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SAR:WABBS

FUNCTIONAL REQUIREMENTS DEFINITION

Version *1.2*
10/05/2018

VERSION HISTORY

Version #	Implemented By	Revision Date	Approved By	Approval Date	Reason
1.0	*Soeren Orlowsk, Vinh Tran, Kellen Mendenhall*	*09/27/2018*	*Soeren Orlowski, Cecilia Clark*	*09/27/2018*	Initial Functional Requirements Definition draft
1.2	*Kellen Mendenhall, Soeren Orlowsk, Vinh Tran*	10/13/2018			Added additional details and implemented Debra Parcheta's suggestions

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INTRODUCTION

1.1 PURPOSE OF THE FUNCTIONAL REQUIREMENTS DEFINITION

The Functional Requirements Definition documents and tracks the necessary information required to effectively define business and functional requirements. The Functional Requirements Definition document is first created during the planning phase of the project with future revisions and additions/removals made to the requirements document being done throughout the project lifespan. Its intended audience is the main client of the project, the creator of the Wellness Augmentation Based Bot System (WABBS), Cecilia Clark.

2 SOFTWARE REQUIREMENTS OVERVIEW

The requirements of this project is to create the foundations of an Android application that will detect a child's face and read what emotion the child is currently displaying. After reading what emotion the child has, the app will display a cartoon rabbit face that mimics the same emotion the child currently has. The application will be installed onto an Android smartphone and inserted into the face slot of the Socially Assistive Robot (SAR) WABBS. The purpose of the app, and the WABBS itself, is to be used with children who have cerebral palsy in an effort to help the children reach developmental milestones as seen with children who are typically developing.

The WABBS will accomplish this goal by having the child engage with it during a session of playing with the WABBS (overseen by a family member or clinician), which will last for at least thirty minutes per session. In this context, engagement can be measured by sustained eye contact (as the children lack motor function) on the WABBS' face with the child's attention being focused on the face alone. The app's emotion mimicry technique is to draw and maintain this engagement from a child during each session of play. While the scope of the requirements is only laying the foundations of the face application, the goal of the WABBS project is, after acquiring the child's attention, to then coax the child to mimic the WABBS' face and ultimately to have the child mimic the WABBS' gestures. By successfully getting the child to mimic the WABBS' face and gestures via this social interaction, the SAR will help the child reach the same development milestones that typically developing children progress through as well, improving motor functions, social skills, and quality of life.

3 FUNCTIONAL REQUIREMENTS

3.1 USABILITY REQUIREMENTS

1) The smartphone face app must be a hands free device.
    a) It must be capable of starting automatically as the WABBS robot is powered on and shuts down as the robot is powered off.
    b) No family member or clinician supervising the child's play session will need to specifically boot or resume the app during a normal play session.
    c) The app's emotion mimicry must be automatic, without input or control from a family member or clinician.
2) The application must draw and maintain a child's attention, measured via sustained eye contact and focus.
    a) The application must accomplish this via a cartoon rabbit face being displayed on the front screen.
        i) The app must currently have three faces: happy, sad, and sleeping.
        ii) The face must have thick black outlines and a white background to contrast with the robot's red fur and rainbow LEDs.
        iii) Every rabbit face must include eyes, mouth, whiskers, and a nose.
        iv) No rabbit face may have cheeks or ears, they will be on the robot physically.

3.2 PERFORMANCE REQUIREMENTS

1) This app will have to process camera images taken with the front (face) camera in one second intervals.
2) Every phone the app is used with must have a battery capable of lasting at least thirty minutes.
    a) Every phone will also need 1.5GB of internal storage to install the app itself, phones that do not meet this requirement cannot be used.
3) The children lack object permanence, therefore:
    a) The app, during normal sessions of play, must display a rabbit face at all times.
    b) All bugs and exceptions must attempt to be caught internally and must not interfere with the functions of the app as much as possible.

3.3 SUPPORTABILITY REQUIREMENTS

1) The app must allow the users make a report to the development team with bug reports.
    a) This will be done through touching the left side of the screen.
        i) After touching the button, the user will fill out a form and submit the report to internal storage.
        ii) Once the report has been submitted, we will return to the main screen of the app and resume emotion recognition and face displaying functions until another report is submitted or the app is shutdown.
            (1) Mistaken bug reports can be canceled via a cancel button.
        iii) The form will consist of the following information.
            (1) Current time and date.

(2) Location (Clinic or Home).
(3) Type of bug (Unexpected Power-down, Odd behavior, Crash, or Unexpected Sleep).
(4) Description box for the user to describe the bug and what they were doing when it occurred.
(5) List of variables and important data (such as runtime)
(6) Checkbox to indicate if the report was made after a shutdown had occurred, invaliding the variables and data printouts if true as they are out of date.

2) This project must be very well documented so that a future group can expand on this project.
    a) The app must also be built with future expansion in mind.
        i) It must be possible to include new faces and expand the list of possible emotions that the app can detect.
        ii) It must be possible to expand the bug reports to include new information.
    b) The app will be documented with Javadoc:
    c) https://docs.oracle.com/javase/9/javadoc/javadoc.htm#JSJAV-GUID-7A344353-3BBF-45C4-8B28-15025DDCC643
3) The face app must be usable to family members and supervisors with minimal instruction in its function and use.
4) Should the supervisor of the session need to reset WABBS or stop it in the case of erratic/undefined behavior, the app must allow a sleep function to activate upon touching the right side of the screen
    a) The app must dim the screen upon sleep mode activation and must restore screen brightness when sleep mode deactivates.
    b) The app must display a sleeping rabbit face and cease emotion recognition while sleep mode is activated.
    c) The sleep mode, once activated, must be canceled or deactivated by touching the right side of the screen again.
5) Children touching the screen by mistake is not a concern due to impaired motor function.

4 HARDWARE REQUIREMENTS

1) We will be using a Galaxy S4 with Android 5.0.1 as our production phone.
    a) Every smartphone that will use the app must have Android 5.0.1 and Android SDK 21 support, smartphones that do not meet this requirement cannot be used.
2) The smartphone must have an integrated camera that is on the same side as the display screen
    a) Any smartphone's front camera can be used but cameras below 640x480 megapixels cannot guarantee accurate results and are not recommended.

5 SOFTWARE REQUIREMENTS

1) The app must use the OpenCV library for image manipulation (https://opencv.org/)
2) The app's programming language will be Java with JNI calls being made to code written in C/C++
3) Security wise, the files stored on the phone app itself will contain no identifying information about a child that the app was trained to recognize, so security is not a concern.
4) The app must currently recognize two emotions.
    a) Happy
    b) Sad
5) Data / Resources
    a) XML File that will be used to read in and detect a person's face to pass on to Yohan's code for cropping out the face specifically, at which point, it will be used to classify the child's emotion.
    b) Image files for the robot's face, recommend .png or .jpg.
    c) Internal storage for bug reports.
6) When the robot is shutdown, the phone will, after no more than one minute, also shutdown to conserve battery life.
7) When the robot is reactivated, it will awaken the face app by connecting the phone to the arduino uno that powers the robot briefly via USB
    a) The app will then connect to a bluetooth signal inside WABBS to receive pings and keep the smartphone from going into sleep mode while the robot is on.
8) The app will utilize code written by Yohan to detect and crop an image around a child's face.
    a) The app will pass this new image to a classifier trained to recognize emotions to detect what emotion the child currently has.
        i) The app must utilize tensorflow to accomplish this by reading tensorflow's .pb files.
        ii) To produce the .pb files needed, tensorflow must be trained with each individual child by taking a series of images and telling tensorflow what emotions those images have.
            (1) The smartphone itself cannot train and produce the .pb files.
            (2) This training must be done on a PC, Cecilia Clark's team will handle this and the face app does not need to be concerned about it.
    b) Based on this input, it will then output to the code displaying the rabbit face.
        i) Based on that output, the app will then display the correct face image.
9) The only output will be the cartoon face images and bug reports.
    a) The WABBS project is not currently at a stage where it can measure data or investigate the effects of play, therefore:
        i) The app will not be quantifying/qualifying data or metrics or the effects of play, in both single and multiple sessions.
        ii) It will not directly aid in attempting to prove or disprove the SAR hypothesis.
    b) The app will respond to a child's emotions and display the emotions back to them.

FUNCTIONAL REQUIREMENTS DEFINITION APPROVAL

The undersigned acknowledge they have reviewed the SAR:WABBS **Functional Requirements Definition** and agree with the approach it presents. Any changes to this Requirements Definition will be coordinated with and approved by the undersigned or their designated representatives.

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APPENDIX A: KEY TERMS

The following table provides definitions for terms relevant to this document.

Term	Definition
SAR	Socially Assistive Robot. Helps those who are disabled through social means (Autism/Cerebral Palsy)
WABBS	The SAR that is the main focus of this project. Stands for Wellness Augmentation Based Bot System
ASD	Autism Spectrum Disorder
CP	Cerebral Palsy
TD	Typically Developing Children
IDD	Intellectual and Developmental Disabilities
Android Studio	Program to create and design Android Applications
Android	Smartphone Operating System, main OS for WABBS
OpenCV	Library for Programming Functions mainly dealing with real time computer vision
TensorFlow	Open Source Library for Dataflow Programming
Dataflow Programming	Programming Paradigm that models a program as a directed graph with the data flowing between operations
Data Definition File	File containing output data for the WABBS, will allow recognition of a child's emotions.
HIPAA	Health Insurance Portability and Accountability Act
CITI	Collaborative Institutional Training Initiative
IRB	Institutional Review Board

APPENDIX B: FUTURE EXPANSIONS

The following table provides ways in which future groups can possibly expand the Wellness Augmentation Based Bot System.

Term	Definition
Session Tracking	Track metrics such as number of face changes and session lengths to measure the effectiveness of WABBS over multiple sessions
FIle Transfer	Wireless transfer of Bug Reports (and possibly Session Files mention above) to a database hosted either by the team or the clinic itself
Additional Emotions	The project will allow the addition of new emotions for future teams to implement, although they will have to create new drawings of WABBS' face for each emotion
Gesture Based Reactions	The face app, if possible, can read data from Bluetooth input to react to the gestures that WABBS will do during a play session.
Classifier Retraining on Smartphone	Future teams may consider looking into tensorflow advancements that may have occurred to allow retraining the app and creating new .pb files on the phone itself, allowing WABBS to retrain itself for every child automatically and not needing to have it be done on a desktop
Classifier Retraining Security	Should any future teams allow the face app to retrain itself, possible security concerns regarding the training data could emerge that will require file encryption protocols.
Gesture Recognition	In addition to recognizing emotions, tensorflow may also allow recognizing gestures with arms/hands. Such recognition should be investigated for possible inclusion into the WABBS to aid in acquiring attention and focus.