Neural Stepper

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Abstract: *Diseases from the brain come in different forms and shapes ranging from highly disabling and eventually fatal neurological condition to mild, treatable depression. Such diseases also referred to as a neurological disorders are diseases of the central and peripheral system which mainly affects the brain, spines and nerves that connect them. Epilepsy, Alzheimer's, Cerebral Palsy and other cerebrovascular diseases like stroke, multiple sclerosis and Parkinson's disease are some of them. The common symptoms include muscle weakness, difficulty in reading and writing, changes in coordination and balance, tremors, poor speech delivery and numbness in arms or legs. To detect these symptoms several tests have to be performed such as balance and gait for muscle weakness in legs, audio recording for poor speech delivery and several tests which make use of hands to check muscle weakness or tremors in them. This paper presents a way where some of the tests common to most of the neurological disorders can be performed through an iOS application. This application is programmed using a relatively newer and naive Swift language. Once functional, it can reduce the number of visits to the doctor by performing some of the tests by himself through the application.*

Keywords: *iOS application, neurological disorder, Swift, symptoms, test.*

I. Introduction

Neurological disorders are the diseases which mainly affects the brain,nerves and spinal cord.Thee three parts which work together and control everything in the body are referred to as the central nervous system.It can affect a single neuron or an entire neurological pathway.Example of such disorders include multiple sclerosis,Parkinson's,Cerebral Palsy,Alzheimer's and many others.Each of these disorder have some common symptoms for which several tests have to be performed.Therefore several visits have to be made to the doctor in order to perform these tests.In order to avoid this,an iOS application is developed in Swift language where some of the tests common to most of the neurological disorders can be performed.Once functional,it can reduce the number of visits to the doctor by performing some of the tests himself through the application.

II. IOS Architecture

1.1 Core OS Layer:
This is the bottommost layer of the ios architecture which provides a variety of functions such as access to external accessories,memory management,file system handling and threads.It sits directly on top of the device hardware.In situations where one needs to deal with security or accessing external hardware,this layer is used by the frameworks.

1.2 Core OS Service Layer:
This layer provides all the services needed by most of the applications.It contains individual technologies to support features like icloud,networking and location.It includes the following frameworks:

1.2.1 Address Book Framework: This is used to access the iphone phone book directories in order to update and modify entries.

1.2.2 Core Data Framework: This framework is provided to ease the creation of data modelling and MVC (model View Controller).

1.2.3 Core Location Framework: This framework allows one to obtain geographical location of the device

1.2.4 SQLite Library: It facilitates light weight SQL based databases for iphone applications.

1.3 Core OS Media Layer:
The job of Media Layer is to provide the OS with audio and video capabilities. It also us to build applications that look and sound great.

1.4 Core OS Cocoa Touch Layer:
This layer contains the framework one uses in order to build the applications.It defines the appearane of the application which support different technologies such as multitasking ,push notifications and touch-based input.

III. Swift Language

Swift is a language which is used to develop iOS, OSX and watchOS applications. As compared to Objective-C it is safer to use and concise at the time of coding. Using this language one can create faster running applications as compared to Objective-C.The entire concept of class for unsafe code is eliminated using Swift. Variables are always initialized before use, arrays and stacks are checked for overflow and memory is managed automatically. The reason to code this application in Swift instead of Objective-C is because Swift is more easier to read as compared to Objective-C because it is written in simple English language unlike Objective-C which certain rules and syntax to write the code thereby making it difficult for a common man to read. It is also easier for one to code. For example one need not to write semicolon to mark the end of a particular line. So this saves a lot of time and becomes easier for a developer to code.

IV. Structure

The main characteristics of this application are to view the available tests that the patient must perform and perform these tests according to the instruction specified in the respective fields. The results of the tests will be mailed to the patients on their respective mail address.Inorder to perform these tests, one needs to register by entering the asked details after which one can login into the application by entering the email id and password.After logging, the patients can view the tests that needs to be performed.After performing the tests, the results of the tests will be sent to their respective email ids.This result will include their areas of weaknesses, whether they need treatment and what treatment is needed. These results will be sent by a doctor through a website after viewing the values of the tests performed by the patient.

1. Objectives : The objectives are as follows :

1.1 Security:
The doctor and the patient need to enter a secure encrypted password while logging in. The doctor can log in through a website and the user can log in through the iOS application. If a patient logs in through an application, a set of tests will be displayed to them which they need to perform based on the set of instructions. The doctor can view the values of the tests performed by these patients and provide appropriate results to them.

1.2 Reliability:
The system should reproduce the proper information incase the person has logged in before already and should therefore bypass the login phase and go directly to viewing the session phase.

1.3 Maintainability:
The tests performed by the patients are directly stored in to the database which is retrieved automatically at the time of doctor login thereby enabling him to generate results.

1.4 Reusability:
It can be used as and when required for any in house purposes of other hospitals.

2. Hardware:
The system requires a single Mac PC, as well as any Apple device with an internet plan. There are no restrictions on what these 2 items need to be other than they can run the software in any capacity.

3. Software:
This project has an iOS software requirement. The phone must have an iOS operating system and the desktop will need a Xcode simulator.

V.   Stages In Implementation

1. Planning:
  This phase deals with defining the scope and feasibility of the project. The deadlines, budget, launching and the complete foundation of the project is done in this stage.

2. Analysis:
  This phase deals with gathering of requirements for the project, generating alternative solutions, feasibility of alternative solutions and appointing a proper analyst in order to check the workflow of the project.

3. Design:
  The complete implementation of the project is done in this stage. Based on the resources available, the entire layout of the project is done in this stage. The entities, attributes and the relationships between them are now allocated into a system and the design specification must be specified within the constraints of the physical environment.

4. Implementation:
  The activities specified during the design phase on the basis of the requirements specified during the analysis phase are implemented in this phase. This implementation can be done with the help of different programming languages like C, C++, HTML etc.

5. Testing:
  Test and evaluation is the set of practices and processes used to determine if the product under examination meets the design, if the design correctly reflects the functional requirements, and if the product performance satisfies the usability needs of personnel in the field.

6. Maintenance:
  To ensure that the system is operating correctly in the operating environment, continuous updates of the system must be done on a regular basis.

VI.   Testing

  Testing is the way a product, system, or capability under development is evaluated for correctness and robustness, and is proved to meet the stated requirements. Testing is done at each stage of development, and has characteristics unique to the level of test being performed. At a macro level, testing can be divided into developer testing conducted before the system undergoes configuration management, and testing conducted after the system undergoes configuration management. Testing done before configuration management includes peer reviews (sometimes called human testing) and unit tests. Testing done after configuration management includes integration test, system test, acceptance test, and operational test. An operational test is normally conducted by government testing agencies. The other tests are conducted by the developer; in some cases, such as acceptance test, government observers are present.

1. Levels in Testing
1.1 Unit Testing
  This tests the minimal software component of the module. Each unit of the software is tested to verify if the detailed design for the unit has been correctly implemented.

1.2 Integrating Testing
  This exposes defects in the interfaces and interaction between integrated components. Progressively larger groups of tested software components corresponding to elements of the architectural design are integrated and tested until the software works as a system.

1.3 Final Testing
Before shipping the final version of the software, alpha and beta testing are often done additionally.

1.4 Alpha Testing
  This is a simulated or actual operation testing with the potential users or an independent testing at the developer's site. Alpha testing is often employed for off the shelf software as a form of internal acceptance testing before the software goes to beta testing.

1.5 Beta Testing

This comes after alpha testing. Versions of the software, known as beta versions, are released to limited audience outside the programming team. The software is released to groups of people so that further testing can ensure that the product has few faults or bugs. Sometimes, beta versions are made available to the open public to increase the feedback field to a maximal number of future users. Finally, acceptance testing can be conducted by the end user, customer or client to validate whether or not to accept the product. Acceptance testing may be performed as part of the hand off process between any two phases of development.

Thus the above tests were conducted and implemented successfully.

2. Using Black Box Testing:

Black box testing treats the software as a black box without the knowledge of internal behavior. It aims to test the functionality according to the requirements. Thus the tester only inputs data and sees the output from the test object. This kind of testing requires the test cases to be provided to the tester who then can simply verify that for a given input, the output value is the same as the expected value specified in the test cases.

VII.   Working

1. Application:

Initially the patient must download the application and register himself/herself onto the application. They can then log in by entering their user name and password. After logging in, they will be given a list of tests which have to be performed. Consent from the patients will be taken regarding the same. Code for consent is shown below:

```swift
import Foundation
import ResearchKit

public var ConsentTask: ORKOrderedTask {

    var steps = [ORKStep]()

    var consentDocument = ConsentDocument
    let visualConsentStep = ORKVisualConsentStep(identifier: "VisualConsentStep", document: consentDocument)
    steps += [visualConsentStep]

    let signature = consentDocument.signatures!.first as! ORKConsentSignature

    let reviewConsentStep = ORKConsentReviewStep(identifier: "ConsentReviewStep", signature: signature, inDocument: consentDocument)

    reviewConsentStep.text = "Review Consent!"
    reviewConsentStep.reasonForConsent = "Consent to join study"

    steps += [reviewConsentStep]

    return ORKOrderedTask(identifier: "ConsentTask", steps: steps)
}
```

1.1 Audio task:

This activity emulates your voice by recording it at the bottom of your iPhone. This activity is used to check the condition of your audiometry system. A pre decided sentence is provided to the user to read aloud and his/her words are recorded.
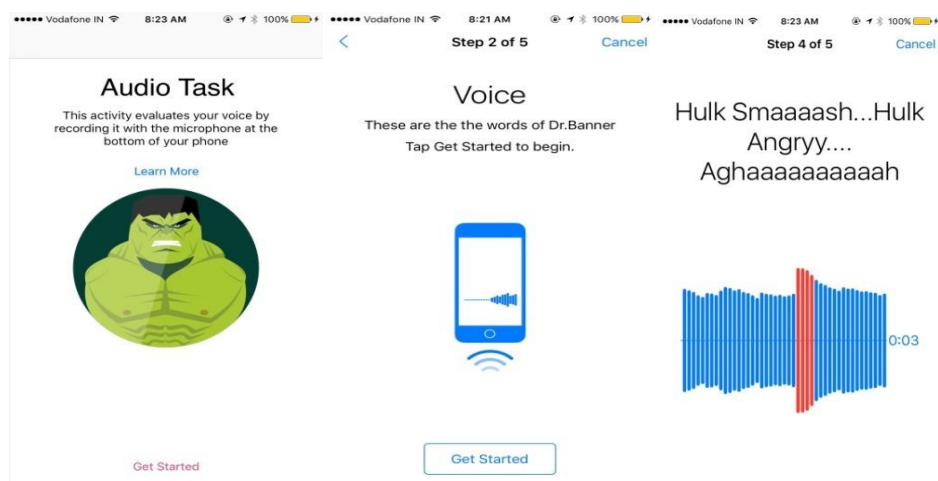
```
1  import ResearchKit
2
3  public var MicrophoneTask: ORKOrderedTask {
4      return ORKOrderedTask.audioTaskWithIdentifier("AudioTask",
           intendedUseDescription: "A sentence prompt will be given to you to read.",
           speechInstruction: "These are the the words of Dr.Banner",
           shortSpeechInstruction: "Hulk Smaaaash...Hulk Angryy.... Aghaaaaaaaaaah",
           duration: 8, recordingSettings: nil, options: nil)
5  }
```

1.2 Balance and Gait:
This activity measures your gross motor skills. It measures your gait and balance as you walk straight and stand still. This is done using the accelerometer, gyroscope and pedometer.
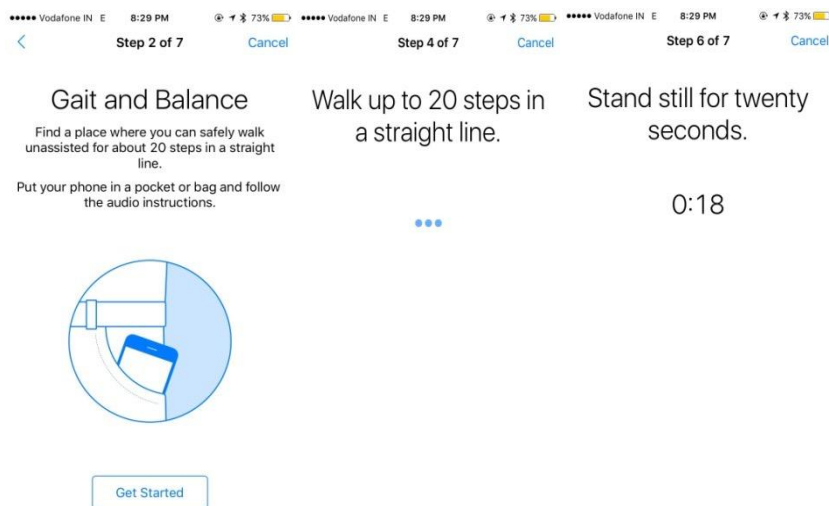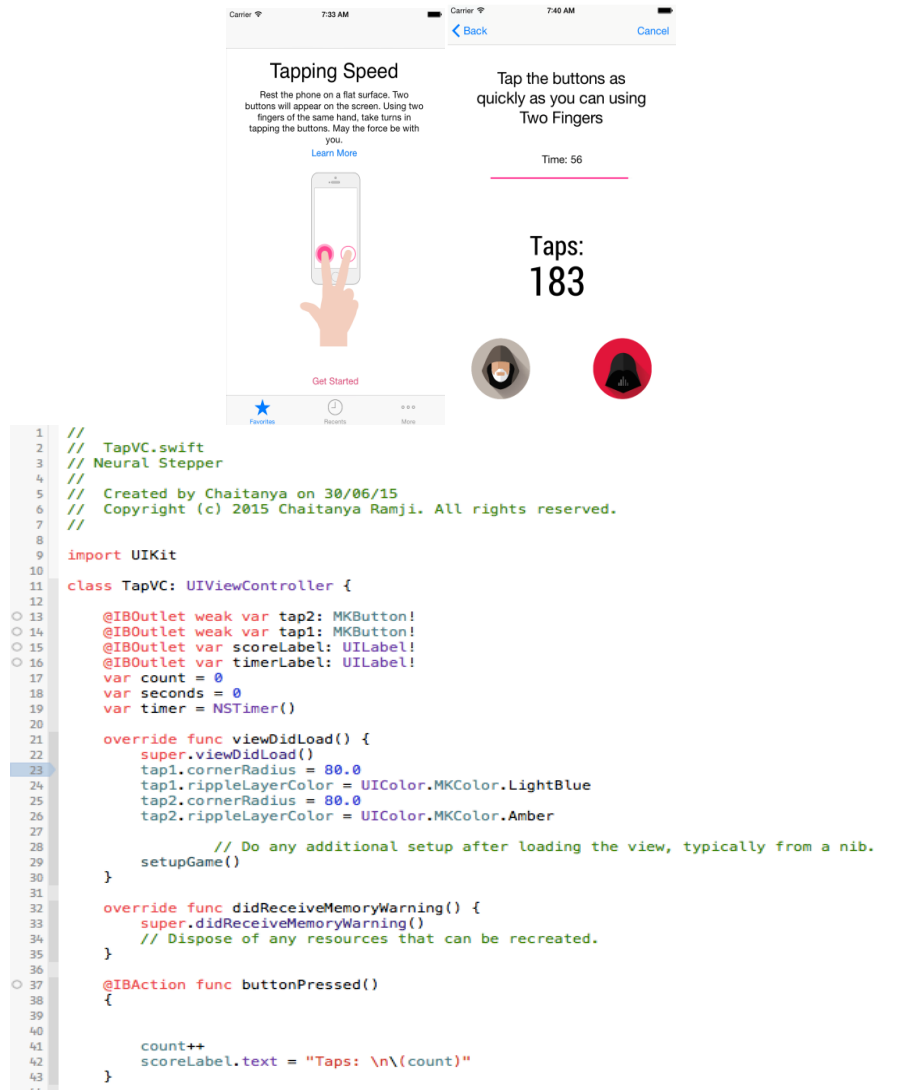


```
1  //
2  // ShortWalk.swift
3  // Neural Stepper
4  //
5  // Created by Chaitanya on 05/07/15.
6  // Copyright (c) 2015 Chaitanya Ramji. All rights reserved.
7  //
8
9  import ResearchKit
10
11 public var ShortWalk: ORKOrderedTask {
12     return ORKOrderedTask.shortWalkTaskWithIdentifier("Short Walk", intendedUseDescription:
           "This activity is intended to monitor your motor skills and fitness",
           numberOfStepsPerLeg: 20, restDuration: 20, options: nil)
13 }
```

1.3 Two Finger Tapping:
This activity too measures motor skills. This activity however is concerned with just the hand. Two buttons appear on the screen. The user has to alternatively press the buttons on the screen using two fingers of the same hand.

```
1    //
2    //  TapVC.swift
3    //  Neural Stepper
4    //
5    //  Created by Chaitanya on 30/06/15
6    //  Copyright (c) 2015 Chaitanya Ramji. All rights reserved.
7    //
8
9    import UIKit
10
11   class TapVC: UIViewController {
12
13       @IBOutlet weak var tap2: MKButton!
14       @IBOutlet weak var tap1: MKButton!
15       @IBOutlet var scoreLabel: UILabel!
16       @IBOutlet var timerLabel: UILabel!
17       var count = 0
18       var seconds = 0
19       var timer = NSTimer()
20
21       override func viewDidLoad() {
22           super.viewDidLoad()
23           tap1.cornerRadius = 80.0
24           tap1.rippleLayerColor = UIColor.MKColor.LightBlue
25           tap2.cornerRadius = 80.0
26           tap2.rippleLayerColor = UIColor.MKColor.Amber
27
28                   // Do any additional setup after loading the view, typically from a nib.
29           setupGame()
30       }
31
32       override func didReceiveMemoryWarning() {
33           super.didReceiveMemoryWarning()
34           // Dispose of any resources that can be recreated.
35       }
36
37       @IBAction func buttonPressed()
38       {
39
40
41           count++
42           scoreLabel.text = "Taps: \n\(count)"
43       }
44
```

1.4 Spatial Span Memory:
        This test is used to measure your short term spatial memory. This is done by asking the user to follow the pattern of lit up Superhero logos and repeat the same. This activity is adaptive and adapts according to the users' results.
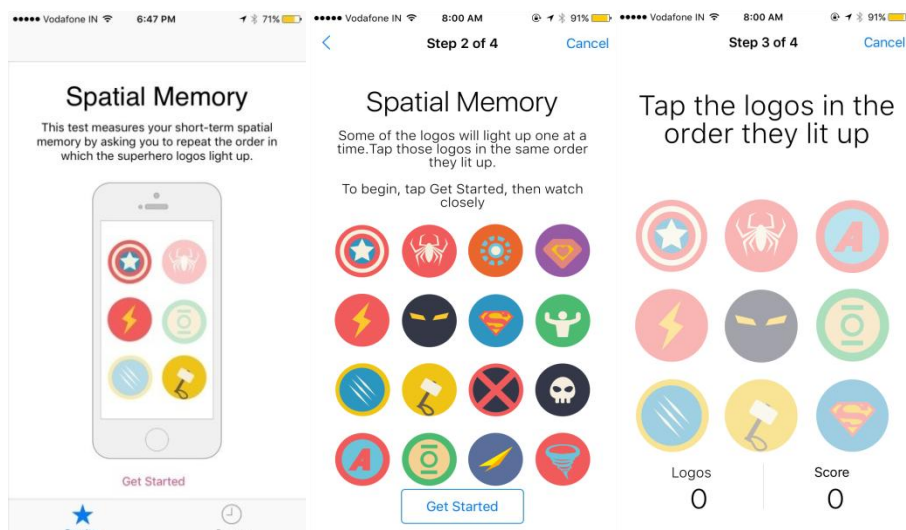
```
1   //
2   //  Spatial.swift
3   // Neural Stepper
4   //
5   //  Created by Chaitanya on 03/07/15.
6   //  Copyright (c) 2015 Chaitanya Ramji.| All rights reserved.
7   //
8
9   import UIKit
10
11  class Spatial: UIViewController {
12
13      override func viewDidLoad() {
14          super.viewDidLoad()
15          // Do any additional setup after loading the view, typically from a
16      }
17
18      override func didReceiveMemoryWarning() {
19          super.didReceiveMemoryWarning()
20          // Dispose of any resources that can be recreated.
21      }
22      @IBAction func Cancel(sender: AnyObject) {
23          if((self.presentingViewController) != nil){
24              self.dismissViewControllerAnimated(true, completion: nil)
25              println("cancel")
26          }
27      }
28
29
30  }
```

All the results are collected and are compared in contrast to healthy individuals as well as set stipulated limits under medical norms. On the basis of all the test results the user may or may not be diagnosed with a particular disease or syndrome. All data gathered in the process is encrypted by SHA1 encryption and is completely anonymous. No data is distributed without the patients consent. The user at any point of time has the right to withdraw from the research.

2. Website:
The doctor has to register himself/herself to view the results of the tests performed by the patient and provide a report for the same.After logging in,the doctor is provided with the list of patients under him.On writing the patients name,the results of the test of that particular patient is provided.

name	age	sex	blood
sow	20	F	A+
san	21	F	A+

Enter patients name
submit
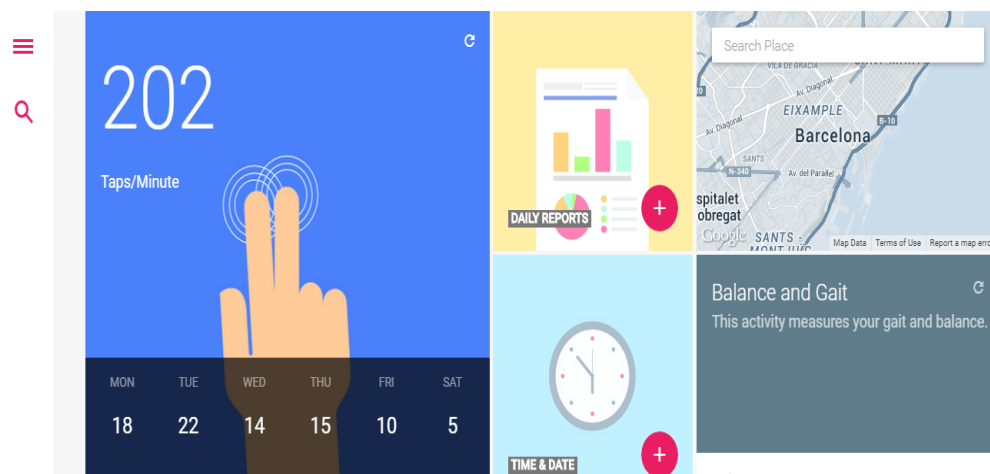
VIII.   Conclusion

Based on the research conducted,following conclusion can be drawn:

1. Using the iOS application,the number of visits to a doctor can be reduced by the patient by performing the preliminary tests through the application.
2. The report of these tests is provided by the patient via email.

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