***Nao Robot in the Classroom***

Requirements Document

# 1. Introduction

## 1.1 Overview

*The Buffalo Academy of Science Charter School in Buffalo, NY has recently purchased a Nao Robot for use in the classroom in their k-2 classrooms. The Nao robot is a powerful device, the robot has an impressive list of features that would allow it to communicate and navigate through the environment. The use of the robot is currently limited by the one user and the limited amount of pre-existing applications and programs of using the Nao robot in a classroom environment. The goal of the project is to create multiple scenarios where the robot can be used by teachers in a typical school environment, both inside and outside the classroom.*

## 1.2 Scope of the Product

Using the Nao Robot in the classroom shall consist of 3 goals.

1. The first deliverable is a simple task that allows students to see the robot function at a simple task of interacting with one person (teacher) in a classroom environment to "read" a book to the students. This first goal is to allow coders to become familiar with the code and robot behavior while being able to observe students’ reaction to the robot in the classroom.
2. The second deliverable is to expand the use of the robot into a one on one scenario that the robot (under adult supervision) can interact with a student to walk down a hallway with a student and engage with the student in a calming conversation modeling appropriate behaviors, ideally using feedback from the student to engage in a behavior change.
3. The last deliverable is to take the basic Nao shell and integrate a function of A.I. to develop a program that will allow the robot to interact on its own with no assistance from a teacher to engage with students in an activity. This could be accomplished with machine learning, A.I. connectivity to the internet, or a programmable game that can be edited by the user, but once running will be completely autonomous.

## 1.3 Business Case for the Product

It is estimated that the U.S. will spend $56 Billion in educational technology this year alone. Each school district of the more 3,500 in the U.S. is trying to use their resources as best as possible and at the same time prepare their students for the future, a future of AI and robotic-assisted devices. Currently, the Nao robot is the best mass-produced system on the market ready to be used in the classroom. There are currently over 20,000 units in use with more added each year. However, the robot is more of a training tool in the college classroom rather than a companion in the classroom. Currently, there are few program packages out there for the Nao robot system other than the basic Python, or Choregraphe software it comes with. Currently, there are no new software packages designed exclusively for the elementary classroom. One benchmark supplier, Zorabotics sells an app system for the Nao Robot for $5,000 for use in the health or service industries ($3,995 for schools). Zora also purchases the NAO robot at wholesale prices and installs its own software package for even greater savings for the consumer, and assumed greater profit for Zorabotics. BuffSci is not looking to retain any rights to the developed software for the robot and any person(s) working on the project would be free to develop their own business plan to extend this project into a viable product.

# 2. General Description

Children that growing up today are already living in a world we could just imagine 30 years ago. They are being driven around in autonomous cars the IoT allows them to have access to more information than we were ever able to access before, and the cost of technology continues to smash Moore's law in becoming cheaper and more powerful at astonishing speeds. Students who grow immersed in these technologies will be ahead of their peers in perceiving what the future holds and may lead them onto the careers of the future that don't even exist...yet.

With the development of AI in a humanoid shell that the Nao robot provides, students at the Buffalo Academy of Science (BuffSci) will be able to interact with a robot in their classroom. Unlike the typical use of the Nao robot in a classroom that is used to allow students to code, the goal of this project is to have the robot function alongside of the students to model appropriate behavior and not to be a TV set for entertainment, but a companion to assist in their learning.

The Nao robot can function as a teacher's aide in providing course content such as in scope 1, reading a book to the class. But moves beyond that in scope 2, to help provide social clues in a non-judging way to connect with individual students, especially in situations when adults may not be the best resource like calming a child in distress outside the classroom. Last the robot can be linked with pre-existing AI technologies that expand its function in the classroom as a resource in either providing opportunities for learning having students by interacting with the robot.

Current software system allows the robot to be programmed with a series of outcomes based on scripted inputs. As the initial scope takes advantage of these basic programs, we are hoping to develop more complicated systems in which the robot is able to move "off script" and through the use of AI packages, it can interact with our students with minimal supervision.

Current software includes Python and a Python-based software package called Choregraphe, although both powerful tools, additional resources may be required for use with AI applications that were never intended to be used with the NAO robot. This is why the first scope is to use existing systems to provide the deliverable "book reading" exercise. There is research for use of the Nao robot working with children diagnosed on the autism spectrum, and although scope 2 is for all kids, such research may be very valuable in providing successful interactions with children in distress. Last scope 3, increases the AI ability of the Nao robot beyond its original design scope. Some work in blending AI with Nao movements has been done. The significant use of this in the classroom has not been explored.

Developers in this project not only have to understand the software, and hardware components of the project, but most also understand the pedagogy of a k-2 classroom and how such a classroom currently functions and the possible outcomes of using a robot in the classroom. Multiple visits to the classroom may be required to complete the project.

## 2.1 Product Perspective

*Why have you chosen to develop this product? What need does it serve? Who are the primary stakeholders, who is developing the project, and who will benefit from the finished product?*

## We have chosen to develop this product; because we know it is a fact that technology is in every part of human lives and now AI-enabled Robots are on the rise. This project will enable us to apply machine learning principles to a good use in a school environment where it will benefit both students and teachers. Primary stakeholders are a public school in Buffalo, its students’, teacher and administrators. This project is being developed by the STEM Coordinator of the school. Students and teachers will benefit from the finished product.

## 2.2 Product Functions

At the successful completion of the project the Nao Robot should be able to function within a narrow scope of use inside a k-2 classroom providing actual learning content to students in either subject areas of ELA or mathematics or help with the emotional development of proper behaviors in the classroom. Ideally, all software developed will be available as a single download to any Nao unit. Each of the three deliverables from the scope should be easy for a classroom teacher to use within their classroom as most teacher elementary teachers are not familiar with programming or IoT skills.

*What does your product do? What activities can users perform while using it? List the main functions that you will build into your product here. For example, if you were creating an application to generate exams, the main functions might be that it will allow the ability to enter, edit, and review questions, and that it can generate exams in different formats and lengths. The details will come in the specific requirements - this should cover the high level.*

## 2.3 User Characteristics

## The robot will be maintained by the school's STEM Coordinator, and already one person from BuffSci is on the project team, however, the robot functions can not be limited to the availability of these positions. The successful use of the robot in the classroom will be greatly affected by the ease of use for a classroom teacher to have the robot function autonomously and require minimal effort by the teacher to start and stop the robot interactions.

*Who do you expect to use your finished product, and why? What is their technical background, their training or education, their motivation to use it? What obstacles might they encounter, and what specialized skills will they need? For example, an application designed to let a security expert quickly assess the state of the network, firewalls, and intrusion detection logs will have a very different approach than an application designed to let elementary school students learn math by playing games.*

## 2.4 General Constraints

## The Nao robot has an Intel Atom E3845 @ 1.91GHz processor, with 2.8 G of RAM with WiFi speeds of 124.45 Mbit/s download and 83.90 Mbit/s upload speeds.

## The robot is able to connect to the same wifi throughout the entire building as each classroom has its own spot to connect to. However, outside the building the robot would not be able to connect to the internet.

*Did you work under any constraints such as platform or development environment? Did you have to make your product compatible with any existing software or other products currently in use? For example, if you are developing a piece of software that has to run on department severs, you may be limited to MySQL and PHP as your development environment, as they do not support frameworks like Laravel or Flask.*

## 2.5 Assumptions and Dependencies

*In this section, list any assumptions you made about your project (for example, did you assume that the finished product would need to be delivered over the internet? Do you assume that all users will have google or facebook accounts? Does it require that data be available as a starting point for analysis?). If your project depends on any particular technical infrastructure, or requires administrators or others with specific skills, note that here.*

# 3. Specific Requirements

# The Nao robot has an Intel Atom E3845 @ 1.91GHz processor, with 2.8 G of RAM with WiFi speeds of 124.45 Mbit/s download and 83.90 Mbit/s upload speeds.

# The robot is able to connect to the same wifi throughout the entire building as each classroom has its own spot to connect to. However, outside the building the robot would not be able to connect to the internet.

*This section of the document lists specific requirements. Requirements are divided into the following sections:*

1. *User requirements. These are requirements written from the point of view of end users, usually expressed in narrative form.*
2. *System requirements. These are detailed specifications describing the functions the system must be capable of doing.*
3. *Interface requirements. These are requirements about the user interface, which may be expressed as a list, as a narrative, or as images of screen mock-ups.*

## 3.1 User Requirements

## As a final end-user a school administrator (IT or other designated person) should be able to access and modify any variables in the program that may be customized.

## Additionally, the successful use of the Nao robot in the classroom will be dependent on the ability of the classroom teacher to be able to; turn on and start the robot, run the right software for the application, and the ability for the robot to remain autonomous. Last, the robot needs to be able to be turned off or paused easily as situations in the classroom can change quickly.

## *List user requirements (functional) here. This should be a numbered list of your commitments. What will the user be able to do? Login? Create an account? View their account balance? Send messages to other users? View detailed reporting? Set up email notifications? This is the heart of your contract with the stakeholders. These requirements should each define a user function, and should be testable by the user during UAT.*

## 3.2 System Requirements

*List detailed system requirements (non-functional) here. If your system is large, you may wish to break this into several subsections. System requirements are those that the system must support but that may not be testable by an individual user. For example, does the system need to log all transactions? Does it need to support two factor authentication? Do all reports need to render in 2 seconds or less? Does it need to be deployed by automated script? Does it need to replicate data to multiple databases?*

## 3.3 Interface Requirements

*List interface requirements here; or* ***include wireframes / screen mockups****. If you use mockups, be sure to explain major features or functions with narrative to avoid confusion or omission of desired features. If there is a user interface, you MUST consider usability factors here - error handling, navigation, consistent presentation, etc.*

# 4. Appendices

*If you wish to append any documents, do so here. You may wish to include some or all of the following:*

· *Personas and scenarios developed for this project*

· *Transcripts of user interviews, observations, or focus groups*

· *Copies of communications which contain user requirements*

· *Original project proposals or other historical documents*

· *Lists of similar projects or products, with notes about how they differ from yours*

· *A list of requirements which were "wish-listed" or marked unfeasible at present*

· *Original screen mockups, if they are relevant*

# 5. Glossary

*Include a glossary of definitions, acronyms, and abbreviations that might be unfamiliar to some readers, especially technical terms that may not be understood by end-users or domain-specific terms that might not be familiar to developers.*

*AI: Artificial Intelligence*

*IoT: Internet of Things*

*Nao: Robot system created by Aldebaran Robotics*

# 6. References

*List references and source documents, if any, in this section.*

https://www.youtube.com/watch?v=A7XFcnJE29A

http://www.ling.helsinki.fi/users/gwilcock/Pubs/2013/ICMI-2013.pdf

http://www.about-robots.com/make-pepper-know-everything-using-wikipedia.html

https://www.academia.edu/30082501/Open-Domain\_Conversation\_with\_a\_NAO\_Robot