

Hello Robot!

A website to raise interest in a STEM future through Internet speech controlled robots.

Torben E. Svane
School of Information Technology
Halmstad University
Halmstad, Sweden
torben.svane@hh.se

Abstract — This Research to Practice Work in Progress paper reports on a project to interest children in STEM subjects (and later on, hopefully to encourage them to enroll in engineering and science programs). Initially (in 2014) the project used proprietary technology (Microsoft Xbox/Kinect). In 2015, Internet-based but region-limited technologies were tested (Google speech recognition API). In 2017 it changed to its current form, a website using the Annyang JavaScript speech recognition library. The site allows children (and others) to program robots through speech commands, or by clicking buttons. Once finished, the commands are sent by email to the university that has the robot. There, the robot actions are videotaped and uploaded to YouTube or its Chinese equivalent Youku. This will allow for a future scenario where a 7-year-old tells his/her friends “Yesterday, I programmed a robot in China. Let’s watch the video!”

Keywords — *speech recognition, Internet, children, STEM, robots, Annyang.*

I. INTRODUCTION

Many studies have reported on projects intended to raise children’s awareness of (and interest in) what is often labelled STEM subjects [1 - 3]. Others point to the anticipated need for engineering and science professionals in the future – and today’s lack of students enrolling in such programs at university level [4, 5]. The imbalance between the genders in STEM professions [6 - 8] is also an obstacle for such future recruitment.

Other works (without explicitly focusing STEM) have studied children’s interest in robots and programming. As examples, introduction of technology [9] and experimenting with interfaces [10] (both in Kindergartens) have been investigated. Another study of interfaces but with a wider age range of children [11] found tangible (hands-on) interfaces more useful than a graphic, isomorphic alternative. A review on use of robots in young children’s education [12] found that several skills (e.g. cognitive, conceptual, language and social/collaborative skills) improved but that parents’ perception of the actual value varied.

A desire to raise interest seems global. Suggestions for creating interest are many, ranging from free classes and summer camps to university open days, and more [13 - 16]. There are websites as well, but many offer games rather than real robots, toys/hardware to buy, or K-12 classroom activities. Few options seem to exist if the child wants to do something “real”, in that very moment – although there are exceptions [17].

Adhering to the argument “many approaches are better than few”, the aim of the project is to develop a website where children around the world can program robots (initially, at universities). This is the first published work from the project which has been ongoing for almost five years – and started even earlier.

In short, the Hello Robot project is a website where universities can add robots, and children can program them. Depending on type of robot, different commands are available. Once programming is complete, the commands are sent to the university and the generated code is loaded into the robot. The university then makes a video of the programmed actions and uploads it to YouTube or the Chinese equivalent Youku, as YouTube is not available in China. A link to the video is then posted on the website (www.hellorobot.net) so the child can see the result.

II. CONTROLLING ROBOTS: A BRIEF OVERVIEW

Traditional (industrial) robots are often “trained” in cooperation with a (human) positioner although it is often seen as a time-consuming process. In recent years, software programming which displays the programmed sequences directly on a computer has become more popular [18, 19]. In simpler (NC) machinery direct coding is also used, but the literature for this topic has not been reviewed, as a raw coding approach was not deemed interesting to the proposed target group.

Voice programming has been explored in many studies [20 - 22]. A report on “programming by voice” for a social robot [23] investigated how sequence function charts (SFC) could be implemented in that process. In later work [24], the logic of speech interpretation was in focus. Different from this project, the developed robot allowed free speech, requiring interpretation and applying logic to NLP (Natural Language Processing). Because of the risk of possible audio quality problems using the Internet, only a given set of commands is available for use at this project’s website at any time, with the offered set being determined by previous command(s).

The quality of input for recognition may be a limiting factor but the API used in this (Hello Robot) project seems very robust. Non-human originated speech (from a speech-generating device, to help disabled children) has also been used in programming [25] (but not currently with a web API). Child-robot interaction for rehabilitation purposes is also reported, in [26].

A different approach to programming is through body and hand movements [27]. In early phases of the Hello Robot project movement sensing was also implemented but later dismissed as an alternative, mainly because there was not any general (and affordable) hardware available on the market at that time.

III. DEVELOPMENT/TIMELINE OF THE PROJECT

The mission of the project has been to address “the STEM interest challenge” with a global audience in mind. In order to do so, a website seemed viable. The first attempts investigating speech commands and movement sensing used a Microsoft

Xbox and its Kinect unit (as in [27, 28]), and the development of an app, which then needed to be downloaded. Using the system at that time required however the user to own the devices, hence offering only limited utility with a global audience in mind. It did however bring about valuable insights into the next step (leaving the proprietary domain and creating a website, which didn't require anything but a web browser and a microphone – and not even the latter, in the latest versions).

The initial idea of “programming by moving” was deserted as it required user hardware. Voice commands seemed a better solution (supported server-side by a speech recognition library /API). Early (pre-2014) studies of such technologies included the MIT WAMI [29] service but the sensitivity in understanding commands was deemed too low for general audience use, at least to the intentions of this project. The feasibility of voice commands has however increased in recent years with Google's speech recognition API [30, 31] as an early forerunner. Using Google services directly was however not feasible with a global scope: tests of the software were not possible in e.g. China. To still make some testing available in China, clickable buttons with commands were added. The latest version of Hello Robot uses the Annyang [32] speech recognition API, as testing shows it works in China. Currently, three languages are offered, for programming and website: Chinese, Dutch and English.

From interviews, there seemed to be most interest in programming humanoid robots. Currently, there are only NAO robots available. Other types of robots that could be included are more traditional (industrial) robots, used e.g. in manufacturing. The application has been designed (e.g. for coding and database structure) with functions to handle more robot programming languages in mind. When the end user finalizes the programming and requests “send to robot” the coding sequences (in the specific language used for the robot) are sent by email to the hosting institution. There, students will monitor the email account, copy the code into the robot, videotape the actions, upload the video, and add the new video to the playlist.

Studies of off-the-shelf speech recognition software started in 2011. The development has relied heavily on student engagement and programming and has – for Hello Robot – been ongoing since 2014. The website with the application is currently in its 2017 version and will be undergoing further development in the summer of 2018. The application has so far a limited set of commands available, but will be extended over time. Another ambition is to add more languages. Suggestions include Arabic, Russian, and Swedish. Developing the administrative package so institutions can add more content is also needed. Discussions have likewise included suggestions, where users themselves could upload videos of their own robots (e.g. created with Lego Mindstorms, and after content review) to increase the popularity of the site. This would change the initial aim of programming somewhat, but would still support the overall purpose of promoting interest in STEM subjects.

IV. WEBSITE

The website has been given a simple design for fast and easy page-load. There are two versions available, for desktop/laptop computers and tablets/mobile phones. Images herein are showing screenshots from both versions.

The start page gives the visitor the option to select platform (image 1). The user will be notified if the browser does not have support for Annyang (e.g. Safari and IE) but buttons will still work. Language settings can be changed on all pages. Subject to choice, the user will be redirected to the platform home page for the selected language (examples in image 2 and 3). The home page has a short informative text about the project. Robot selection is done via the top menu and shown in image 4.

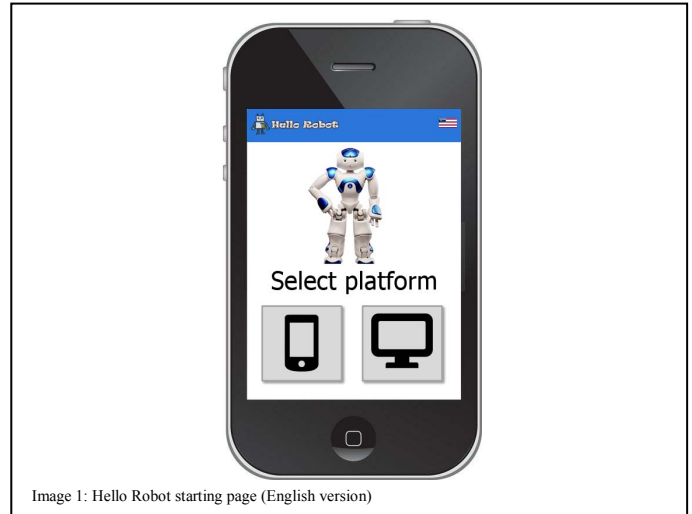


Image 1: Hello Robot starting page (English version)

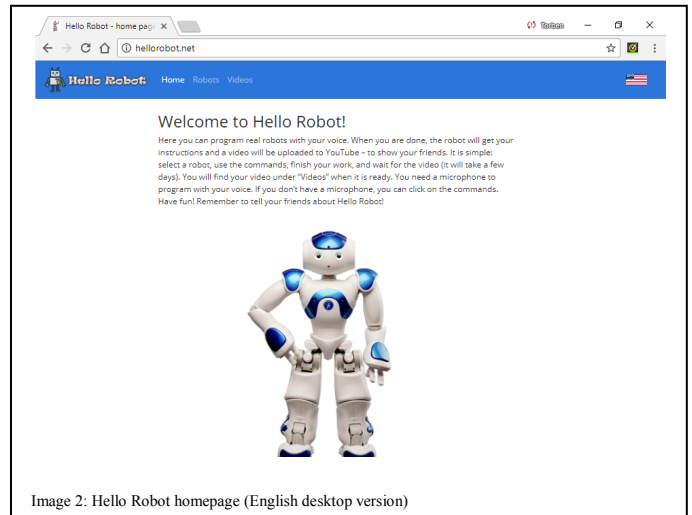


Image 2: Hello Robot homepage (English desktop version)

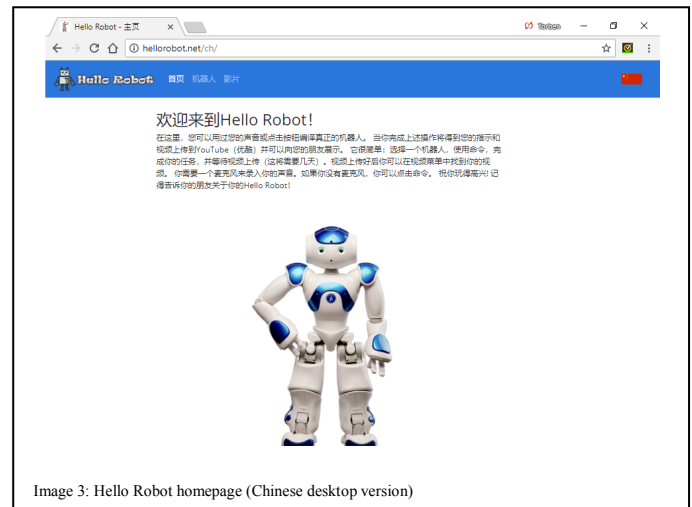


Image 3: Hello Robot homepage (Chinese desktop version)

Current robots are all humanoids (NAO), located in China, Macedonia and Sweden. The language used for the robots is Python. The database is designed so other robots can have other languages automatically packaged during the web programming phase. An example of the programming set (with programming ongoing) is shown in image 5 below.

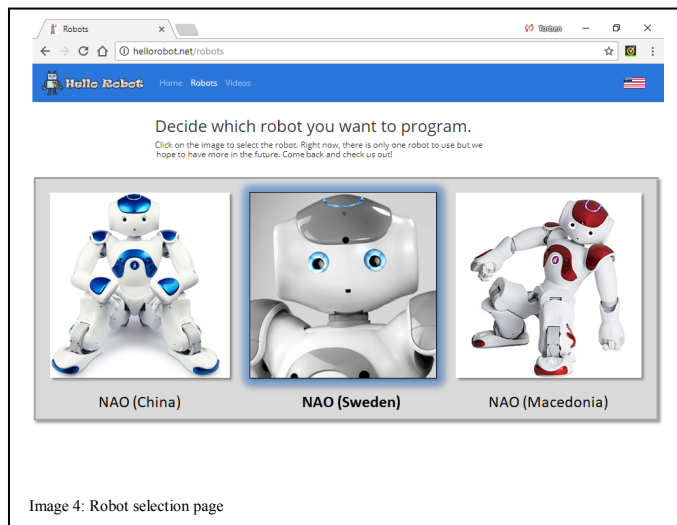


Image 4: Robot selection page

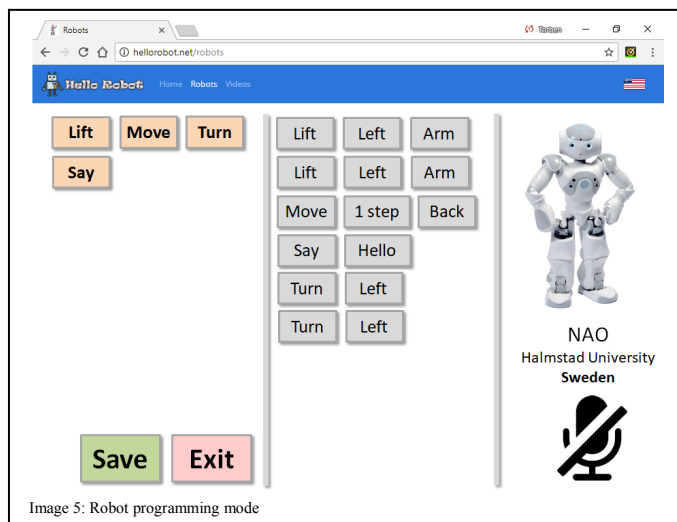


Image 5: Robot programming mode

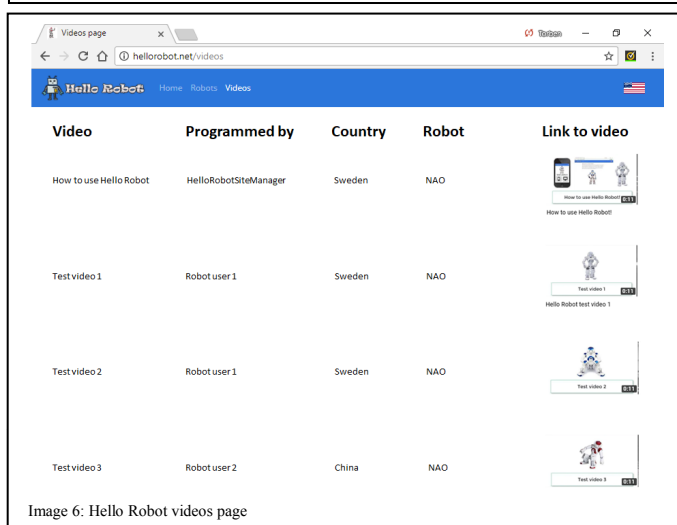


Image 6: Hello Robot videos page

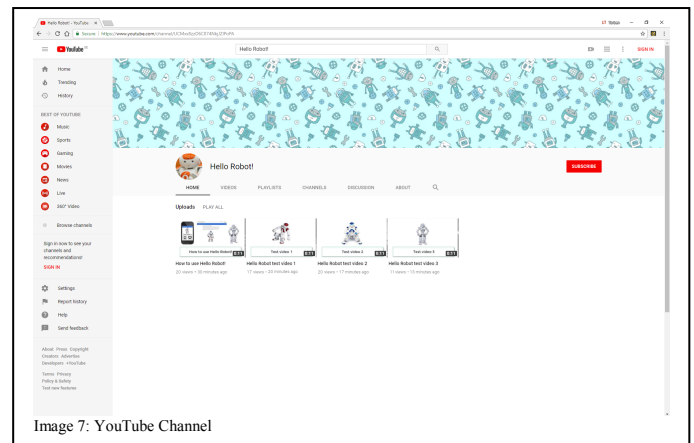


Image 7: YouTube Channel

To cancel a command already made, the user clicks on a button in that command line or says *Cancel Say Hello* or *Cancel first Say Hello* if there is more than one. The last command given is *Save programming*. Once the programming is completed and saved, the user will have an option to add a user tag, country, and e-mail address for a notification when the video is uploaded.

As Chinese users cannot access YouTube, there is a setup to save videos on Youku, the Chinese equivalent. The control of the channel is maintained by a Chinese partner university (a Chinese phone number is required to set up/manage a Youku channel).

V. TECHNICAL OUTLOOK AND CHALLENGES

Although the website is working, there is still much to improve. The current functions are however enough for suggestions and external testing. Improvements will be implemented during the summer of 2018. A student project has also been set up for additional work during the spring of 2019.

A feature which could improve user feedback during programming would be a more “live” interface, where the child/programmer could “see” the programming results. If the command *Lift Left Arm* was given, an image would show the robot in the currently programmed state. Studies have shown how direct/graphic feedback may make understanding programming and possible errors better [33]. Although developed for signaling if an error occurred, concepts as states and transitions may be useful also for Hello Robot, especially as more and different robot models are incorporated including social robots, e.g. Pepper.

At time of writing, the Annyang speech recognition API is undergoing changes which may affect the project. To fully use new functionalities, a website now must have a Secure Sockets Layer (SSL) certificate on the server. This added requirement is not implemented yet. Further tests with different browsers will be needed. Currently, only Chrome and Firefox works properly.

VI. CONCLUSION(S)

From discussions with young children in Sweden it seems as humanoid robots draw most attention. The children also seem to relate better to what they can do in terms of programming compared to traditional (one-arm) industrial robots, as e.g. from FANUC or ABB. From a commercial perspective, distance programming *any* robot may be interesting – through speech or otherwise – such services already exist [34].

As the project still is in its early phases, drawing conclusions concerning learning, skills development, or raised interest seem premature. Different from other work with a robot component, this project does not focus e.g. programming [35 - 36] or classroom interaction [37]. Its only aim is simple: to raise interest.

The technical goal – to create a website with global access, where robots can be programmed using speech commands – is progressing. Successfully reaching the overall goal (to raise further interest in STEM subjects through this approach) has yet to be seen. It will take many years to know, as the target group is children at time of writing. Such a process will not only require a technical solution but also a range of activities to inform about the website's existence, attract the target groups, and document if Hello Robot indeed influenced. Hence: challenges remain!

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