fiber optics in a patented fabric and powered by a rechargeable flat battery that works approx.15 hours or more. (Moon Berlin, 2017)

#### 2.2.1.3. Philips Lightning – Lumialive:

Philips Company succeeded in generating a kind of luminous textile used for a range of applications concerning fashion and interior designs. The company pays pig attention towards the new projects during its launch at different fairs and in media. (Berglin Lena, 2013) The main focus of Philips Luminous textiles is producing garments made of "sensitive" qualities compatible with human skin. As an example, the "Bubelle" dress (Fig.4), which is a delicate dress illuminated with patterns changed depending on skin contact. This dress was specially developed as part of the skin research project, which focuses on emotional sensing and explores technologies which tend to be 'sensitive' rather than 'intelligent'(Fig.4). (Phillips, 2017)

#### 2.2.2. Fashion designers working in illuminative smart fashion:

##### 2.2.2.1. Hussein Chalayan:

He is a British from Turkish Cypriot. Chalayan tends to integrate human body and clothing with, science technology and architecture inspired by



Figure 5. Video dress



Figure 6. Olympic Ceremonies

the narratives around culture and anthropology. (Chalayan, (2017) He designed In 2007, a "Video Dress", displayed short films and were embedded with 15,600 LEDs that in the fabric and combined with crystal.. (Seymour, Sabine (2008)

Despite the excessive need for power and being impractical for use, the "Video Dress" is considered one of the most brilliant ideas that worth observation. Chalayan totally realizes the concept of combining electronic functionality with technology to create highly fashionable dresses (Fig.5). (Him Lam Chi, 2012)

##### 2.2.2.2. Moritz Waldemeyer:

He is a German -British fashion designer and engineer, his work is merging between technology, art, fashion and design. Waldemeyer collaborates with many of the top architects, artists and fashion designers such as Ron Arad, Rihanna Hussein Chalayan. (Berglin Lena, 2013) He participated in Olympic closing ceremony by using a collection of LEDs embedded carnival costumes. The LEDs issued lights moving simultaneously with the music (Fig.6). (Moritz Waldemeyer, 2017)

##### 2.2.2.3. Mary Huang:

She is an American fashion designer. (Mary Huang, 2017) In her work Huang created an evolving collection of "Rhyme& Reason. She explored the use of light as a material to create transformative fashions. Depending on the shift from day to night, the white knitwear and fabric was filled with illumination elements to create an evening look which never fails to draw attention (Fig.7). (Mary Huang, 2017)



Figure 7. Rhyme&Reason

### 3. Method and experiment:

This research focuses on the innovating contemporary illuminated smart fashion design for women by using aesthetics of light-emitting diode

(LED) and inspired from lighting creations of famous industrial designer Achille Castiglioni.

#### 3.1 Achille Castiglioni (1918-2002):

He is an Italian designer, born in Milan and

studied architecture in 1944. Castiglioni established his office which became one of the most inspiring and innovative office for modern design.

He adapted a certain believe of having "a constant and consistent way of designing, not a style," which accordingly encouraged him to create new products. The aim of such products was to restore Italy's quality of life in the post-war years and to innovate it upon the household object. Castiglioni depended on the viewpoint stating that design must restructure the object's function, form and the whole production process and he applied this in all his designs. He also described his working process as: "Start from scratch. Stick to common sense. Know your goals and means". (Antonelli, P. 1997)

The following is a presentation for the designs:

### 3.2.1. Design 1:

#### 3.2.1.1. Garment construction:



Figure 8. Design.1 from three sides



Figure 9. Viscontea lamp



Figure 10. LEDs in tulle coal



Figure 11. LEDs in skirt and belt

### 3.2.2. Design 2:

#### 3.2.2.1. Garment construction:

Fitted dress without sleeve with high coal in the back and long zipper in the front. Decorating the front of the dress with opened zippers (Fig.12).

#### 3.2.2.2. Inspiration by lighting source:

Diabolo was suspension lamp designed in 1998 by Achille Castiglioni. It is characterized by a

Cocktail dress without sleeve with tulle high coal, tulle skirt-bouffant gown and tulle belt which end in the back with bow, in (Fig.8) see dress from three sides.

#### 3.2.1.2. Inspiration by lighting source:

The suspension lamp "Viscontea" was designed in 1960 by Achille Castiglioni. It provides diffused light. Besides, its internal steel structure sprayed with a unique "cocoon" and coated with white powder. (Fig.9). (Fiell. C'. 2005)

#### 3.2.1.3. Illuminative material:

The second layer of glitter tulle was embroidered with a total about 100 pieces of 5 mm white LEDs in tulle high coal (see Fig.10), tulle skirt-bouffant gown and the tulle belt which end in the back with bow (see Fig.11).

#### 3.2.1.4. Fabrics:

The basic dress made of satin, the second layer and bow made of glitter tulle.

total about 10 pieces of 5 mm blue LEDs. The skirt was decorated with seven line of red, blue and white LEDs ribbon (Fig.14).

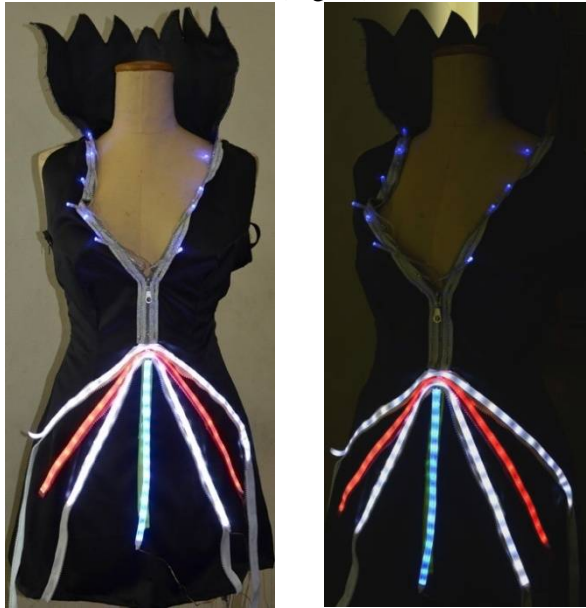


Figure 12. Design.2

**3.2.3. Design 3:**

**3.2.3.1. Garment construction:**

Fitted short dress without sleeve and decorating the dress by draping a piece of glitter tulle with illuminated flowers, in (Fig.15) see dress from front and side.

**3.2.3.2. Inspiration by lighting source:**

Giovi was the wall lamp (Fig. 16) designed in 1982 by Achille Castiglioni .It was coated with white powder and was able to make indirect and luminous lighting pattern on the wall, and its



Figure 15. Design.3

**3.2.4. Design 4:**

**3.2.4.1. Garment construction:**

Crochet short dress without sleeve and decorated

**3.2.2.4. Fabrics:**

The basic dress made of satin and the zippers made of silver metal.



Figure 13. Diabolo lamp



Figure 14. LEDs in skirt

another half was covered by an aluminum screen to reflect and prevent emitted bright light. (Castiglioni, A. 2011)

**3.2.3.3. Illuminative material:**

The inner layer of the glitter tulle was embroidered with a total about 20 pieces of 5 mm yellow LEDs which inside illuminated flowers (see Fig.15).

**Fabrics:3.2.3.4.**

The basic dress made of Knitted fabric and the decorative piece made of the glitter tulle.

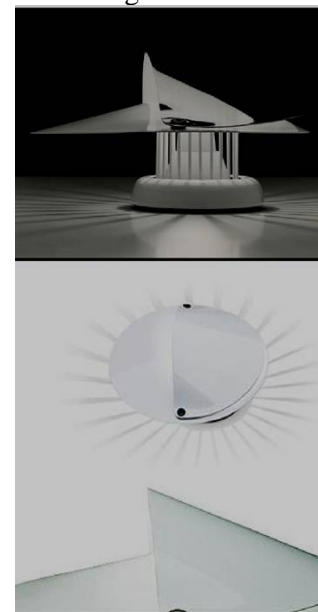


Figure 16. Giovi lamp

at the front with LEDs, at the back with LEDs ribbons, in (Fig.17) see dress from three sides.

**3.2.4.2. Inspiration by lighting source:**

The wall lamp 'Giovi' (Fig. 16) was explained before.

#### 3.2.4.3. Illuminative material:

The dress was embroidered with a total about 40 pieces of 5 mm multi colors LEDs at the front. At

the back, there is a curved line with white LEDs ribbons.

#### 3.2.4.4. Fabrics:

The crochet dress made of synsticyarns (Fig. 18).



Figure 17. Design.4 from three sides



Figure 18. Crochet dress

#### 3.2.5. Design 5:

##### 3.2.5.1. Garment construction:

Evening dress consists of basic fitted dress, second layer of tulle and the last layer was decorated with metallic coins (Fig.19).

##### 3.2.5.2. Inspiration by lighting source:

Taraxacum was designed in 1960 by George (Fig. 20). It was sprayed with a "cocoon" of plastic polymers and protected with a clear finish.

Taraxacum as word is Latin word means name for the dandelion. (Design Within Reach, 2007)

##### 3.2.5.3. Illuminative material:

The dress was embroidered with a total about 40 pieces of 5 mm white LEDs.

##### 3.2.5.4. Fabrics:

The basic dress made of satin, second layer made of tulle, the last layer made of organza and the dress was decorated with metallic coins (Fig.21).



Figure 19. Design.5



Figure 20. Taraxacum lamp



Figure 21. Matalic coin in dress

#### 3.2.6. Design 6:

##### 3.2.6.1. Garment construction:

Fitted dress with one shoulder was decorated by draping a piece of silk; in (Fig.22) see dress from three sides.

##### 3.2.6.2. Inspiration by lighting source:

The Taraxacum lamp (Fig. 20) was explained

before.

##### 3.2.6.3. Illuminative material:

The inner layer of the silk was embroidered with a total about 30 pieces of 5 mm yellow LEDs.

##### 3.2.6.4. Fabrics:

The basic dress made of cotton the draped layers made of silk.



Figure 22. Design.6 from three sides

**3.2.7. Design 7:**

**3.2.7.1. Garment construction:**

Cocktail dress without sleeve with tulle flower, tulle skirt-bouffant gown and satin belt which end in the back with bow, in(Fig.23) see dress from three sides.

**3.2.7.2. Inspiration by lighting source:**

The SplügenBräu lamp was designed at 1961 (Fig. 24). When the light falls on polished spun-aluminum construction animate it gets wonderful.

(Fiell. C'. (2005)

**3.2.7.3. Illuminative material:**

The second layer of glitter tulle was embroidered with a total about 100 pieces of 5 mm white LEDs in tulle flower (Fig.25), tulle skirt-bouffant gown and the top of dress (Fig.26).

**3.2.7.4. Fabrics:**

The basic dress made of satin, the second layer made of glitter tulle and bow made of satin.



Figure 23. Design.7 from three sides



Figure 24. SplügenBräu lamp



Figure 25. LEDs in tulle flower



Figure 26. LEDs in dress



### 3.2.8. Design 8:

#### 3.2.8.1. Garment construction:

Evening dress with skirt-bouffant gown and the top of dress consists of light sticks (Fig.27).

#### 3.2.8.2. Inspiration by lighting source:

The SplügenBräu lamp (Fig. 24) was explained before.



Figure 27. Design.7

The artistic study of the latest illuminative fashion products in the market and those applications in visual expressions that helped to create illuminated smart fashion design for women.

- The ability to make fashion designs for women by using light-emitting diode (LED).

#### 4. Results:

- At the end of this study, the research achieved the hypotheses which are posed at the research introduction. The research reached the following results:
- The artistic study of the latest illuminative fashion products in the market and those applications in visual expressions that helped to create illuminated smart fashion design for women.
- The identification of some companies working in illuminative smart fashion like: CuteCircuit, Moon Berlin and Philips Lightning Lumialive.
- The identification of some fashion designers working in illuminative smart fashion like: Hussein Chalayan, Moritz Waldemeye, Mary Huang.
- The research presented eight fashion designs for women by using light-emitting diode (LED) which inspired from lighting creations of famous industrial designer Achille Castiglioni and analyzed these fashion designs from garment construction, inspiration by lighting source, illuminative material and fabrication.

#### 3.2.8.3. Illuminative material:

The luminous stick was embroidered with a total about 100 pieces of 5 mm white LEDs (Fig.28).

#### 3.2.8.4. Fabrication:

The basic dress made of satin, the second layer made of glitter tulle and bow made of satin.



Figure 28. LEDs in dress

#### 5. Conclusion:

This research focuses on the possibility of using the Leds to show the aesthetic aspects in the contemporary fashion design of the ladies clothes. The different types of Leds, which are in the markets, are displayed in terms of composition, advantages and disadvantages.

In this research, we shed lights on some of the companies producing luminous clothes like (CuteCircuit, Moon Berlin and Philips Lightning Lumialive), as well as the fashion designers who are interested in using the Leds in their designs, such as (Hussein Chalayan, Moritz Waldemeye, Mary Huang.).

The research presented In practical part eight women contemporary fashion designs using the Led technology, these designs were inspired by Achille Castiglioni's innovative light units, with an analysis of its construction, its illuminative material and its fabric.

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