

# CarolApp

## *A Mobile e-Health Software Project for Remote Monitoring of Children enrolled in the Carolina Curriculum*

Salvatore Cuomo<sup>1</sup>, Pasquale De Michele<sup>1</sup>, Francesco Piccialli<sup>1</sup>, Antonella Olivo<sup>2</sup>  
and Ennio Del Giudice<sup>2</sup>

<sup>1</sup>University of Naples "Federico II", Department of Mathematics and Applications "Renato Caccioppoli", Naples, Italy

<sup>2</sup>Fondazione Istituto Antoniano, Ercolano, Naples, Italy

<sup>3</sup>University of Naples "Federico II", Faculty of Medicine, Via Pansini, Naples, Italy

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**Abstract:** The *Carolina Curriculum for Infants and Toddlers with Special Needs* (CCITSN) is a well established assessment curriculum-based for early intervention programs, where sequenced items data collection and analysis allow for monitoring, incremental program change, and recognition of areas of relative strength and weakness in children with mild, moderate, or severe disabilities. Unfortunately, this protocol, and the support developed software *C@rolin@*, is concerned only with the medical aspects, which are basically recorded with a huge gap of time intervals. Moreover, due to lack of funding in local health care facilities, the medical staff is not able to care adequately the involved children that, as provided by this program, must perform most of the assessment activities in their own homes, supported by parents that often are left alone during the period between two medical visit. In order to reduce the gap between families and medical staff, this paper describes the design and development of *CarolApp*, a mobile framework that allows, from one side, parents of enrolled children in the Carolina Curriculum to capture situations by using collected photos and videos relating to the behaviors of their children during the assessment period at home and to send these to the *ad-hoc* social network by means of their mobile devices, and from the others side, medical staff to care adequately the patients in a "remote-way", analyzing and providing certified feedback, answers and if needed request an additional visit, by following the progress of these children thanks to the received multimedia objects.

## 1 INTRODUCTION

The study of medical protocols for monitoring and analyzing the cognitive development of children with disabilities is a very spread out research area (Chapman and Hesketh, 2000). In this context, the *Carolina Curriculum for Infants and Toddlers with Special Needs* (CCITSN) (M. Nancy, 2014) is a well established curriculum-based assessment for young children with disabilities. Recently in Italy the Carolina Curriculum has been adopted as a basic service within several local Regional Service Systems (ASL) (see (Del Giudice et al., 2006)). A full web application software system, named *Carolina*, based on the Carolina Curriculum protocol is available in (Cuomo et al., 2011). This software allows, from one side, to efficiently collect, represent, and evaluate the relative data along the curriculum and, from the other side, to support educators, doctors, parents, volunteers, thera-

pists, and the children themselves in the assessment-intervention process of the children involved. Unfortunately, the Carolina protocol, and so the software developed in (Cuomo et al., 2011), takes care only of the medical aspects, which are basically recorded with a huge gap of time intervals.

Moreover, families and children cannot communicate, ask questions and post experiences on the software. Indeed, the missing of interaction makes the use of the Carolina program less useful in practice. The major difficulty that prevents a wide dissemination of this medical protocol is the long time interval between a medical visit and the next one. During this period, of about four/six months, the enrolled child receives a list of items (activities) that he has to improve through specific practices; but although he's constantly monitored by his parents, in the majority of cases situations that would require the medical intervention occurs.

To address this problem, we consider the applications,

services and tools that are web-based for health care consumers, caregivers, patients, health professionals and biomedical researchers.

The Social networking service embedded in the Carolina software is a preliminary solution (Cuomo et al., 2012); it involves the explicit modelling of connections between people, forming a network of relations, which in turn enables and facilitates collaboration and collaborative filtering processes. In the proposed framework, this service enables the families enrolled in the Curriculum to ask assistance to medical operator by means of messages, web conference, etc.; moreover, it enables to see what their peers or others with a predefined relationship (“families friend”, “doctor”, “assistant operator”, etc.) are doing in the same assessment; finally, it enables to have supplementary medical advices on demand by means of their smartphone. An increasing number of healthcare professionals put into use smartphones’ applications that enable remote monitoring or healthcare management (Zorba et al., 2012). Moreover, lots of patients already take advantage of m-health applications to improve and assist their own life and health. According to this perspectives, this paper describes the design and development of *CarolApp*, a mobile framework that allows, from one side, parents of enrolled children in the Carolina Curriculum to capture situations by using collected photos and videos relating to the behaviors of their children during the assessment period at home and to send these to the *ad-hoc* social network by means of their mobile devices, and from the others side, medical staff to care adequately the patients in a “remote-way”, analyzing and providing certified feedback, answers and if needed request an additional visit, by following the progress of these children thanks to the received multimedia objects. The outline of the paper is: Section 2 draws some motivation and related work; in Section 3 we describe the system framework; Section 4 explains a first experiment. Finally, in the Section 5 we give the conclusions.

## 2 MOTIVATION AND RELATED WORK

Familiarizing people with smart devices and the constantly growing use of medical related mobile applications enables complete and systematic monitoring of a series of chronic diseases both by health professionals and by patients. A large number of mobile applications have already been developed to support medical staff and to record and manage information

related to chronic diseases. Handheld devices have been exploited in many cases to facilitate health oriented procedures. M-health can be defined as “mobile computing, medical sensor, and communications technologies for health-care”. This emerging concept represents the evolution of e-health systems from traditional desktop “telemedicine” platforms to wireless and mobile configurations (Altini et al., 2010). Developments in wireless communications integrated with developments in pervasive and wearable technologies will have a radical impact on future health-care delivery systems (Istepanian et al., 2004). Mobile applications solutions are becoming increasingly popular because they can be used by a great number of people and target different health issues or groups of patients (Karan et al., 2012).

Many consumers nowadays take advantage of m-Health applications to improve their lives and assist their health (Fox, 2010). Benefits of m-Health Applications and Solutions are widely known and accepted. Many existing applications meet the needs of individual specialties in medicine (Chemlal et al., 2011) and work in similar ways, whether they are stand-alone applications or they work online. These applications usually have common characteristics; they record critical medical data and communicate with other applications in an effort to solve a health issue (Klug et al., 2010). Data related to health records are often sent to servers storing personal health record services or directly to physicians (Boulos et al., 2011).

To better understand the motivations behind our work, it is important to analyze the gap between the children enrolled in the Carolina Curriculum and the medical staff that should care them, throughout the period of assessment at home. Provide the possibility for parents of these children, to be assisted through a few simple clicks on their mobile devices, during this period, is a fundamental task. In fact, the guidelines of this curricular protocol strongly recommend that the child has to be constantly monitored during the course of his daily activities at home, suggesting where necessary correctives.

## 3 FRAMEWORK OVERVIEW

CarolApp is conceived to be a stand-alone application, evaluated for iOS and Android platforms. Main criteria used to develop CarolApp are: (i) operating stand-alone on a mobile platform; (ii) increasing the interactions between patients and medical operators covering a wide range of specific topics. In the following, we highlight some important requirements, in this case, were respected in the application develop-

ment, namely:

- **Medical Usability.** The application should have been easy to use for physicians. It should have required minimal training and minimal maintenance. It should have minimized power consumption to avoid the inconvenience of recharging. It should be portable so that all actors unrolled in the assessment program can use the application anywhere they go and on several devices.
- **Manageability.** The application should be easy to install, deploy, and maintain. It should have provided tools to assist solution to the clinical problem treated.
- **Reliability.** The application should have worked specific security policies for preserving sensitive informations stored in the web Carolina web application.

The proposed framework design and implements an architecture for enabling a remote support strongly connected with the social networking healthcare platform, by means of a mobile application that offering the opportunity for parents to request medical support and feedbacks, during the assessment program of their children at home. The overall information obtained by the Carolina Curriculum therapy are elaborated by different software modules and the planning program in reported in Develop Progress Diagram charts (see (Cuomo et al., 2011; ?)). We expand the assistance due to the actors of this protocol with a social network.

Taking some of the terminology from Carolina Curriculum and mapping them to social networking, we define the following terms:

**Carolina Assessment Group:** A group within a buddy-list comprising of health-care professionals and the patients.

**Carolina Medical Group:** A group within a buddy-list comprising of health-care professionals only.

**Families Context:** A group of families enrolled in the Curriculum.

**Supplementary service:** Experts that sit in the care groups offering predefined services to the users of the group.

**Social Networking Services:** Instant Messaging (IM), Web Conferences, Posted Messages, Wiki, etc.

The following is an experimented scenario that shows the integration of social networking terms into the work of the Carolina community. In the Figure 1 we report the use case diagram of the overall Carolina framework. The Carolina web based features, named *Carolina Assessment*, are integrated and extended with the Social interactions in the green rectangle of

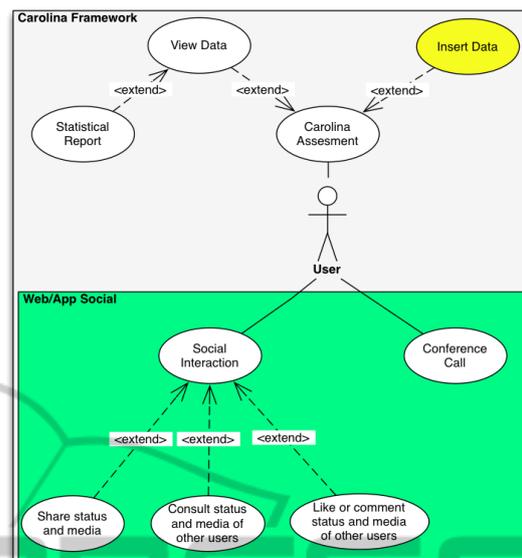


Figure 1: Use case Diagram.

the figure. All users can access to *Carolina Assessment*, *Social Interaction* and *Conference call* system modules. The *Social Interaction* is extended many functionality options, as the possibility to share or view video, photo, posts and media. In the proposed software only power users, such as doctors or authorized operators, are able to manage reserved data of the Carolina medical protocol, reported in the yellow chart of the use case diagram.

In this framework we have implemented new modules and services of the social networking without changing the modular software infrastructure of the Carolina Software (see (Cuomo et al., 2011)). In the Figure 2 we report the graphical interface of the web based social interaction module. Finally, in the next section we reports preliminaries results.

## 4 A PRELIMINARY EXPERIMENT

We test the alpha-version of the CarolApp with 5 medical operators that were involved in the care of 10 families (with children enrolled in the assessment program). The families are split logically into care groups associated with the age of patients. The patients within a fixed age group have to develop the right skills in accordance to the age. Here for brevity we report an interaction that has taken place in the Carolina Assessments program through CarolApp. A patient performs (see Figure 3) some of the tasks assigned to him for the achievement of a certain skill. The family have posted the event and had a feedback

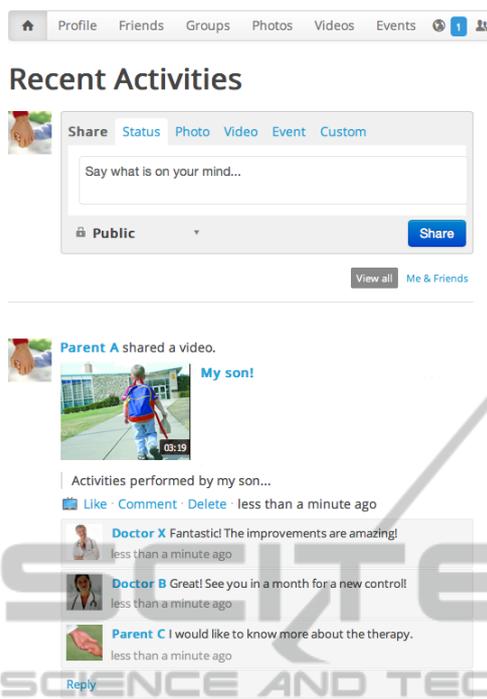


Figure 2: Web Based Social interaction module.

from the Doctors. Consequently, the family decides to post a request for assistance in Carolina Call Conference to the Carolina Medical Group. A parent of the children decides to activate and schedule on-line assistance service through the web conference tool provided by CarolApp (see Figure 4).

In the meanwhile, the community starts to answer and post advices on the Group of Families Context, so exploit the services offered by social networking. According to the model showed, four ideas emerge from the Social Network service applied to Carolina, succinctly described in the following. The *Participation* of families, patients and medical operators that became active actors of the medical assessment program. The *Openness* of the system that permits to individuals and healthcare organizations to operate by a communal management decision-making process. The *Collaboration* between all enrolled people of the curriculum that work all together to improving the patients development skills. Finally, the *Communication* that enables the efficient exchange of experiences and sharing emotional states. Our model is a multidimensional scheme in which we have different levels of interactions. Horizontal interactions between families and patients enrolled in the assessment. Vertical communications between families and medical operators that work with Carolina. Each user of every group has received a different level of training assessment. Families and patients can be seen as experts and their

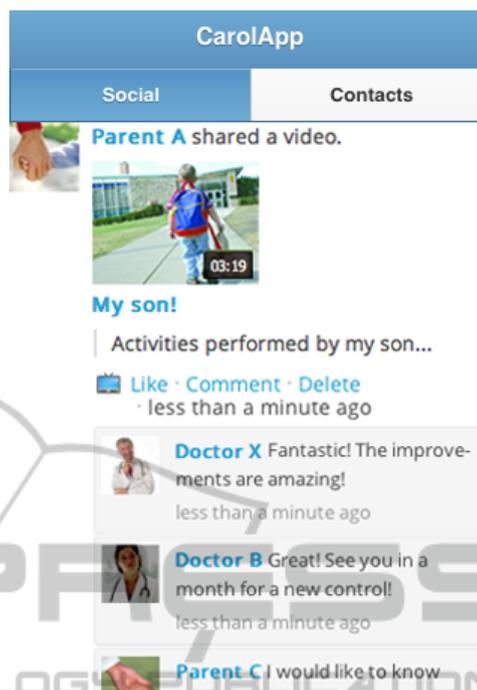


Figure 3: Carol App interaction: Share informations.

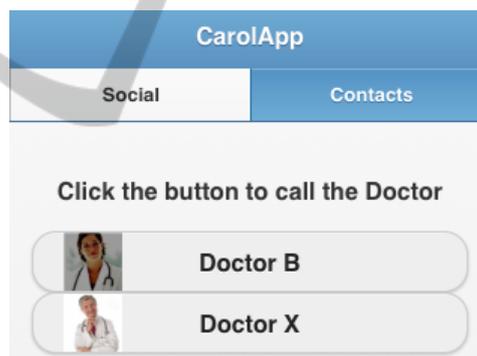


Figure 4: CarolApp Call Conference tab.

collective wisdom can and should be used. It is well known that the health operator is an expert in identifying disease, while the patients and families are experts in experiencing it. The Carolina framework has a client tier, an application tier, and a data tier, working as follows: every single Regional Local Health Department is connected to a Data Center in order to store and manage the data of the medical protocol. The Carolina portal and the Social Network represent the two souls of the framework architecture, working together in a virtuous way.

In the social networking service, a user-friendly graphic interface (see Figure 3), allows the operators and families to easily share data among them, have detailed information about scores and items of the curriculum, monitor skills development along the

time by means of system communication. Doctors, patients and their families can share medical data as well as personal experience and troubles, which turns to be helpful both in the medical and emotional sides. All these features guarantee that every child will have a full assistance, corresponding to his specific needs.

## 5 CONCLUSIONS

In this paper we present CarolApp, an ongoing e-health project for the CCITSN medical protocol, which extends the Carolina software with the embedded Social networking service, implemented in (Cuomo et al., 2011; Cuomo et al., 2012), by means of the design and develop of a mobile application that is able to collect texts, photos, and videos of real-time situations of the child and to forward them to the *ad-hoc* social network. The project is certainly ambitious, it aims to improve the health benefits of the Carolina curriculum thanks to an ad-hoc infrastructure that relies on the ICT technologies; the main goal of the described framework is to reduce the government spending decreasing gradually the unnecessary clinic visits. Preliminary experimental results showed the usability of our approach and encourages further research. Future work will be devoted to finish the deploy of the entire system in the next months and collect more complete and interesting experimental results about the real advantages of the proposed framework also considering the related costs and benefits, for example in terms of maintenance needs.

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