In this forum we celebrate research that helps to successfully bring the benefits of computing technologies to children, older adults, people with disabilities, and other populations that are often ignored in the design of mass-marketed products.
— Juan Pablo Hourcade, Editor

A University–NGO Partnership to Sustain Assistive Technology Projects

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Non-governmental organizations (NGOs) are often plagued by a dearth of human and financial resources. IT Without Borders (ISF, from the Italian *Informatici Senza Frontiere*) is an Italian NGO that considers IT to be an asset of primary necessity and an essential prerequisite for economic and social development. Founded in 2005 by a small group of Italian IT professionals, ISF today includes 10 active regional sections and more than 300 members. ISF organizes its volunteers to work on computing projects, focusing its action on the contexts of marginalization, difficulties, and emergencies, both in Italy and in low-income countries. Since it is primarily volunteer-run, ISF has very limited human and financial resources.

In this article, we share the story of successful collaboration between the Collaborative Development Group (Collab) at the University of Bari and ISF, and how the academic institution is helping the NGO achieve sustainability in three major assistive software projects. We describe our experience in building this relationship, along with the projects and the process through which they were developed and sustained thanks to the help of student volunteers. We also report on the challenges encountered along the way, while reflecting on the reasons for success.

HOW WE MET

The longest-running project at ISF is Open Hospital, an open source software for hospital management developed by ISF to help hospitals in their daily activities. Open Hospital is currently used in several hospitals in Kenya, Tanzania, Uganda, Ethiopia, Benin, and Afghanistan. In 2008, Open Hospital was the only active software project at the NGO. A group of volunteers was constantly working on it, adding new features and making it more useful. In the same year, a group belonging to the local ISF chapter sent a call for participation to the Department of Computer Science at the University of Bari to establish a collaboration to help the newborn local group grow. We thus decided to start the collaboration through a M.Sc. thesis project with the goal of refactoring Open Hospital on top of a new framework. Since then, there have been eight final-year theses that extended Open Hospital and developed telemedicine technologies for rural hospitals. More recently, we have started to focus on assistive technologies [2].

Today, most of the same software systems on which nondisabled users rely heavily for common tasks, such as communicating or reading news, are a severe handicap to people with disabilities, especially on smartphones and tablets.

Starting less than two years ago, we have developed three major assistive technology projects, one designed to ease on-demand access to newsfeeds for the visually impaired, and two for alleviating, respectively, the communication and motor impairments of people unable to use a keyboard and control a wheelchair. All these projects were sustained by recruiting both undergraduate and graduate student volunteers working on their final-year theses as developers.

Paperboy (a.k.a. *Strillone* in Italian) allows visually impaired people to listen to newspaper feeds on demand by leveraging vocal synthesis. Paperboy was developed based on a request from the Italian Blind Union association. We initially developed it as an application for PCs with screen readers and then developed the mobile version for Android, iOS, and Windows Phone.

The Paperboy app UI was designed after observing how visually impaired people use their smartphones: We noticed that they build their spatial perception of the screen by keeping their fingers on the borders. From there, they remember the relative positions of the screen elements with respect to the four corners (Figure 1). The awareness of how strongly they sensed the position of screen corners inspired us to design the

Insights

- → Helping NGOs through final-year students' theses work is a win-win strategy.
- → Students' high turnover rate calls for measures to reduce the increased coordination effort facing NGO senior members.
- → The academia-NGO collaboration model promises to be successful in areas other than just assistive technologies.

app UI by dividing the screen into four equal parts, splitting the whole area in half both horizontally and vertically. Doing so, we obtained four large areas in direct correspondence of the corners. As for the content, newspaper feeds are retrieved from an XML document because its hierarchical structure can be easily navigated by interacting with the four action areas on the screen.

After developing the first release of the app for all the three major smartphone platforms, a validation test was arranged to assess our UI design approach. When conducting accessibility research, it is fundamental to involve users with disabilities in the design process [1], so we conducted a usability assessment informally with blind people and people with low vision. Visually impaired people tend to keep their smartphone either resting on the table or in one hand and close to an ear so they do not bother others with speech synthesis (Figure 2). In the latter case, they are often bothered if the power button is located on the side of the telephone body. Therefore, we found that the iPhone version for iOS was the one they appreciated the most, also because of the absence of the on-screen buttons (e.g., menu, search, home, and back) typically found in Windows and Android smartphones.

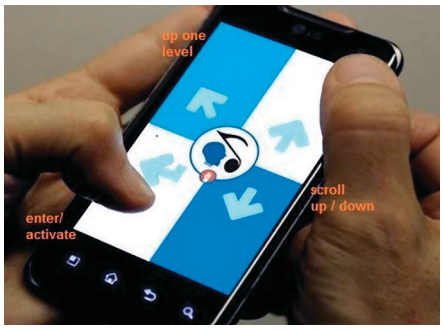

Figure 1. The Paperboy UI: the four main screen areas and the associated actions to easily navigate the news feed.

Overall, our split-screen approach and the idea of putting action areas in direct correspondence to the corner hot spots turned out to be successful, as it is much more forgiving than small icons that require the precise touch of a fingertip. Since its release on all three app stores, Paperboy has been very well received, with more than 4,000 downloads.

I Speak Again (ISA) is a

Figure 2. A volunteer from the Italian Blind Union of Bari during the usability validation test of Paperboy, organized at the Collab laboratory.

IMAGE BY GAJUS / SHUTTERSTOCK.COM

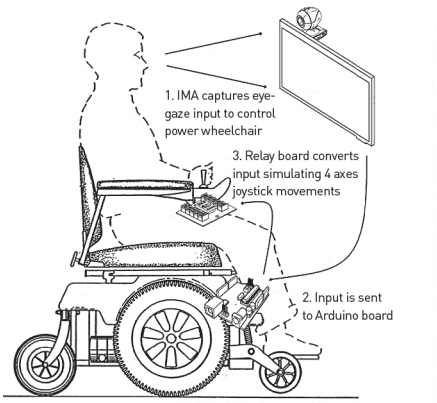

Figure 3. The conceptual design of the I Move Again prototype with main hardware components and their interactions.

communicator designed for people who have a communication impairment and great difficulty using a standard mouse and keyboard due to a dexterity impairment. One goal of ISA is also to bring an affordable technological solution to this population.

Back in 2011, ISF received a request from an Amyotrophic Lateral Sclerosis (ALS) association to help patients communicate with friends and relatives. People affected by ALS use costly eye-tracking devices that allow them to compose words on a screen and play them back through vocal synthesis. Communicators like these are prohibitively expensive; the Italian public health service cannot provide them to all patients in need.

ISA is a virtual on-screen keyboard controlled through eye movement, using any device equipped with a camera and a Web browser. Other than text-to-speech synthesis, a notable feature is the use of a text-predicting and -correcting algorithm to expedite sentence composition in both English and Italian. In addition, ISA allows selecting built-in images and common sentences that express basic needs like "I feel cold," "I want to eat," or "I'm tired." In order to keep overall costs as low as possible, we built ISA using open source components, with the exception of a commercial eye-tracking software module.

I Move Again. ALS patients also have motor disabilities. Therefore, after completing a prototype that helped them "speak again," the natural next step was helping them "move again." This is how the I Move Again (IMA) project started as a spinoff of ISA. In fact, we envisioned that the gaze input could also be used to control the movement of a power wheelchair.

On the software side, we decided to leverage the infrastructure already available in ISA. Therefore, with regard to presentation and eye tracking, the whole screen was split into five main areas, corresponding to the four directions (i.e., left, right, forward, and back) plus the stop command. As for the hardware, Figure 3 shows the main components of IMA. The eye-tracking movement captured by the ISA module is sent to an Arduino board mounted on the wheelchair, which controls the relay board that actually transforms the eye-gaze input into signals for the power wheelchair engine. In other words, when one's gaze is directed onto, say, the "back" area of the screen, the boards mounted on the wheelchair activate one relay simulating the input that the joystick would provide were it to be moved backward.

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CHALLENGES AND LESSONS LEARNED

Carrying out these projects with ISF has been particularly challenging. In fact, as with most NGOs, ISF has no (or a very limited) budget for running projects. Typically the only resources available to ISF are premium accounts donated by Google and GitHub, which are used for hosting Web content and code repositories, respectively, and volunteers' time and goodwill. Lack of funding is particularly problematic with the development of assistive technologies, which often involve acquiring dedicated hardware or software for building a working prototype. In addition, as ISF is distributed nationwide, these development challenges are exacerbated by the need to coordinate between geographically distributed contributors [3].

In our case, academia facilitated sustainable software development at the NGO by (a) calling for final-year students to develop extensions, refactor, and build new solutions as part of their final-year thesis work; (b) sharing knowledge and experience as well as providing feedback through agile planning and review meetings; (c) supporting remote interaction through adopting and developing collaboration tools [4].

Most of the lessons we learned during our partnership are related to finding ways to decrease the burden carried by ISF members in order to optimize their volunteer efforts. When we began our collaboration back in 2008, we also began to advertise collaboration opportunities with ISF on our Web pages, reporting calls for final-year theses. In the past six and a half years, there have been 92 final-year students at Collab, of whom 14 (15 percent) chose to help ISF on our joint projects. Yet, although involving students as volunteers helped us to effectively sustain these projects, we then started to face the resulting challenges of a high turnover rate, which meant an increased training effort imposed on senior project members, who must train new student volunteers every few months.

Therefore, to counteract the effects of high turnover, over the years we refined how we manage projects so that the ISF senior member acting as project manager never has to coordinate with more than two students at the same time on the same project. In addition, students' work might include some refactoring of existing code. We have learned that these refactoring efforts should be self-contained and defined in a way that they can be carried out by just one student rather than split among two or more. In addition, we have also observed that urgent "hot fixes" are best executed by senior members.

IMAGE BY ALPHASPIRIT / SHUTTERSTOCK.COM

Finally, and possibly most important, we have learned the hard way that when a new solution is to be designed, the technologies to be involved should be picked among those already mastered by ISF senior members. In fact, due to the limited amount of time that ISF volunteers can reserve to project development, they do not have the leisure to face steep learning curves for new technologies. And when a student's work is over, it is their responsibility to maintain the project and fix issues while no other volunteer is working on it.

CONCLUSION

Collaborations are successful only when they grant mutual benefits to all parties involved. In our case, on one hand, the NGO students are fundamental to help these projects stay alive and respond to requests from people with special needs. In fact, unlike the senior NGO volunteers who can help with development only in their spare time, final-year undergraduate and graduate students grant a full and continuous commitment to the project for at least three or six months, respectively. On the other hand, students are attracted to the project because they have a practical perception of creating something useful for someone in need. Rather than thinking they are working on a thesis project, students soon realize they are doing voluntary work, while also graduating in return. Some students also become members of the NGO after graduation, and although the extent of their commitment is destined to change after taking a job, they tend to stay around, providing maintenance for something that they perceive as theirs.

The story reported here has shown how an academic institution can help NGOs to sustain their projects, both product- and process-wise. While our case is focused on developing assistive technologies, we believe that this successful collaboration model can be exported to other fields too. As such, we hope that our experience inspires other academic institutions and NGOs to pursue similar efforts.

ENDNOTES

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