Early Stage Detection of Parkinson Disease

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***Abstract*—Parkinson's disease is a chronic neurodegenerative condition that demonstrate the progressive loss of the ability to correlate movements mainly occurs in the elderly. For the purpose of monitoring tremors in Parkinson's disease, a system has to be designed and developed. For coordination of movements, people with Parkinson's, deprive of a chemical called dopamine which behaves as the messenger between the brain parts and the nervous system .Detecting Parkinson's disease is a very arduous task as there is no evidence currently present to do this. Therefore, the main intention of our work is the designing of a system for recognizing Parkinson's disease at an initial stage. An Android application is being designed that allows the status of PD patients to be assessed based on the tests found on the Unified Parkinson's Disease Rating Scale approved by the Movement Disorders Society (MDS-UPDRS).**

Keywords- Neurodegenrative, Tremor, Dopamine, Android application.

I. Introduction

In Parkinson's disease the central nervous system of the patients brain is effected. the central nervous system of the patients. Because of this, there is a direct effect on the movements of the body. The motor neurons gets damaged. It slowly starts with tremors. At the initial stage, it occurs only in one hand. It gets worse with the ongoing time. Although, there is no cure for Parkinson's, medications might improve the conditions slightly.

The method used for detection of Parkinson's disease is performing motor tasks manually as mentioned in MDS-UPDRS scale which is the Movement Disorder Society (MDS)- sponsored new version of the UPDRS. . The Task Force for Rating scales in this disease, formulated this. The MDS-UPDRS scale has a disadvantage which is the requirement of a trained clinician while performing the tasks [9]. According to the paper "Using wearables to assess bradykinesia and rigidity in patients with Parkinson's disease" , a focused, narrative review of the literature, the reliability of these methods lie on the final statement given by the clinician [14]. This may lead to intra and inter-rater changeability. This also reduces the accuracy of assessments in both clinical and research settings. Next is that according to the website "Parkinson's Foundation", the most used medication for Parkinson's disease is Levodopa. Common Side Effects of this medicine is lowering of blood pressure, sickness, confused behaviour, dyskinesia. Hence there is a need of system which discards this disadvantages [8].

There are no specific tests to detect PD. Along with tests like MRI, ultrasound, etc. Medication gives levodopia carbidopia, a Parkinson's drug. A dose sufficient to show the benefit. The confirmation of the presence of this disease is recognised by the slow improvements with the usage of this drug. Sometimes , in order to diagnose this disease , it takes lots of time [3]. The recommendation of doctors is then, a regular follow-up appointment with a neurologist who has training in movement disorders so that he can assess the condition and symptoms for this purpose.

Due to these problems that exist, our goal is to develop a system that helps detect PD mainly focusing on symptoms Tremor and bradykinesia (slowness of movement) at first stage without the use of drugs that ultimately has a lot of side effects. Also, making our system profitable is one of the main goal. The system that will be designed by us can be used by a common man thus reducing the regular check-ups of the patient to hospitals.

So, the goal is to develop a system to detect the existence of Parkinson's disease at an early stage. This system must be profitable. Everyone should be able to use this system, which reduces the number of visits to the doctor.

The rest of the paper is organized as follows: In section 2, the literature survey performed while Parkinson;s disease research was done. In section 3, the software system design used during the process of system used to detect PD is explained. Section 4 represents the implementation details of the designed system. Finally all the results are given in section 5 and the conclusions drawn from this work are presented in section 6.

II. Literature Survey

Parkinson's Disease (PD) is a disease that causes neurodegeneration. Within the substantia nigra there is a reduction of dopaminergic cells which leads to the cause of this disease. Mainly, Parkinson's disease affects the functions which causes motor movements.The major of the PD are bradykinesia, rigidity, resting tremor and loss of balance. the bradykinesia causes slowness of movements. Rigidity causes stiffness or inflexibility of muscles [10]. Resting tremor is a most common symptom while early stage detection of PD. The frequency of occurrence of these tremors is 3 Hz to 7 Hz. Overall 75 percent of PD patients has this symptom. The moment of thumb and index fingers with each other is significant feature of

resting tremor. This tremor may extend to fore arm, elbow and arm. The neurologist subjectively evaluates and diagnoses the patients who are being suffered from this disease by checking the movement disorders, based on the Unified Parkinson's Disease Rating Scale (UPDRS).

There is a revised version of the UPDRS scale which is called as MDS-UPDRS scale. The license and ownership of this is with the International Parkinson and Movement Disorder Society (MDS) .For the usage of this scale, there is requirement of permission . On submitting a permissions request form, this can be done . The submission of the request has to be done on the MDS website.

The MDS-UPDRS consists of four parts:

- Part I includes non-motor experiences of daily living
    1) It is concerned with the behavioural changes that are assessed by the investigators with the help of information provided by patients or caregivers.
    2) The completion of this part is done by the patient itself independent of investigator
- Part II includes motor experiences of daily living
- Part III includes motor examination
- Part IV includes motor complications

However, for ensuring whether all the questions are answered clearly, this sections can be reviewed by the rater. Also any perceived ambiguities can be helped by rater . The design of part II is just like part IB, a self-administered questionnaire. Inspite of this, for ensuring completeness and clarity, review of investigator can be done. There are no "ON" or "OFF" rating to the official versions of PartIA, Part IB and Part II of the MDS-UPDRS. but, if "ON" and "OFF" and ratings are required to the individual programs, the same questions can be used separately. The instructions to the rater for completing and demonstrating to the patient is given in Part III. It is completed by the rater. The instructions which are to be read to the patient and also the one for rater are mentioned in Part IV. The completion of this is done by integrating the information derived by patients and the clinical observations by rater [9]. The Bradykinesia Akinesia Incoordination (BRAIN) test has been shown to be a reliable software method for identifying symptoms of neurological illness, such as Parkinson's disease and cerebellar dysfunction [1]. The Unified Parkinson's Disease Rating Scale (UPDRS) and other PD severity scales have also been compared using the alternative finger tapping measure [2]. The routine neurological examination includes sequential finger tapping to detect bradykinesia, which is described as "slowness of initiation of voluntary movement with gradual reduction in speed and amplitude of repetitive motion" [16]. The authors created a system consisting of tremor sensing device for detecting parkinson's disease which works with android application that tracks the tremors in upper limbs. The tremors at back of patients hand is the area where most of the tremors can be sensed [10]. These therapies include pharmacological regimens (the most critical of which is levodopa) and neurosurgical methods for later disease (e.g., deep brain stimulation; Dams et al. 2011, 2013; Tomaszewski and Holloway 2001) [17]. Chronic disorders with a high prevalence and high medical costs, such as multiple neurodegenerative diseases, including Parkinson's disease, have piqued the attention of health care professionals.

III. System Design

System software design is done using Android software. An application has been developed for detecting Parkinson's disease. Android app the programs are written in Java. This application will consist of several tasks. Tasks developed focuses on detecting symptoms of tremor and bradykinesia. Some of them the tasks included are the following:

- Hand Tremor
- Foot Tremor
- Fimger Tapping
- Spiral Drawing

All the gyroscope and accelerometer values obtained by performing the above tasks will be stored in the database. These values as well as the values obtained by the hardware part of the system will then be evaluated. The results thus obtained after evaluation helps to detect the Parkinson's disease.

TASK 1: HAND TREMOR

Parkinson's tremors are rhythmic, at rest, asymmetrical. The tremors of Parkinson's disease often start in the fingers or hands with what is called a pill-rolling motion. This test focuses on hand tremors.

Directions:

- In this Balance test you stand still for 30 seconds.
- Posture of this test asks you to hold the smartphone with stretched hands for 30 seconds.
- There is a build in counter that increases when any movement is detected.

Detection :

The value will be compared with the default value i.e the counter value of non PD person. If the value is greater than the default value then the patient may have this disease.

TASK 2: FOOT TREMOR

For people with Parkinson's Disease, walking may be difficult (PD). Since the disorder affects a part of the brain that regulates movement, this is the case. As the disease progresses, all activities, including walking, may become slower and smaller. People with PD can develop a stiff appearance as they walk slowly with their chest bent forward, with short quick "shuffling" steps, and with less arm and body movement. People with Parkinson's disease also experience "freezing" episodes, in which they become "stuck" and unable to take a step or continue walking [18].

Direction :

- Walk 30 yards in front
- The examination It can be done at your preferred walking pace or at the highest possible speed.

- To avoid influencing the patient's pace, the test administrator will walk at least a half step behind the patient.
- The gait of the patient is observed during this part of the examination. The patient should walk back and forth several times, preferably in a corridor at least 10 feet long, to maximise the likelihood of picking up any anomalies that might be present.

Detection :

The value will be compared with the default value i.e the counter value of non PD person. If the value is greater than the default value then the patient may have this disease.

TASK 3: FINGER TAPPING TEST

The finger-tapping test (FTT) is a neuropsychological assessment of motor function, especially motor speed and lateralized coordination. This exercise assesses the pace at which you tap each hand. Slowing of movement, lack of amplitude, and delays in finger taps are all signs of 'bradykinesia,' a slowing of movement that is one of Parkinson's disease's most common symptoms [19].

Directions:

- The patient is advised to tap the index finger on the thumb as quickly and as large as possible in finger tapping..
- This means that before tapping the two fingers, the patient can try to differentiate them as much as possible.
- Make sure to test both the right and the left side.

Detection : The counter value will be stored in the database. After comparing all the result of the activites, final result will be displayed

TASK 4: SPIRAL DRAWING Patients with Parkinson's typically write and draw at a slow pace. Patient with PD may notice shakiness when they're holding their hands up. As a result, handwriting and spirals tend to be smaller and tightly bunched. The slower speed and smaller size of the writing movements signal a motor symptom associated with Parkinson's. Spiral tests are typically a better diagnostic tool than using handwriting. Test also allows the neurologist or physician to better determine the severity of the tremor.

Directions :

- A test that involves drawing a spiral on a piece of paper may be used to detect Parkinson's disease in its early stages.
- Both are helpful in identifying the disease, which induces muscle rigidity and trembling.
- In the detection process, patient is told to draw spiral drawing coinciding with the template which is already present in the application.

Detection : After the drawing, the clinician with whom the patient is present, must check whether the drawing overlaps with the template. Accordingly, points will be provided which will be useful for the detection.

IV. System implementation

In the last section, hardware and software design of the system was discussed. By using these designs, the system is implemented. A survey is conducted, in which people from different age groups are told to perfrom the tasks. Based on the results of their tasks, a threshold value ranging from 0 to 5 is decided. This range is decided using MDS-UPDRS scale.

Algorithm of the tasks in the android application is mentioned below

1) Application starts with the basic information of the disease.

2)TASK 1: HAND TREMOR

- Declare all the necessary variables such as sensor, textviews, sensor services required
- Declare database variable
- Initialize all the sensors, textviews, buttons.
- Writing OnClickListeners for the buttons Start, Stop, Reset and Submit.
- Under OnClickListener for start button, describe a function onClick which will start the functioning of the accelerometer sensor on clicking the button.
- Under OnClickListener for stop button, describe a function onClick which will stop the functioning of the accelerometer sensor on clicking the button.
- Under onClickListener for reset button, describe a function onClick. In this function, write a code for resetting the counter value.
- Under onClickListener for submit button, describe function onClick which will add the counter value obtained on performing the task to the database.

3) The above algorithm is same for both hand tremor and foot tremor task.

4) TASK 3: FINGER TAPPING TEST

- Declare all the necessary variables such as sensor, textviews, sensor services required.
- Declare database variable.
- Initialize all the sensors, textviews, buttons.
- Writing OnClickListeners for the buttons Start, Stop, Reset button for timer, tap1 and tap2 button for counter as well as reset button for counter and Submit button.
- Under OnClickListener for start button, describe a function onClick which will start the functioning of the accelerometer sensor.

5) TASK 4: SPIRAL DRAWING TEST

- Declare all the necessary variables such as sensor, textviews and buttons required.
- Declare database variable.

- Initialize all the sensors, textviews, buttons for color selection, increasing pen size in order to draw
- Initialize Paint view variable
- In the Paint view java class,
  1) Declare variables for Path which will give the path in which pen is moving and Paint which will give the pen color.
  2) Under canvas object, using canvas.drawPath() command, drawing can be done.
- Write onClickListener for buttons increment, decrement of pen size, selecting the pen color and reset button.

V. Results and Analysis

All the counter values calculated using various sensors in the application, are stored in the database. Patient needs to click the submit button, at the end of every task. Because of this, the result of individual task will be displayed at the end of the application.

For finalizing the range as mentioned in MDS UPDRS, a survey was taken of people having age more than 50. Results of the survey helped us to analyze and set the range. The range is between 0 to 4, each having its own meaning as mentioned below: Here,

0 : No problem

1 : Slight

2 : Mild

3 : Moderate

4 : Severe

Lastly, based on the rating of individual tasks, final rating for the disease is provided. The following figure represents the result page in the application.

Figure 1: RESULTS OF THE TASK

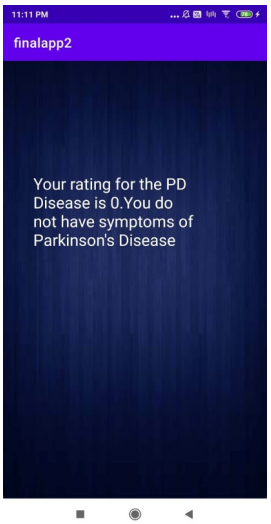

Figure 2: FINAL RESULT OF THE TASK

VI. Conclusion

The system designed has following advantages:

1) Since any medications are not used while detecting using our system, all the side effects of the medications like carbidopia – levodopia are thus discarded
2) Cost effective
3) Less complications involved
4) Time required for detection is less as compared to other systems

Thus using our proposed system, early stage detection of Parkison's disease is possible. This will result in cost effectiveness thus making it an efficient system.

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