FINAL YEAR PROJECT (Proposal)

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Executive Summary:

Among many frustrations that come with paralysis, one the most prominent is that of constant dependency. Smallest actions to control the environment, such as accessing the switch to the lights and fan of the room, require a human assistant around the clock. Controllo will relieve the dependency of that human assistant.
The application will allow users to operate switches using simply their facial gestures. For example: blinking their eyes, thrice consecutively, will signal the application to switch the fan ON. Controllo is designed specifically for users with very limited physical movement. Because no other muscle, be it hands or legs, is involved, Controllo becomes the ideal solution.

How it works:
This application will run on most versions of Android operating system. The smartphone will be placed in a way where the camera is directly pointed at the user's face. The app will utilize the camera of the smartphone to capture user gestures.

- User makes a facial gesture (example: blinking eyes thrice consecutively)
- Camera captures the gesture
- Application processes the gesture to map what it is meant to do
  Example:
- Blinking eyes thrice consecutively = switch the fan ON
- Nod head twice = switch the lights OFF
- Application sends a signal to the arduino through bluetooth
- Arduino receives the signal
- Arduino controls the specific relay (which acts as a switch) to operate the circuit of the relevant appliance connected to it.

Controllo falls under the domain of assistive technology. Although there have been numerous efforts under this domain, there is still a vast area unexplored. This application aims to improve the quality of life of paralyzed people by granting them the power to independently control their room appliances.

Project Description:

Background and Motivation

One of the things that frustrate paralyzed people is their inability to perform everyday task such as getting up opening/closing room's light or fan. It makes them annoyed to call someone every time they need to do something. There are assistive tools available to call the assistant by a click but then again they are dependent on someone. Their own free will is lost and they feel worthless and useless.

This defines the core idea behind our project. Our project is based on assistive technology that will provide assistance to paralyzed patients. Paralysis is a loss of muscle function in any or whole part of the body. We are concerned specifically about those who are paralyzed shoulder down. These are the people who can't move either their hands or legs and have become bed ridden. Not much work has been done to help these kind of patients. There are tools available that can control the environment with a button click but that involves functioning of hands.

Our motivation is to help those who are completely dependent on others and give them a sense of relief of not requiring assistance every time they want to do something. The idea is to make him independent enough so that he becomes able to perform simple tasks without constant assistance by using facial gesture recognition.

Project Goal

Our project aims to develop an application that can assist paralyzed person to control their room environment to some extent. The idea is to make him independent enough so that he becomes able to perform simple tasks without constant assistance. This app will help patients to be independent and not rely on an assistant to be around them 24/7. This application will also reduce the frustration level that is easily known phenomenon among these people.

Project Requirements

a) Functional Requirements

The functional requirements will include the following:

- Smartphone (With Operating System Android 4.0 or higher).
- Arduino
- Relays
- Specific gestures (As an input to our project).

b) Constraints

- Initially the app will only work on android phones but in later versions we'll make it a cross platform application.
- The application will only work on Smart phones because having camera is necessary to read the facial gestures.
- Arduino setup will be required for this application to work.
- Positioning the smartphone such that it is able to correctly detect gesture.

c) Objectives

Assistive technology is a fairly new idea in the recent advancements in technology. It has been widely neglected on a mass scale. Though there have been numerous efforts on communication, little work has been done on allowing paralyzed patients to control their physical surrounding environment. We wish to contribute in this domain, and develop a product that is both accessible and affordable to the average man.

Validation and Acceptance Tests

The best judge of the system would be the user this project is targeted for. Our usability testing phase involves users (paralyzed patients) to try using the application in a monitored room. The observers will judge the system for the following usability goals:

- Effectiveness
- Efficiency
- Safety
- Learnability
- Utility
- Measurability

Along with the result of the above observations, we plan to apply Nielsen's usability heuristics to further enhance the usability of this application. Since it a user-centered application, it is highly important to gain the best user experience from it.

Technical Design:

Possible Solutions and Design Alternatives

To implement gesture recognition, there must be a camera directly pointed in the direction of the user's face. This can be done is a number of ways:

- A camera can be fixed on a wall in the patient's room. This camera will either be wireless or otherwise. It will constantly face the direction of the paralyzed patient's bed. The initial cost and maintenance is slightly high.
- A smartphone camera, placed on a stand, facing the patient on the bed or sofa or wheelchair, wherever they may be. The initial cost and maintenance is low.

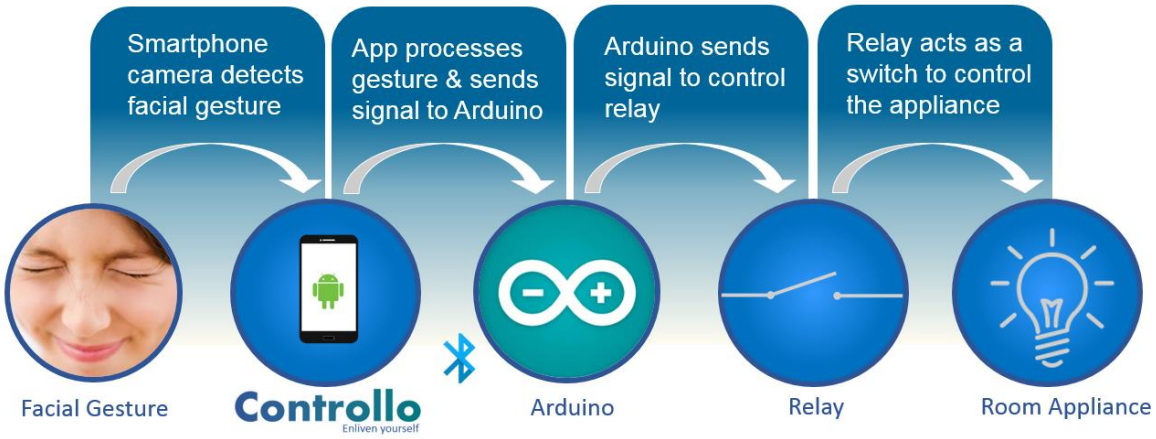
Communication between the application on android phone and the arduino physically embedded on the switchboard must take place. This can also be done in a number of ways.

- WiFi: The android phone and the arduino must always be connected to the Internet at all times. This requirement can get complicated when the home doesn't have an established Wifi facility. Specifically setting up a Wifi to run the application, considering the cost and effort required for its maintenance, will defy the objective of making it accessible and affordable.
- Infrared: Both the android phone and the arduino have an infrared component. But there are several restrictions involved. The infrared waves only travel in a straight line. To restrict the smartphone and arduino to be directly pointed towards each other at all times is senseless.
- Bluetooth: This option is available in both the smartphone and the arduino. It has no such restrictions of direction and the range extends over about 10 meters, conveniently covering the entire area of a large bedroom.

Our Solution:

Keeping in mind the cost and feasibility of our product, we plan to use a smartphone camera, placed on a stand, facing the patient on the bed or sofa or wheelchair or wherever they may be. For communication between camera and arduino, we intend to utilize the bluetooth ability of smartphone as well as of arduino for effective communication.

System Level Overview



Module Level Descriptions

a) Graphical User Interface Modules

So far the graphical interface is at the prototyping phase and is limited to check the facial gestures and head movements (awaiting UAT)

- Initial Screen:
  The very first screen will be displaying an overview of the app. This screen aims to improve the learnability of the paralyzed patient and his attendant.
- Facial Outline:
  This screen helps the user to correctly position his face such that the gestures can easily be detected.
- Feedback Screen:
  A constant feedback would be provided to the users when their face is positioned correctly or when a gesture has been detected.

b) Control Modules

- Once a gesture has been made by the user/patient, the app detects the gesture
- The detected gesture is mapped with the predefined gestures database
- A specific signal is generated for a specific gesture (bluetooth signal)
- The generated signal is detected by the Ardiuno toolkit attached to the switchboard using relays which enables an electric appliance to become active/inactive.
- The application would be using the camera continuously for detecting gestures.

Assessment of Proposed Solution

Keeping in mind the aim of the project which is to make this application easily accessible and affordable to paralyzed patients, we chose to build the application on Android OS as it is relatively cheaper and more widely used. The application will be available on Play Store, free of cost, and will run on all majority of Android Operating system versions.

Our focus is on the usability of the application, not the technical aspects. We want to provide an application for paralyzed patients to improve their quality of life. Having said that, it is important to keep the technical hardware as simple and compact as possible. This was our motivation behind choosing Arduino to perform the task of a microcontroller. Arduino is both a physical programmable circuit board (microcontroller) and a piece of software, or IDE (Integrated Development Environment). This combination reduces hardware issues and allows time and effort to be concentrated onto the usability of the application.

Work Plan:

Feasibility Assessment

a) Skill and Resources

- Expertise in android development.
- Arduino coding.
- Image processing.

b) Risk Assessment

- Technical Risk: High.
- Timing Risk: High.
- Budget Risk: Low.

Time and technical are two considerable risks for this project this is because our goal is to develop a low cost but with easy functionality to make it easier to use. Any unforeseen technical problem would have a high impact on the progress of the project.