1 The project +me

The +me is an experimental device, developed at Institute of Cognitive Sciences and Technologies, National Research Council (ISTC-CNR). The device originates within the project “+me: motivating children with autism to communicate and socially interact through interactive soft wearable devices”, in collaboration with the rehabilitation centre INI, Villa Dante division. The +me aims to be a playful, interactive tool, to be used during therapy, whose goal is to develop and strengthen the social and relational skills of autistic children. Outwardly the device looks like a soft pillow, animal shaped, that can be worn around the neck (fig. 1).

![Current +me prototype.](image)

Figure 1: Current +me prototype.

Thanks to an inner electronics, the +me can emit sensorial responses as sounds and lights, according to the site of touch (the responsive sites are the four paws, see fig. 2). The sensorial outcome can be modified by an adult/therapist, through a tablet bluetooth connected to +me. Further informations can be found on site [www.plusme.it](http://www.plusme.it).

2 Technical description

The following four sections illustrate in greater detail both the technical and qualitative features of the device.

1) Control: the +me is partially mastered by the child/patient wearing it, and partially by the adult/therapist accompanying the baby during the rehabilitation therapy. The child, caressing
Figure 2: Some illustrative colors combinations, emitted according to the site of contact. Colors and sounds can be modified by an external operator, through a bluetooth connected tablet.

The paws, can activate the touch sensors (4 sensors, one for paw), that are hidden under the fabric. In response the control software can light up the corresponding site with a given colour, or trigger the reproduction of a sound, or a combination of both. At any moment the therapist can intervene and modify the behaviour of the +me through a tablet application that is connected via bluetooth to the device. Thanks to this application, the color of lights, their temporal duration, the type of emitted sound, the causal-effect relationships, can be all modified according to the therapeutic needs. The schema in fig. 3 illustrates the dynamic of potential interaction involving child, therapist and +me.

Figure 3: The schema illustrates the potential interaction involving child, therapist and +me, through the tablet control application. The components “wristband” and “bio-sensors” belong to a future development of the project, and are not present in the current prototype.

2) Fabric and padding: The external fabric used in +me is white cotton. The inner padding is commercial synthetic fiber (polyester). Four pockets of tulle fabric contain the padding, so that it does not scatter within the device. The purpose of padding is double: it is used for design reasons and, in the same time, it naturally protects the inner electronics.
3) Inner electronics: Inside the +me, between the padding pockets, there is the electronic apparatus, responsible for the interactivity of the device (fig. 4). This is composed by several components, here described:

control board: it contains the electronics which manages the +me inputs and outputs. It is composed by a PCB (Printed Circuit Board), hosting two microprocessors (Arduino Nano), a sound board (mod. VS1053 by Adafruit), a bluetooth module (HC-05), a driver LED (TLC5940), a 3.7W audio amplifier (mod. MAX98306 by Adafruit), a capacitative touch sensors board (mod. MPR121, by Adafruit). The PCB is protected by a plexiglass box, positioned inside the padding, in correspondence of animal head.

audio speakers: two mini audio speakers, 3W 4 ohm, for sounds reproduction, are positioned beside the protective box.

LED strips: 4 segments of 12V RGB LED, 25 cm long, are positioned on the animal paws. The segments are fastened to inner padding pockets (fig. 5, right).

touch sensors: 4 patches (about 7x9 cm), of conductive fabric (mod. Knitted Superlight Conductive Fabric by Plug&Wear), are positioned on the animal paws. The patches are stitched to the inner padding pockets (fig. 5, left).

battery: a commercial rechargeable 12V, 500mAh, LiPo battery is positioned inside the protective box. An external cable (that can be pulled out by the therapist), allows the battery refill.

4) Safety: The current system underwent several tests during the last year. During this period the system did not reveal any critic issue. The +me underwent to an extended test with audience at MakerFaire 2015, European Edition, during which a previous prototype was presented. During the three days of the exhibition, the +me was handled by tens of persons, and remained turned on for eight hours per day. In the current prototype the electronics is fastened within the padding.
pockets, and is protected by the softness of the device itself. The most fragile components (the control board and the battery), are further protected by the plexiglass box (fig. 7 and 8).

In order to further increase the safety of the device, the following precautions have been guaranteed:

1. The control board is protected by a plexiglass box, which is locked by screws. It is not easily accessible, as it is inside the pillow.

2. The 12V, 500mAh LiPo battery is protected by the plexiglass case, and is placed below the control board. The refill is done through an external cable, preventing the need to extract the battery.

3. A 2 ampere fuse was used to immediately interrupt the power source, in case of any unexpected electrical accidents.

4. The electrical wires connecting the LED strips to the control board are enclosed within a braided sleeving.

5. The board is protected by erroneous polarity inversion in two ways: electrically by a diode, and mechanically by a connector JST (which prevents the erroneous insertion of the battery cable).

The following rules of conduct are mandatory for a safe use of +me:

1. Currently the +me must be always used in presence of a therapist.
2. During the battery refill the +me must not be used or worn, and must be switched off.

**Figure 7:** The protective box in plexiglass, without PCB (lateral and upper parts removed).

**Figure 8:** Left: the control board, protected by the plexiglass case, outside the +me. Right: the case inside the +me.

5) **Development team:** Beste Özcan (main concept and +me design); Valerio Sperati (hardware and software prototyping); Tania Moretta, Alessandro Medda, Simone Scaffaro (experiment design); Gianluca Baldassarre (head laboratory). The authors wish to thank Massimo Cicorella for his help in developing the hardware. Further informations about the team can be found in the web page [http://www.plusme.it/our-team/](http://www.plusme.it/our-team/).