UNIT II

E-TEXTILES

E-TEXTILE

- Electronic textiles (e-textiles) are **textiles that are, or are part of, electronic components that create systems capable of sensing, heating, lighting or transmitting data**. Ultimately, e-textiles will have an important role to play in the fields of medicine, safety and protection.
- **There are two main types of e-textiles:**

Embedded e-textiles have their electronic components woven together with the fabric components. ...

Laminated e-textiles have their circuitry printed onto a non-textile material which is then bonded or sewn to the surface of a textile.

E-TEXTILE[2]

- E-textiles, also known as electronic textiles or smart textiles, are fabrics that enable digital components (including small computers), and electronics to be embedded in them.

- **Properties of e-textile:**

- Flexible
- No wires to snag environment
- Large surface area for sensing
- Invisible to others
- Cheap manufacturing
- Permeability
- Strength
- Thermal Resistance
- Electrical resistance

E-TEXTILE[3]

- An electronic textile is a fabric that can conduct electricity. If it is combined with electronic components it can sense changes in its environment and respond by giving off light, sound or radio waves.. Electronic textiles (e-textiles) are fabrics that have electronics and interconnections woven into them.
- Components and interconnections are a part of the fabric and thus are much less visible and, more importantly, not susceptible to becoming tangled together or snagged by the surroundings.
- An electronic textile refers to a textile substrate that incorporates capabilities for sensing (biometric or external), communication (usually wireless), power transmission, and interconnection technology to allow sensors or things such as information processing devices to be networked together within a fabric.

E-TEXTILE[4]

- Electronic textiles allow little bits of computation to occur on the body.
- They usually contain conductive yarns that are either spun or twisted and incorporate some amount of conductive material (such as strands of silver or stainless steel) to enable electrical conductivity

The field of e-textiles can be divided into two main types:

- E-textiles with classical electronic devices such as conductors, integrated circuits, LEDs, and conventional batteries embedded into garments.
- E-textiles with electronics integrated directly into the textile substrates. This can include either passive electronics such as conductors and resistors or active components like transistors, diodes, and solar cells.

INTRODUCTION

- Body worn systems, endowed with autonomous sensing, processing, actuation, communication and energy harvesting and storage are emerging as a solution to the challenges of monitoring people anywhere and at anytime in applications such as healthcare, well-being and lifestyle, protection and safety.
- Textiles, being a pervasive and comfortable interface, are an ideal substrate for integrating miniaturized electronic components or, through a seamless integration of electroactive fibres and yarns, they have the potentiality to become fully functional electronic systems
- The idea of e-textiles being a viable solution to implement truly wearable, smart platforms as bidirectional interfaces with human body and functions has emerged as a result of the work of independent groups around the world almost at the same time.

INTRODUCTION[2]

- Work performed along this direction for most of the textile-based devices is, with the sole exception of textile electrodes, fragmented at a very early stage of development.
- Besides the great technical challenges to be faced, it is nowadays difficult to predict if issues such as compatibility with industrial textile technology, durability, water resistance, cost and user acceptance can be successfully dealt with

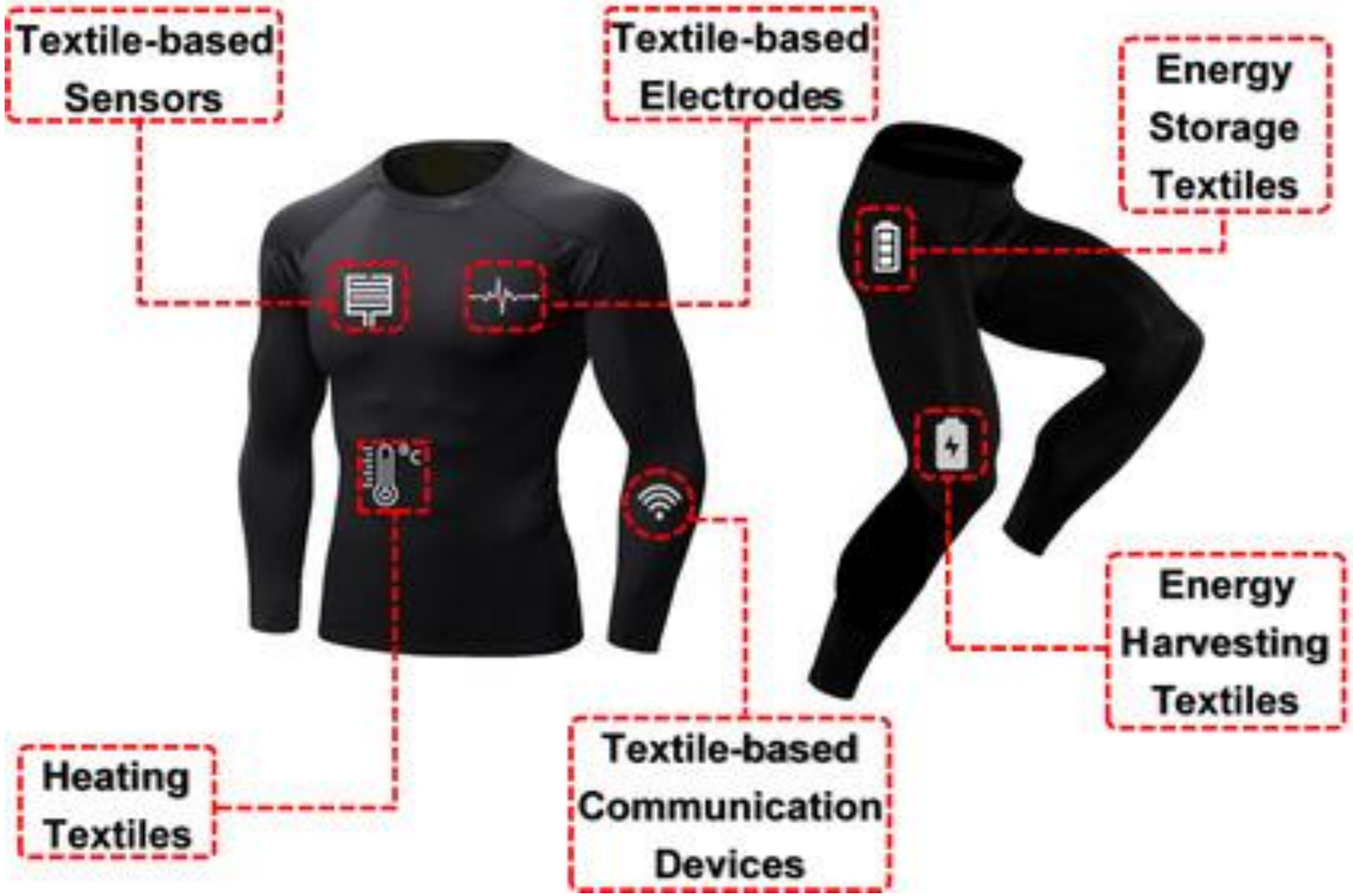
DIFFERENCE BETWEEN E-TEXTILES AND WEARABLE TECHNOLOGY?

- The distinction is that **wearable technology is connected to you or your smart phone, and provides feedback through sensors**. Electronic Textiles (E-Textiles) and Smart Garments are sub-sets of wearable technology. They fall within the category of clothing


Sensors
Data
Processing
Smart
Textiles
Communication
Actuator
Storage

TEXTRONICS –

TEXTILE-BASED WEARABLE ELECTRONICS



FIBERS AND TEXTILES FOR BIOELECTRODES

- Monitoring diagnostics, therapy and rehabilitation in the medical domain are often based on methodologies and techniques exploiting bioelectrical phenomena.
- Noninvasive monitoring of vital signs such as electrocardiogram (ECG), electrodermal response (EDR), electromyogram (EMG), stimulus-evoked potentials (SEPs) and others biosignals need electrodes to convert body-generated ionic currents into electronic signals for further processing.
- Injecting electrical currents into the body for therapeutic purposes is also widely used; functional electrical stimulation (FES) and electrotherapy are good examples. Supporting the extension and expansion of health services outside the classical healthcare establishments through wearable systems has evidenced the need for long-term use of bioelectrodes.

FIBERS AND TEXTILES FOR BIOELECTRODES

- Textile electrodes have been developed and have reached the level of commercial development. Textile-grade fibres made of stainless steel, carbon, silver and silver-coated polyester have all been weaved or knitted to realize fabric electrodes.
- The inappropriateness of using gel coupling in longterm monitoring, the difficulty in proper positioning and fixing electrodes on skin and the susceptibility to motion artefacts still pose problems for the development of dry textile electrodes, in particular when intended to monitor non-sweating or elderly subjects

KNITTED ELECTRODES

- Most textile electrodes have been realized using commercial stainless steel threads wound around a standard cotton textile yarns.
- They have been realized either through a flat weaving process or knitted using the tubular intarsia technique to get double face apparels (see Fig. 7.1), where the external part is realized with the basal yarn, non-conductive, to isolate the electrode from the external environment

Fig. 7.1 Knitted intarsia electrodes and textile connections, particularly on the skin side on the right

TEXTILE ELECTRODES

- Adhesive hydrogel membranes shown in Fig. 7.2, or integrated pushing cushions have been used to improve electrode–skin coupling. Fabric electrodes have been proved to offer very good performances in recording either EMG or ECG signals even also after repeated washing

Fig. 7.2 Hydrogel membrane coupled with textile electrode

- Non-contact capacitive electrodes have also been developed and disclosed, in particular, for EMG recording . Their susceptibility to motion artefacts and power line interference, however, is very high. The use of active electrodes, which implies the integration of miniaturized buffer amplifiers (impedance converters) to suppress noise, is well known; a new embodiment has been recently developed in the form of non-woven fabric, adding complexity and cost but being more effective in term of front-end electronics signal-to-noise ratio
- Existing fabric electrodes still suffer limitations when skin is dry and when the wearer performs intense physical activity. Minimizing electrical contact impedance between the electrode and the skin, maximizing adhesive properties without the use of covalent bonding, and mechanical stabilizing the ionic–electronic interface are crucial interventions needed to improve textile electrode performances in terms of signal-to-noise ratio, motion artefact and power line interference rejection.

FIBRES AND TEXTILES FOR SENSING

- Sensing and monitoring physical and chemical parameters is finding useful application in e-textiles. The signals can be endogenous (related to the person wearing the garment) or exogenous (related to the environment).
- As an example, vital signs monitoring can be useful in the wellness, sport or medical domains, while chemically sensitive fabrics can be exploited for alerting from dangerous chemical or biological substances as needed by people working in noxious environments or, in the longer term, to monitor metabolites and biomarker in sweat or in wounds.

METHOD1:PHYSICAL SENSING

- Many miniaturized sensors have been integrated into fabrics and garments. In this chapter, however, we focus on fibre and yarn sensors or fabric sensors being potentially fully compatible with textile technology. In this respect, thermal and mechanical sensors have been disclosed, relying on thermoresistive, piezoresistive, piezoelectric and piezocapacitive effects or on various types of modifications of optical fibres.
- Thermo- and piezoresistive fabrics, prepared by coating fibres with conducting polymers have been proved to be useful in monitoring surface temperature and surface strain in using body-fitting garments

PHYSICAL SENSING

- A different technique and methodology for developing textile wearable posture and gesture monitoring systems has been disclosed, using redundant arrays of stretch sensors made of piezoresistive rubber, screen printed onto fabrics and garments .
- Very recently, textile-based electrogoniometers have been conceived and tested to further increase the performance of 3D reconstruction of body kinematics through sensorized garments. Experimental work to enable clinical applications, mostly related to neurorehabilitation, is in progress

Fig. 7.3 System developed in the frame of MyHeart project for neuro-rehabilitation therapy

PHYSICAL SENSING

- Fibres, films and patches of piezoelectric polymers such as polyvinylidene fluoride (PVDF) and its copolymers may expand the range of biomechanical and physiological parameters detected by electronic textiles.
- Compared to piezoresistive materialspiezoelectrics offer higher sensitivity and wider bandwidth in transducing mechanical to electrical signals.
- They do not, however, consent the acquisition of static or slowly varying signals because of the intrinsic nature of the physical principle they exploit. PVDF narrow strips have been incorporated into fabrics matrices

CHEMICAL SENSORS AND BIOSENSORS

- **A biosensor is a device that measures biological or chemical reactions** by generating signals proportional to the concentration of an analyte in the reaction
- A biosensor is **an analytical device, used for the detection of a chemical substance, that combines a biological component with a physicochemical detector**.

- Chemical sensors are devices that convert the concentration of target compounds into an “analytical” signal. The term analytical implies the concept of measurability. Then a chemical sensor converts the information about the presence of target compounds into a measurable quantity.

- Currently, electronics is the technology that enables not only the measurement, but also the efficient use of the acquired information. Examples of this are storage, processing, communication, and active utilization of the information to control machines. Sensor technology has been pivotal in the latest pervasiveness of microelectronics, and the continuous extension of sensor properties are gaining unprecedented fields of applications

- Synthetic textile fibres (nylon and polyesters) coated with conductive polymers, polypirrole or polyaniline, woven into fabric mesh have been used for toxic vapour sensing .
- Detection limits of parts per million of vapours such as ammonia and nitrous oxide were obtained. Conducting polymer-based electrospun polyaniline fibre sensors have also been shown to enable pathogens detection through exhaled breath analysis

- More complex textile platforms for sensing chemicals in sweat (Morris et al. 2009) or for monitoring sweat rate (Salvo et al. 2010) have been described, also including fabric pumps and valves (Coyle et al. 2010). Examples are shown in Fig. 7.4 www.biotex.it

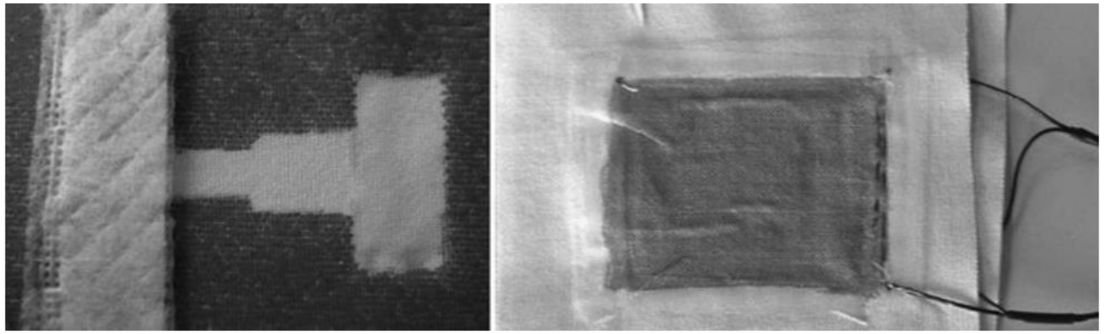


Fig. 7.4 Fabric pump and sweat rate sensor developed in the frame of Biotex project

	Body signals or variables	Sensing devices/components	Device implementation
I.	Electrocardiogram (ECG)	Bioelectrodes	Woven or knitted metal electrodes
II.	Electromyogram (EMG)	Bioelectrodes	Woven or knitted metal electrodes
III.	Carotid pulse and radial artery pulse	Piezoelectric sensors	EAP-based textile fibers or small-size strips
IV.	Hear apex pulse (ballistocardiogram)	Piezoelectric sensors	EAP-based textile fibers or small-size strips
V.	Respiration (respitrace)	Piezoresistive sensors	EAP-based textile fibers or small-size strips
VI.	Articulation segment position and movements	Piezoresistive sensors	EAP-based textile fibers or small-size strips
VII.	Electrical Impedance of skin	Bioelectrodes	Woven metal electrodes
VIII.	Blood oxygenation (pulse oximetry)	Optical fibers	Optical fibers
IX.	Sound	Piezoelectric sensors (microphones)	EAP-based textile fibers or small-size strips
X.	Skin temperature	Thermoelectric sensors	EAP-based textile fibers or small-size strips

ACTIVE FIBRE ELECTRONICS AND WOVEN LOGICS

- A very challenging task resides in the realization of viable textile fibres and fabrics endowed with active electronic and logic functions. Organic field effect transistors (OFETs) are commonly used in flexible electronics.
- The use of OFETs in a textile substrate has been proposed and different configurations examined (Bonfiglio et al. 2005). OFETs on fibres have also been disclosed (Lee and Subramanian 2005; Maccioni et al. 2006), but their realization onto fibres is a complex process, since precise micropatterning of source, drain and gate electrodes is needed.
- A different approach has been disclosed (Hamedi et al. 2007, 2009) making use of micrometre-sized organic electrochemical transistors (OECTs)

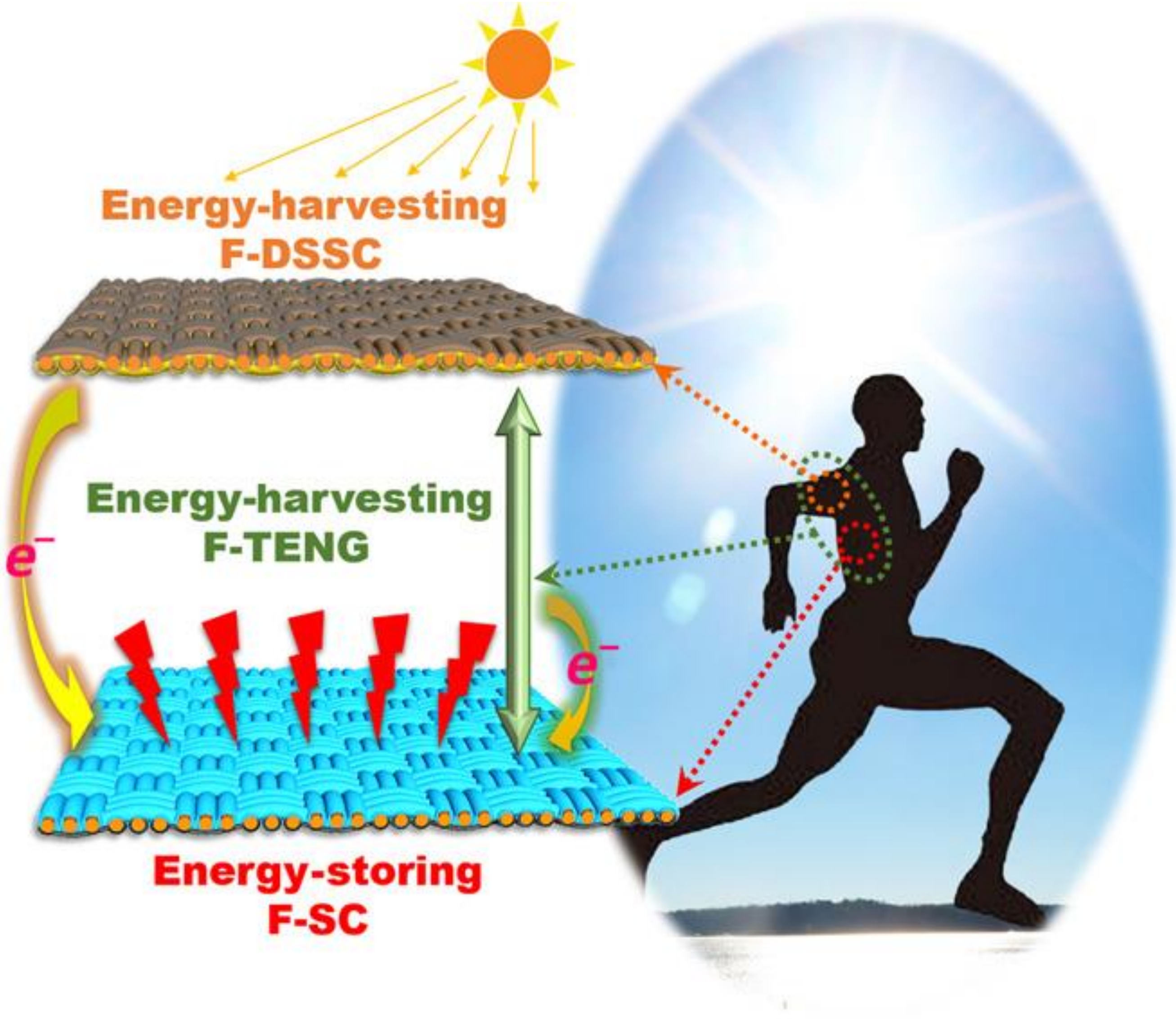
- Wiring fibre OECTs may prove to be an easier route to weaving electronics directly into fabrics to implement universal logic operations (De Rossi 2007), but very major obstacles exist in making these prototypes working in the real world as all these procedures are incompatible with current textile technology.
- In particular, to realize fabric microcomponents, i.e. fibres and yarns endowed with even simple electronic functions, as electrical conductors, insulators, semiconductors, material properties must be deeply modified and this modification must not invalidate other fundamental properties as mechanical flexibility and robustness, not mentioning the fact that these treatments must be done on large scale, to pave the way for the future industrial exploitation of these technologies

FIBRES AND TEXTILES FOR ENERGY HARVESTING AND STORAGE

- Energy harvesting and storage for wireless autonomous systems is a crucial issue in particular for wearables when intended to work continuously.
- Harvesting energy from motion and vibrations, from thermal gradients, from environmental RF or solar irradiation is nowadays actively investigated.
- Besides MEMS and silicon technology, some effort is also devoted to flexible plastic electronics and textile devices.
- Similarly, flexibles, organic batteries and, more recently, fabric batteries and supercapacitors for energy storage have been disclosed. As long as in the previous paragraphs, we confine our discussion to truly fibre and textile-based devices

MODE1:TEXTILE-BASED SOLAR CELLS

- Lightweight, portable solar panels are commercially available using polymer-based organic photovoltaics (www.konarka.com).
- The development of dye-sensitized photovoltaic fibres has been recently reported (Fan et al. 2008; O'Connor et al. 2007) and their mechanical compatibility with textile manufacturing and weaving operation documented (Ramier et al. 2008).
- Several technical challenges have still to be solved, but the potentiality of textile photovoltaic might be substantial, in particular when covering large area and because fibre devices are less sensitive to light source orientation (O'Connor et al. 2008).
- Power conversion efficiencies are quite low at present (no more than 0.5%); the use of more efficient dyes-on-fibres (dyes of this kind are already available) may well bring efficiency to 5% in the near future (Yadav et al. 2008).


Energy-harvesting
F-DSSC
Energy-harvesting
F-TENG
e⁻
e⁻
Energy-storing
F-SC

- Wearable electronics fabricated on lightweight and flexible substrate are believed to have great potential for portable devices, but their applications are limited by the life span of their batteries.
- A hybridized self-charging power textile system is proposed with the aim of simultaneously collecting outdoor sunshine and random body motion energies and then storing them in an energy storage unit.
- Both of the harvested energies can be easily converted into electricity by using fiber-shaped dye-sensitized solar cells (for solar energy) and fiber-shaped triboelectric nanogenerators (for random body motion energy) and then further stored as chemical energy in fiber-shaped supercapacitors

MODEII: ELECTRONIC TEXTILE BATTERIES

- Thin, flat batteries using solid electrolytes are already commercially available covering the need of flexible, lightweight power sources for smart garments in which they can be easily integrated.
- The realization of charge storage devices directly onto a textile substrate is a more recent endeavour.
- Early work on the use of polypirrole and derivatized polytiophene on non-woven polyester as cathode and anode materials, respectively, to enable construction of textile batteries

- Two woven, silver-coated polyamide yarns coated with PEDOT (a conducting polymer) and separated by a solid electrolyte have been proved to be sufficient to realize a very simple textile rechargeable battery .
- Although the performances are still poor, the concept might be useful to enable the implementation of better performing power sources, which can be seamlessly integrated into fabrics and garments

SMART TEXTILES FOR ACTUATION

- The term "actuation" refers to the action a system performs on the environment, usually the external one.
- Different forms of actuation are possible with reference to wearable systems. The main ones are heating and mechanical force generation. Textile-based devices and systems for actuation can be done using Textile Heating Systems and Thermo and Electromechanical Actuation

TEXTILE HEATING SYSTEMS

- Resistive fabrics were early developed for electromagnetic shielding and for body heating. Several commercial products are nowadays available on the market in the form of either yarns, fabrics or whole wearable systems (VDC 2007).
- Metal fibres embedded in the fabric, metal-coated textiles, textile-grade carbon fibres and polypirrole-coated fabrics have all been used, and not much research work appears to be needed in this area.
- Advances would be required in the development of energy sources of high specific capacity because of the very inefficient process of resistive heating.

THERMO AND ELECTROMECHANICAL ACTUATION

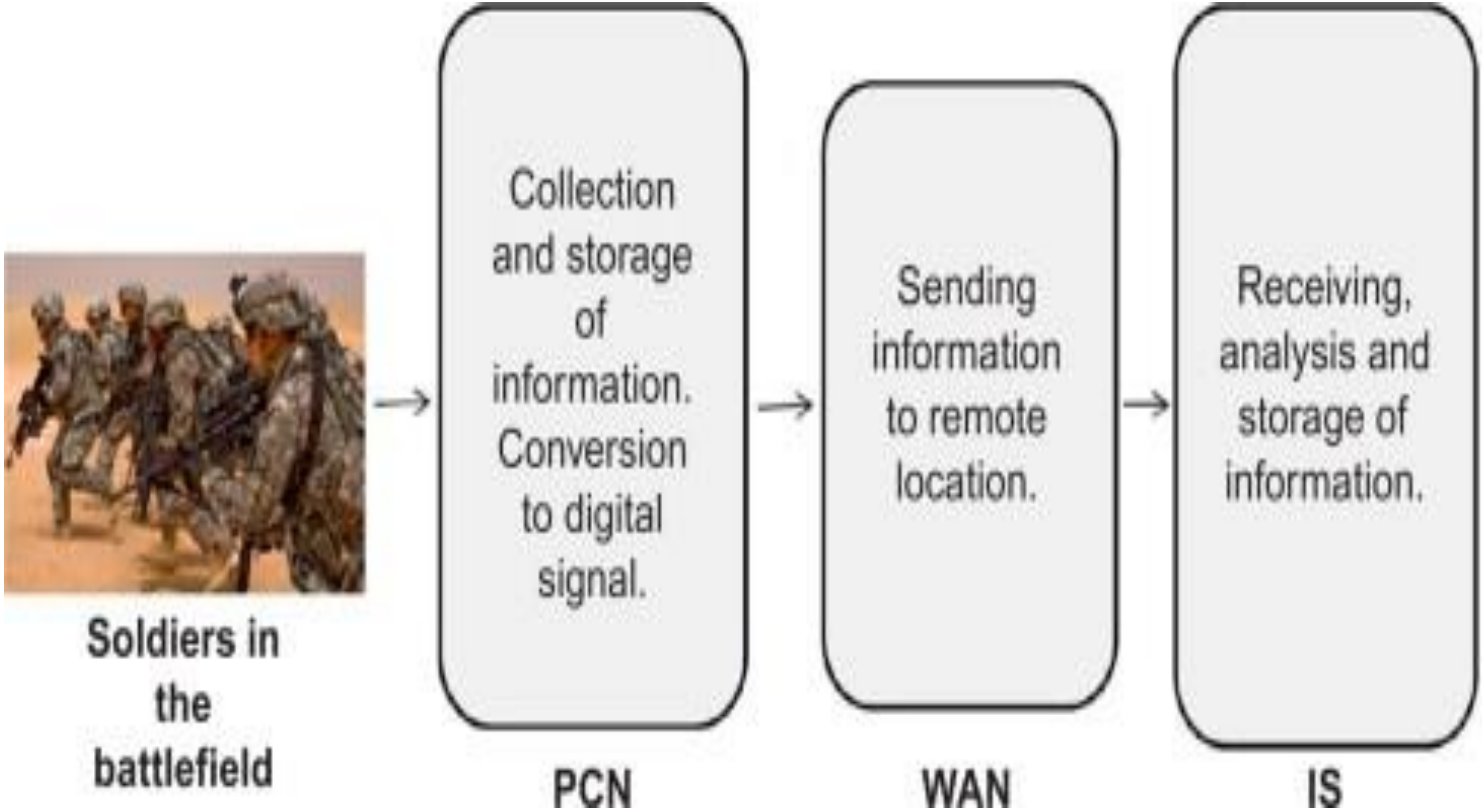
- Engineering actuative materials and embedding them in fabrics and garments may provide new design concepts to enhance functionalities of textiles for apparel and wearables.
- Functionalities such as shape recovery, aesthetics, heat exchange and external motor control functions have been proposed and preliminarily examined.
- Not much work in this field is available in the literature and the technology has to be considered in its early infancy.
- The use of shape memory alloy fibres have been embedded into knitted fabrics and shape memory functions have been demonstrated for design and fashion exploiting thermal memory effects

E-TEXTILES FOR COMMUNICATION

- The integration of communication devices into textiles is rapidly increasing in civilian as well as military applications.
- Developments in both local and wide area networks (WANs) have enabled faster and more accurate data transfer and analysis to be carried out.
- Technologies such as Wi-Fi, WiMax, Bluetooth, RFID, GPRS, 3G/4G and real-time communications are being incorporated into communication and network systems (McCann and Bryson, 2009).
- Of the technologies available, the most appropriate one seems to be the Bluetooth, which is the cheapest and the most energy efficient.

E-TEXTILES FOR COMMUNICATION[2]

- Developments in communication devices have occurred in three main areas: personal communication networks (PCNs), WANs and information systems (IS).
- PCNs are involved with the collection and storage of information provided by sensors and converting the data into signals that can be transferred for analysis.
- WAN systems deal with the information collected from PCNs and transfer it to remote locations. IS help in the analysis, storage and interpretation of results (Figure 11.3).


Soldiers in the battlefield
Collection and storage of information. Conversion to digital signal.
PCN
Sending information to remote location.
WAN
Receiving, analysis and storage of information.
IS

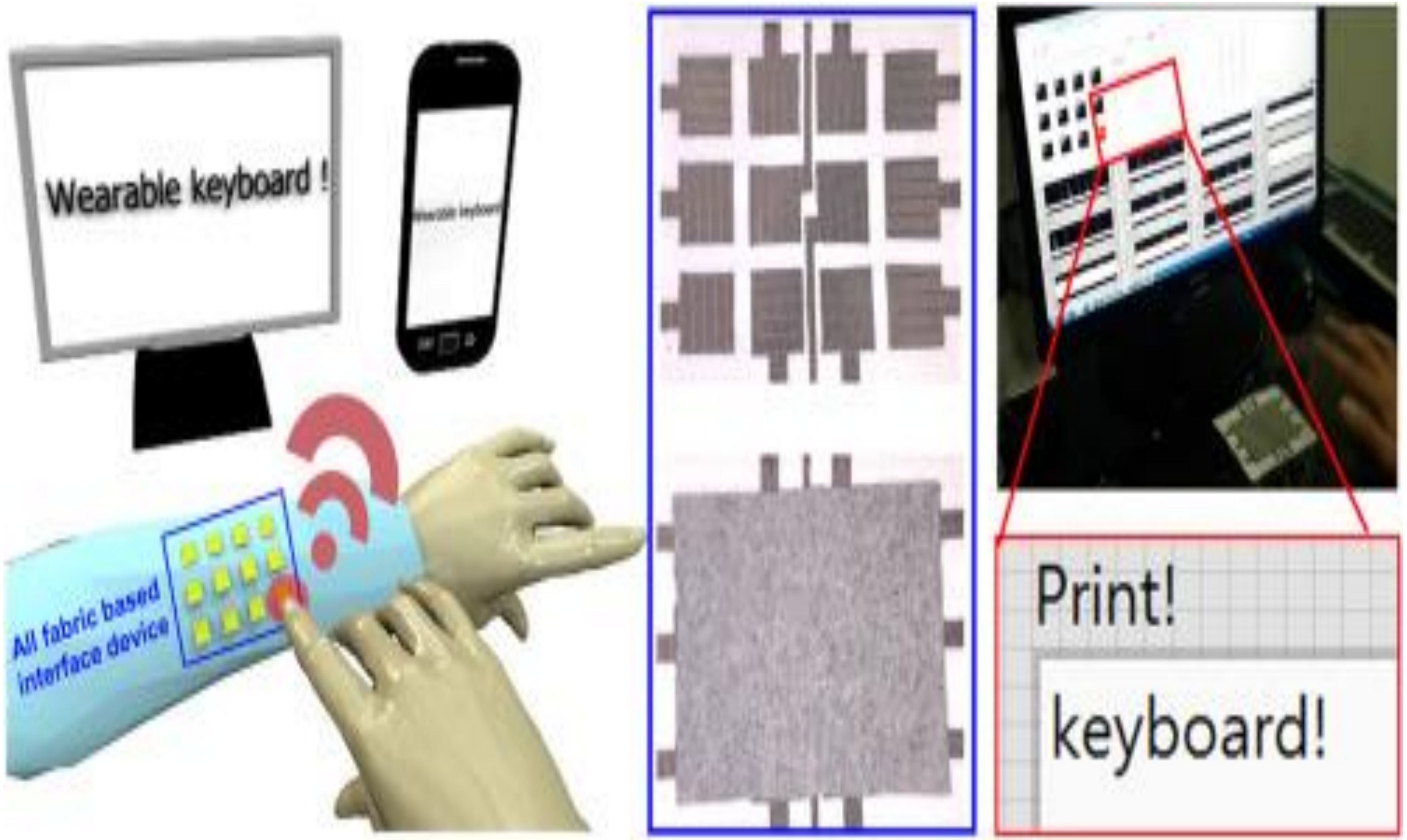
TEXTILE-BASED COMMUNICATION DEVICES

- Input and output interfaces for communication play a very important role in wearable systems. Input–output textile-based communication devices have been proposed as follows:

- Textile key boards
- Photonic Fibres and Optical Displays
- Textile antennas

TEXTILE KEYBOARDS

- Since the early proposal of resistive textiles touch keyboards (Orth et al. 1998) much work has been done in this area and products are available in the market (VDC 2007).
- Textile keyboards have initially attracted considerable commercial interest because their flexibility and compliance make easy the incorporation into garments and apparels.
- It is not clear, however, what their impact could be in wearable systems since other input modalities might be preferable


Wearable keyboard !
All fabric based
interface device
Print!
keyboard!

PHOTONIC FIBRES AND OPTICAL DISPLAYS

- Communication apparel intended for social interaction needs interfaces for optical information restitution.
- In many applications, it is necessary to reproduce and display visual information generated by subsystems integrated into clothing.
- Textile grade photonic fibres exploiting lasing, interference, lateral dispersion and other optical phenomena have been considered as much as the possibility to weave them in the form of textile displays
- Textile-based optical displays are nowadays available only in the form of woven plastic optical fibreswere pixels are addressed in a matrix and optoelectronic sources can be bulky and expensive.

- Electroluminescent fibres, adapting the technology developed to realize flexible organic-light-emitting devices (OLEDs), have been realized (O’Connor et al. 2007) eventually enabling the fabrication of light-emitting fabrics.
- The integration of LEDs mounted on lightweight flexible substrates into clothing has been successfully performed and wearable displays are nowadays commercially available (www.lumalive.com)

TEXTILE ANTENNAS

- Textile antennas are **a special class of antennas that are partially or entirely made out of textile materials**, in contrast to conventional antennas, which consist of rigid materials
- Textile antennas are a special class of antennas that are partially or entirely made out of textile materials, in contrast to conventional antennas, which consist of rigid materials.
- The textiles composing a textile antenna are divided into electrically conductive fabrics, denoted electrotextiles and applied for the radiating and grounding parts, and dielectric materials for the insulating parts of the antenna

TEXTILE ANTENNAS

- As can be intuitively understood, the reason behind the use of textile materials in antennas lies in the application for which they are intended, being *smart textile systems* and *body-centric communication*.
- Smart textile systems represent a new concept of garments that, in addition to traditional functions such as protecting the body against the environment, also offer additional functionality such as *sensing*, *actuating*, and *communication*, realized by wearable devices that are integrated into the “smart” garment.

TEXTILE ANTENNAS

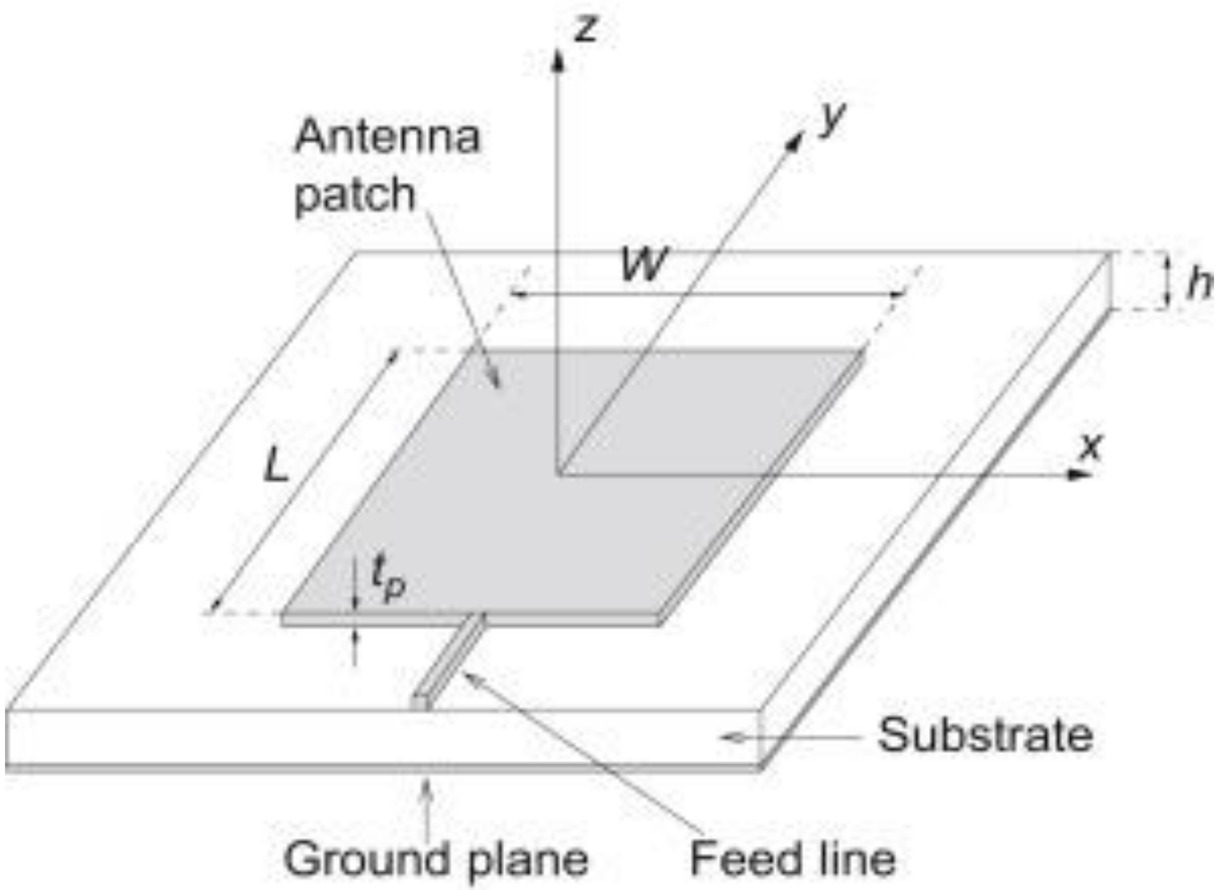
- *Sensing functions* are realized by sensors integrated into the textile garment's material and are intended to detect the state of the wearer (ie, body temperature, heart rate, position) and/or the state of the surrounding environment (ie, external temperature and humidity).
- *Actuating functions* are enabled by garment-integrated actuators that provide signals and/or alarms in order to inform, command, or warn the wearer about certain events regarding his/her state or the state of the surrounding environment.

- Finally, *communication* is realized in a wireless way by means of an integrated *wearable textile antenna* in combination with a wearable transceiver. Such a kind of wireless communication takes place between the human body and the surrounding environment and is also referred to as *body-centric communication.*
- In parallel with textile antennas, this has become a very popular field of research over the last decade [1], with crucial importance for plenty of applications, ranging from monitoring of vital signs of patients to coordination and monitoring of rescue workers [2], but also in the entertainment sector [3] and in sports [4].

MICROSTRIP ANTENNA

- *Microstrip antennas*, often referred to as *patch antennas*, are very well known and have received remarkable attention during the last four decades, even though the first idea dates back to the 1950s [5]. The success of microstrip and patch antennas is mainly due to their low profile and conformability to curved surfaces, which made them initially very suitable for integration on surfaces of aircraft, missiles, satellites, ships, and so on. A patch antenna consists of a very thin conductive microstrip, with thickness $t_p \ll \lambda_0$, placed at a certain distance h above ground plane (typically $0.003\lambda_0 < h < 0.05\lambda_0$), as shown in the scheme of Fig. 26.1. The space between patch and ground plane is occupied by a layer of dielectric material, indicated as *antenna substrate*, with a certain permittivity ε_r, loss tangent $\tan\delta$, and thickness h. A large variety of different patch topologies have been already proposed and applied by designers throughout the world.

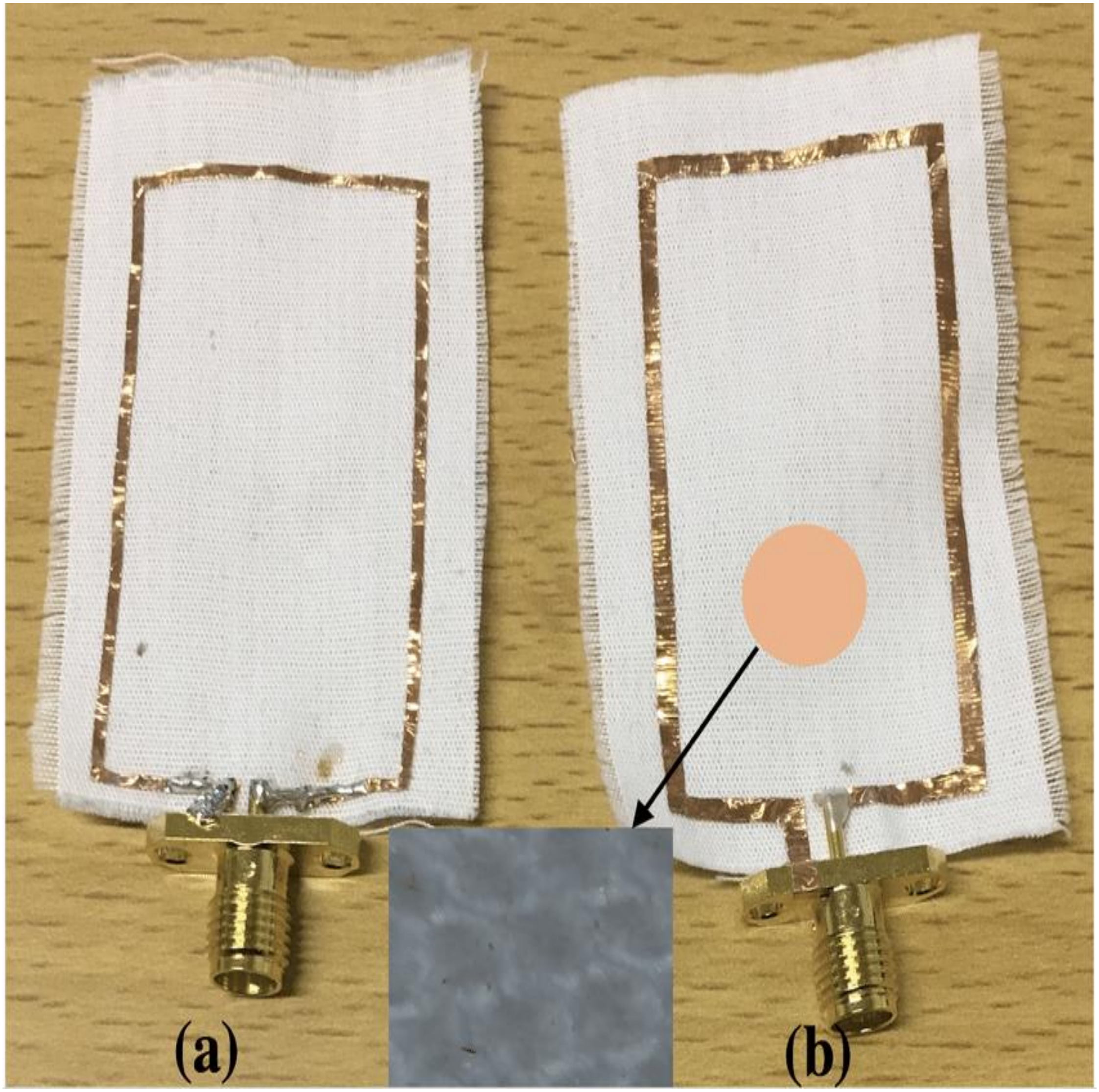
Figure 26.1. Scheme of a patch antenna structur

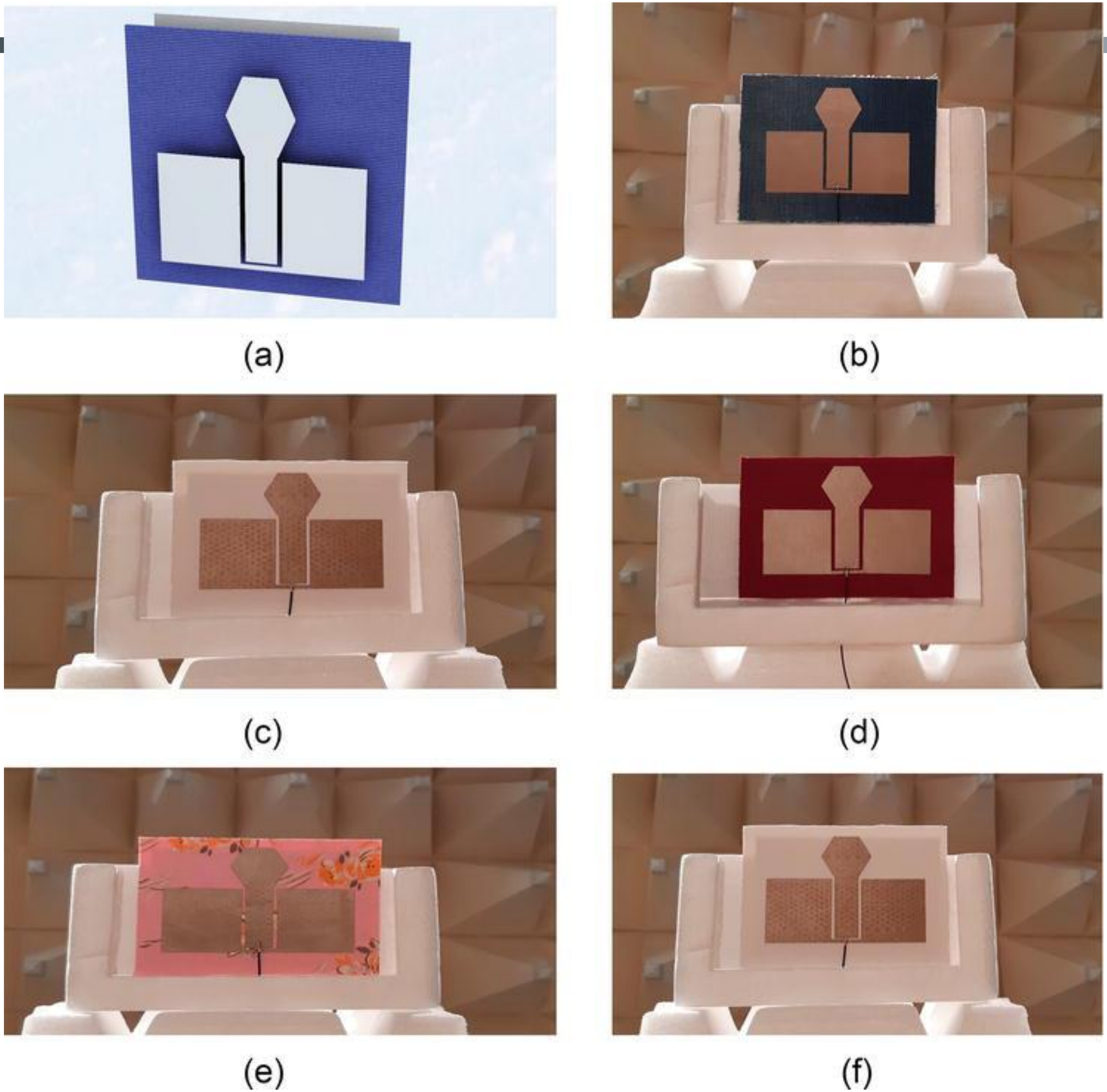


- The microstrip patch represented the natural choice when the first wearable antenna (although not made of textile material yet) was envisaged in 1999 by Salonen et al. [6]: a planar inverted-F antenna for GSM application, with a copper patch printed on a circuit board, suitable for garment integration. Next, the first wearable antenna made out of textile materials was conceived in the Philips laboratories by Massey et al. [7]. Starting from these first prototypes, during the last 15 years, literally dozens of textile wearable antennas were proposed and studied by researchers throughout the world, such as [8–11].

W1	W2	W3	L1	L2	L3
53 mm	2 mm	90 mm	47 mm	10 mm	90 mm

(a) (b)




(a) (b)
(c) (d)
(e) (f)

- Textile antennae can be incorporated into clothing systems for long-distance communication (Salonen and Rahmat-Samii, 2006).
- They can be directly printed onto a textile substrate or a micro-patch antenna attached to a vest. Depending on the environment, such antennae can operate in the range of 10–100 m. Longer-distance communication can be achieved by improved technology and the use of laptop computers or mobile phones.
- Very short distance connections can be made by wireless links using induction.
- Data can also be transferred by Bluetooth modules if the soldiers are located close to a central control facility.

SMART FABRICS AND INTERACTIVE TEXTILES PLATFORMS

- Several attempts to design and build prototypes of wearable integrated platforms based on e-textiles have been undertaken in the last 10 years.
- Textronics has exploited this technology commercially (www.textronicsinc.com).
- Market studiesproject fast growth for this segment; however, its present size is marginal.
- As already mentioned in the introduction, all these systems are hybrid, exploiting various degrees of integration between silicon microelectronic components and clothes, and present technology should be considered transitional.
- The first products, both out of market, have been the Philips/Levi ICD+ which incorporated a mobile phone and a music player (Farringdon et al. 1999) and the LifeShirt of Vivometrics (Grossman 2003), a wearable system for medical diagnostics and monitoring.

WEARABLE MOTHERBOARD

- At the end of 1990s, Georgia Tech has proposed the wearable Motherboard (Gopalsamy et al. 1999) for monitoring "the golden hour" in military operations. It consisted of a shirt into which metal fibres and optical fibres were incorporated to be reversibly connected to off-the-shelf optoelectronic devices for monitoring wearer's vital signs and bullet penetration

OTHER DEVELOPMENTS

- A T-shirt consisted of a breathing-rate sensor, a shock/fall detector, a temperature sensor and electrodes for ECG recording was also developed in the course of the VTAM project (Weber et al. 2004).
- A sensorized baby pyjama, called Mamagoose, was developed by Verhaert in Belgium as a prevention tool for sudden infant death syndrome (www.verhaert.com).
- Heart rate captured by woven electrodes and respiratory activity recorded through capacitive sensors were processed and used to provide an alarm at risky situation

- A sensorized shirt was developed by Smartex within the EC funded project Wealthy (Paradiso et al. 2005) aimed at providing solutions to monitoring cardiopulmonary conditions. The Wealthy platform has shown a very high level of integration between textile technology and a wearable electronic unit endowed with a wearable on-board processing and Bluetooth and GPS wireless transmission (see Fig. 7.6)

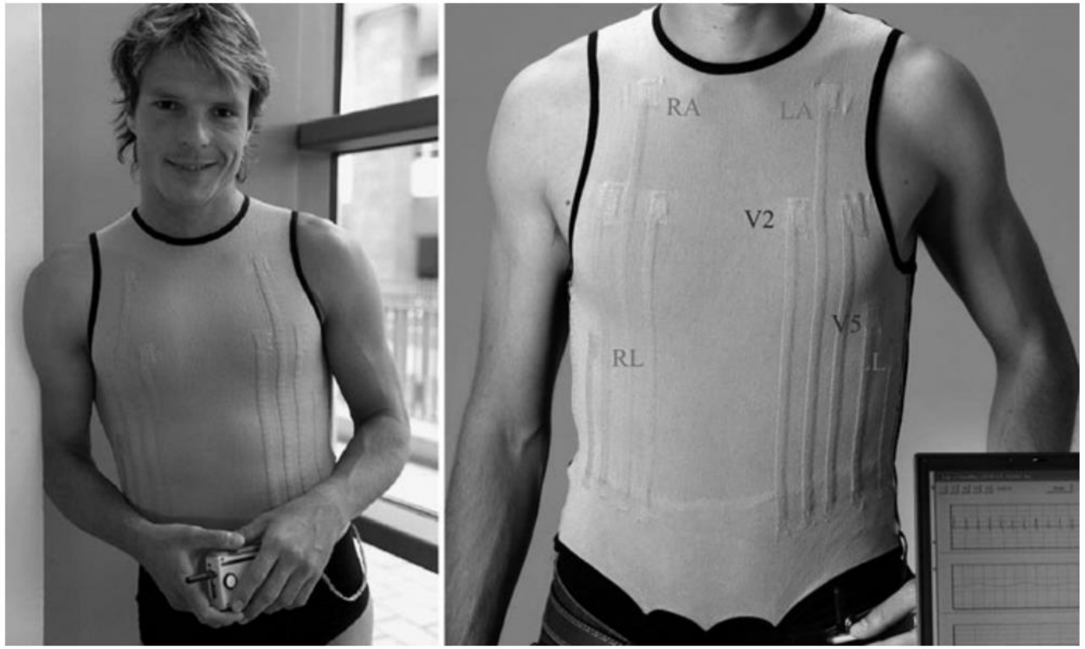


Fig. 7.6 Wealthy system

- Several concepts of SFIT platforms have been designed and prototypes realized in the EC funded project MyHeart (see Fig. 7.7) in which primary and secondary prevention, acute intervention, chronic monitoring and rehabilitation in cardiovascular disease management have been addressed through e-textile-based and microelectronic solutions (FP6–2002-IST-507816).

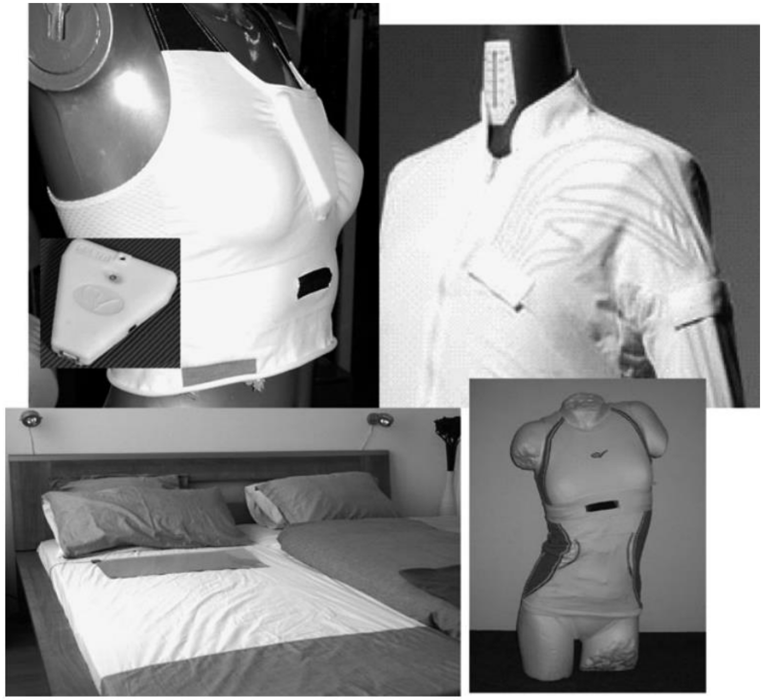


Fig. 7.7 MyHeart's prototypes

- Nowadays several research projects are under way to examine the appropriateness of e-textile solutions in different areas, such as neuro and cerebrovascular rehabilitation, safety and security. A very sophisticated platform, under development in the frame of the EC funded project Proetex (FP6–2004-IST-4–026987) is shown in Fig. 7.8, it addresses the issue of endowing with smart functions both inner and outer garments for firefighters and specialized personnel for disaster management.